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DEPARTMENT OF MINES

GEOLOGICAL SURVEY BULLETIN

No. 13

The Preolenna Coal Field

AND

The Geology of the Wynyard District

BY

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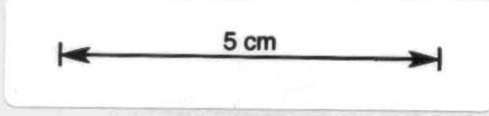

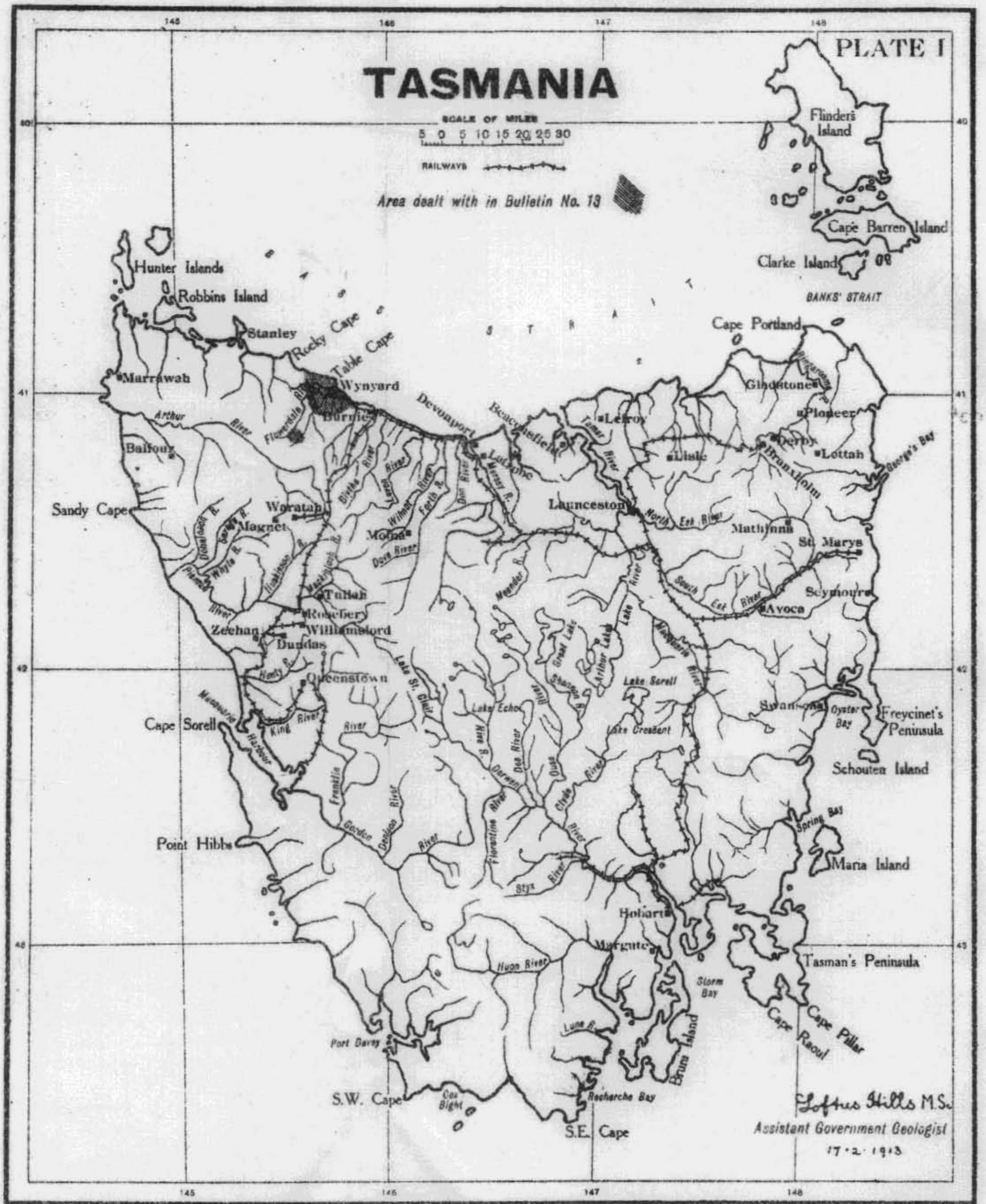

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The Preolenna Coalfield.

I.—INTRODUCTION.

(1)—General.

The following bulletin comprises the results of a geological examination of the district, extending from 11th December to 23rd December, 1912. The area covered, therefore, is necessarily not large, as, in addition to the limited time available, the country is heavily timbered, and frequent patches of horizontal scrub occur, thus making travelling somewhat slow.

The writer, therefore, confined his detailed examination to the country actually included within, or in close proximity to, the coal sections already taken up, and particularly to the coal outcrops which had been discovered up to the time of his visit. The examination of the remainder of the country covered necessarily partook more of the nature of a rapid geological reconnaissance.

Quite sufficient was seen, however, to justify the writer in making certain deductions as to the possibilities of the field as a whole.

The geological survey of this region was carried out with the assistance of the chart of the coal-mining sections issued by the Department of Mines, and the county plan (Wellington No. 3) issued by the Department of Lands. The latter plan needs correction in some particulars. The Jessie River is shown in this plan to be flowing through Pearson's block and a proposed town reserve, whereas in actual fact it touches neither of these areas. The Arthur River Track is also shown in a wrong position, the 9-mile peg being situated within Section 5965-M, and not in the proposed town reserve as indicated in the chart. The writer has corrected these errors, and in the maps accompanying this report the courses of the Jessie River and the Arthur Track have been charted with all the care possible; but in the absence of any accurate trigonometrical survey, their positions must be regarded as approximate only.

(2)—Geographical Position.

The district of Preolenna is on the North-West Coast of Tasmania, and is situated to the south of Wynyard, being, in a direct line, 13 miles distant therefrom.

The coal sections are situated on the northern slopes of the Campbell Range. The more important coal outcrops occur on the western side of the deep precipitous gorge of the Jessie River, which drains part of the northern fall of the Campbell Range, and flows into the Inglis River at a point about 3 miles distant from the present mine workings.

The Arthur River Track strikes the Arthur River at 17 miles from the end of the Calder-road, and is thus 8 miles distant in a general southerly direction from the 9th mile.

Mt. Bischoff lies to the south-south-east, distant about 10 miles.

II.—THE HISTORY OF THE FIELD AND PREVIOUS LITERATURE.

Mr. **A.** Montgomery, then Government Geologist of Tasmania, visited the Wynyard district in 1895, and his report, entitled "The Mineral Fields of the Gawler River, Penguin, Dial Range, Mount Housetop, Table Cape, Cam River and portion of the Arthur River Districts"(1), deals in part with the area surrounding Wynyard and the southern side of the Campbell Range. In this report, when discussing the geological age of the "Wynyard Formation" and the origin of pieces of cannel coal found on the banks of the Inglis River and Seabrook Creek, he states: "It is possible that the Wynyard formation is the base of the coal measures, and that high up in it the fossiliferous beds and the coal-seam may yet be found. Both for scientific and commercial purposes search for them is desirable."

No notice seems to have been taken of this very accurate prediction, no prospecting whatever being attempted, and, as has happened in the case of many valuable mineral deposits, the actual discovery of the coal-seams was made quite accidentally. In the year 1901, six years after the publication of the above prediction, Messrs. Lowrie and Harris, whilst engaged cutting the track from the Calder-road to the Arthur River, on descending a gully near the 9th mile to obtain water, observed a seam of coal outcropping in the bed of the creek. This discovery encouraged prospecting in the neighbourhood, and subsequently the outcrops were traced for about a mile and a half back towards the 7th mile.

In August, 1901, Mr. G. A. Waller, then Assistant Government Geologist, visited the locality, and the results of his examination are included in his report entitled "Report on the Recent Discovery of Cannel Coal in the Parish of Preolenna."(2)

Subsequently the "North-West Coal and Shale Company, No Liability," was formed and Mr. Austin L. B. Brain was employed to prospect and explore the country, and after tracing and mapping the various exposures, that gentleman reported that a considerable tonnage was assured, and that if the sections were near to the coast

(1) Report of the Secretary for Mines, 1895-6.
(2) Report of the Secretary for Mines, 1901-2.

or a railway he would not hesitate to recommend the commencement of work on a fairly extensive scale.

At that time the only communication with Wynyard was by means of the Arthur pack-track, which, after starting from the end of the Calder-road (itself $9\frac{3}{4}$ miles from Wynyard), plunges 500 feet down into the valley of the Calder, to rise to the same height on the other side of the valley. It then drops, and again rises another 500 feet across the Inglis Valley, whence with occasional undulations it rises to the 9th mile. It was found impossible to work the coal-seams under these conditions, and the company suspended operations.

In March, 1903, Mr. Twelvetrees visited the locality, to report on the field in general, and in particular on the possibility of the seams being picked up nearer the coast, and the results of his investigations are contained in "Report on Kerosene Shale and Coal Seams in the Parish of Preolenna," dated at the Government Geologist's Office, 15th July, 1903.

Its isolated position and the lack of transport facilities caused the field to lie idle for about seven years, until in 1911 the present owners started work in a more systematic manner than had previously been attempted.

Thus, after lying practically untouched for 11 years after its first discovery, the field is only now having the attention paid to it which every indication seems to justify.

The three reports by officers of the Geological Survey, mentioned above, have been of material assistance to the writer in his present investigations, and much of the information contained therein is embodied in the present report.

III.—PHYSIOGRAPHY.

(1)—TOPOGRAPHY.

The district is one which shows typical youthful topography. The higher crests and ridges are remnants of a former peneplain, which the writer has recognised as extending from Table Cape to the top of the Campbell Range.[4] The whole area has been uplifted in Post-Tertiary times, and all the streams, having thus become rejuvenated, have started upon a new cycle of erosion, which has advanced sufficiently to produce a succession of deep precipitous gorges.

The main coal outcrops are approximately 1200 feet above sea-level, while the highest point in the immediate neighbourhood, namely, the crest of the ridge to the south-east of the present mine workings, is 1530 feet.

The two most important rivers are the Flowerdale and Inglis, whilst the Jessie, which is a tributary of the latter, is also a considerable stream. The Flowerdale and Inglis Rivers unite at a point about 5 miles above the debouchure of the latter. They all three take their rise in the Campbell Range, which in this region forms the watershed between the river systems flowing into Bass Strait, and the Arthur River drainage system which flows westwards to the Southern Ocean. The Jessie flows through a V-shaped gorge (about 900 feet deep at the 7th mile) for about 5 miles in a general north-easterly direction before joining the River Inglis. The creeks which drain the western side of this gorge flow into the Jessie—Nine-mile, Fault, Spirifer, and Fenestella Creeks flowing directly thereto, while Preolenna,[5] Tangle, and North-Eastern Creeks all join a larger creek, which the writer has designated as Junction Creek, and which, flowing in an easterly direction, joins the Jessie in the south-east corner of Section 5704-M.

The divide between the Jessie and Flowerdale drainage systems is a narrow one, and the crest of this watershed is almost exactly followed by the Arthur River Track from the 6th to the 10th mile. The present road from Wynyard to the coal sections follows this dividing-ridge southwards from a point near the Flowerdale railway-station.

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(4) *Vide* p. 61.

(5) This creek is shown in Mr. Twelvetrees' report as Camp Creek, but in order to avoid confusion with Camp Creek at Wynyard, the writer has assumed the responsibility of renaming it.

Another notable topographical feature of this region is the Diabase Range. This is a long narrow ridge, composed of diabase, situated east of the Flowerdale, and running almost due north and south from north of Section 4969-M to Section 5965-M. Both flanks of this range are drained by the Flowerdale, the creeks on the eastern side flowing either north or south, and, bending westwards around either end of the ridge, ultimately flow into the main stream.

The only development of level country of any extent within the coal sections is on the north side-line of Section 4967-M, and extends to the south thereof. The general elevation is 1160 feet above sea-level.

The geological structure seems to have exerted a marked effect on the development of the topography in two particulars. In the first place, it is very noticeable that the fall on the east side of the Arthur Track is much more rapid than that on the western side. This is undoubtedly due to the fact that the Jessie River, flowing in the direction of the strike of the Permo-Carboniferous beds, has worn its way through the overlying harder sandstones to the relatively soft mudstones beneath. The softness of these mudstones has hastened the rate of erosion, which has also been increased by the undercutting of the beds along the planes of stratification. The western slope is in the direction of the dip of the strata, and it is a well-established fact that this condition lowers the rate of erosion.(7) In the second place, the Diabase Range has been developed as a result of its superior hardness. It is in fact a "hill of circumdenudation."(8)

(2)—Transportation Facilities.

Naturally, this question of communication with other parts of Tasmania is one which is of vital importance to the prospects of this field as a coal-producing district. The chief reason for the stagnation of the field has been the great difficulty of access.

As mentioned previously, the only means of communication with Wynyard, and therefore with the rest of the island, was by means of the Arthur River pack-track. It was found impossible to develop the field in a proper manner with a track of this character as the only means of obtaining supplies, &c. A far better grade for this track

(7) *Vide* Chamberlin and Salisbury's "Geology," Vol. I., pp. 125-127.
(8) *Vide* Sir A. Geikie's "Text Book of Geology," Vol. II., p. 1381.

could, however, have been obtained by following the ridge between the Inglis and Flowerdale from near their point of confluence. This is the route which is followed by the present road. This road is 19 miles in length, measured from the Wynyard post-office to the loading-station above Preolenna Creek. It is metalled to a point about three-quarters of a mile to the south of Mr. A. Armstrong's farm, which is about 9 miles from Wynyard. The remaining 10 miles have been opened up during the past 12 months, the forming being just about completed, and it is hoped to complete the metalling of the worst portions at least during the present summer. At the time of the writer's visit there were several very bad boggy parts, caused by heavy continuous rains, but with continued dry weather these will harden sufficiently to allow a bullock-dray to pass. Even in the wet condition of the road, however, a spring-cart made several trips from Wynyard to the loading-station. The grade of the recently-formed 10 miles is very good, but the other 9 miles are certainly of rather a heavy grade, particularly the hill known as Alexander's, which is most exceptionally steep.

It has recently been proposed to construct a Government tramway to the Preolenna district, and part of the writer's investigations were directed towards the location of a possible tramway route. He was fortunate, therefore, while in the district, in coming in contact with Mr. P. Doyle, the Government Inspector of Roads for the Wynyard district, who has a thorough knowledge of the whole region. Mr. Doyle has located a route for a tramway which he has traversed completely, and has indicated this route to the writer. There is no doubt that this route is the most suitable for access to both the coal deposits and the timber, as there are apparently no great difficulties to be overcome in construction work. Two general routes had previously been proposed, but both of these have very serious drawbacks. One general route was to have followed the valley of the Inglis until the junction with the Jessie is reached, but it is from this point onwards that almost insuperable difficulties present themselves. The other general route follows the Flowerdale Valley, and this is a better route than the former, but the northern portions of the valley consist of very rugged country, which would entail the surmounting of some difficulties. Mr. Doyle's proposal really utilises the easier portions of these two routes, and the result is one of good grade, and between 13 and 14 miles in length. The only problematical portion of this route seemed to be in connection with the negotiation of the ridge between the Flowerdale and Inglis Valleys. However, by crossing this ridge through the centre of T. B. Margetts' property a good grade from one valley to the other can be obtained. This route is marked in the general map accompanying this report. Its southern terminus, if planned to serve the coal and timber resources, would be somewhere near the centre of Section 4967-M, and its northern terminus the present railway-station at Flowerdale. From this southern terminus the line could be extended very easily, as regards the existence of a good route, to open up the rich agricultural and timber land to the south-east. This proposed extension is also indicated on the general map.

(3)—The Relation of Topography to Mining.

The greater number of the coal outcrops have been found outcropping in creek-beds, and the liberation and subsequent removal down the streams of loose pieces of coal from these occurrences has not infrequently brought about the discovery of a coal-seam at a higher level. Occasionally coal-seams occur in the face of the cliff which forms part of the western side of the Jessie Gorge.

Although the district is essentially one of high relief, it does not lend itself in a perfectly ideal fashion to mining by the adit system. This is the direct result of the topographical features, combined with a high angle of dip of the coal-seams.

As mentioned previously, the main coal outcrops occur on the western side of the Jessie Gorge, about 50 feet below the Arthur Track. The seams are dipping at an angle of 14° to the west. An adit driven westwards into the hill, which would cut the seams in a reasonable distance, would not open up a very great amount of coal which could be worked from the rise. Another drawback which results from working by means of such an adit is due to the fact that the most convenient tramway terminus will be situated on the slope of the hill towards the Flowerdale Valley. This would necessitate the raising of the whole output to the top of the ridge, and subsequently lowering it to the tramway.

An adit driven eastwards from some point on this westerly slope—the lowest point of which, namely, Main Creek, is 115 feet below the level of the tunnel at Preolenna Creek—would have to be extended some considerable distance before cutting the coal-seams. When cut by such an adit the greater portion of the coal would have to be worked to the dip and hauled to the adit-level. This, however, is not altogether a disadvantage, when we consider the aid to ventilation which this system of working would bring about.

It is certain, however, that although the conditions are not ideal for working by means of adits, yet mining can be carried on far more cheaply and conveniently than would be the case if shafts were necessary. It would seem most advantageous, therefore, to continue the present adit at Preolenna Creek in its present direction until it emerges at the surface on this western slope, about 800 feet from the present end and at a point slightly above the proposed tramway.

(4)—Rainfall and Water-supply.

No meteorological observations have been made in this district, and consequently no definite pronouncement can be made as to the actual amount of the rainfall. There is one fact certain, however, and that is, that the annual rainfall is some considerable amount in excess of that at Wynyard, which in 1911 totalled 37 inches. Apparently, this region, having an elevation of from 1500 to 1800 feet above sea-level, shares the heavy rainfall which is so characteristic of the West Coast generally. The nearest meteorological station to which the rainfall of Preolenna most probably approaches is Waratah, which in 1911 had an aggregate fall of 83·97 inches.

The high relief of the region, however, brings about a quick return of this rainfall to the sea, and consequently a few weeks of dry weather causes a marked falling-off of the water-supply away from the main streams, and especially near the tops of the ridges. The present site of the mine workings at Preolenna Creek is only 50 feet below the top of the ridge in this locality, and consequently the water-supply is limited, and in the summer almost completely fails.

On the lower ground towards Main Creek, where in the writer's opinion will be the future site of the workings, a plentiful and apparently unfailing supply of good water is assured.

IV.—GENERAL GEOLOGY.

A.—IGNEOUS ROCKS.

(1) *Diabase.*

This is the basic igneous rock which is almost invariably found intruded into the coal measures of Tasmania, whether Permo-Carboniferous or Jurassic. The geological date of the intrusion is generally accepted as being at the close of the Mesozoic era.

The only occurrence in this region is the Diabase Range, which is wholly composed of this rock, the superior hardness of which is the direct cause of the existence of the range. This rock-type apparently closely resembles the ordinary diabase of our island, and no detailed description is necessary for purposes of this report.

(2)—*Basalt.*

This occurs as a sheet of lava covering several portions of this area. It at one time most probably formed a continuous sheet over this region, but has since been partly removed by denudation. There is only one patch actually within the coal sections, this being situated in the northern half of Section 5704-M. Here it is lying directly on the Permo-Carboniferous mudstones. On the southern side of the Jessie, on A. A. Harnett's block, basalt occurs overlying Tertiary clays and lignite, whence it spreads southwards and eastwards, forming a capping to practically the whole of the Campbell Range.

At no place observed by the writer does the basalt appear to be very thick, the occurrence in this locality partaking of the character of a rather thin lava-flow, which was outpoured in the Tertiary era, and covered a more or less denuded land-surface.

At the bottom of the Jessie Gorge loose boulders of basalt occur, but these have undoubtedly been shed from the neighbouring heights.

The rock is the normal olivine-bearing variety so common throughout Tasmania, and especially in the northwestern portions of the State. By its decomposition it has given rise to the phenomenally rich chocolate soil so much sought after by agriculturists.

B.—SEDIMENTARY ROCKS.

(1)—*Permo-Carboniferous.*

These constitute by far the most important development of sedimentary rocks in this region, and, together with the lower members of the system so typically represented at Wynyard,(9) form as complete a series as exists anywhere in Tasmania. They occur practically throughout the whole area, and where not actually shown at the surface, are protected by only a relatively thin covering of Tertiary basalt.

The following are the subdivisions of this system as represented in this district:—

F. Yellow to reddish-brown sandstones, unfossiliferous........ ... 550′

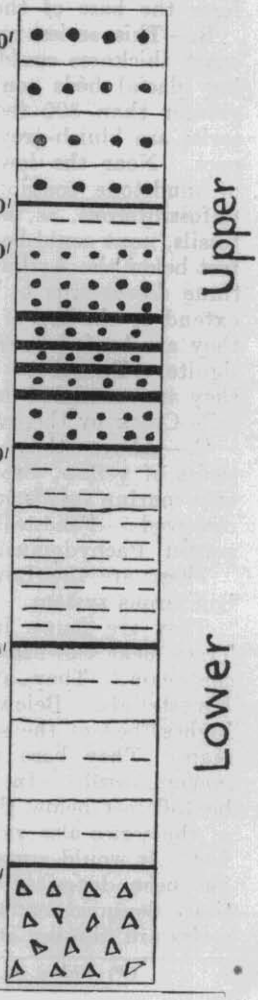
E. Sandstone, pebbly sandstone, and mudstone, with marine shells. 50′

D. White, yellow, and black sandstones, with coal-seams .... 140′

C. Mudstones with marine fossils... 140′

B. Blue-grey mudstone, with bands of mudstone-conglomerate, unfossiliferous .... over 300′

A. Glacial conglomerate.............. 1220′



(9) *Vide* p. 63.

5 cm

A.—These are the beds of conglomerate, glacial till, mudstone-conglomerate, and mudstone which are strongly developed at Wynyard, and will be described when dealing with the geology of that district.[10] The writer did not actually see an occurrence of this series at Preolenna, but both Mr. Montgomery[11] and Mr. Waller[12] record their occurrence, both in the upper reaches of the Inglis River and in the Arthur River Gorge. These beds form the base of the Permo-Carboniferous in Tasmania.

B.—This series rests on the basal glacial beds. The exact thickness could not be ascertained, as the underlying glacial beds could not be observed; it is, however, greater than 300 feet. The mudstones constituting this series are bluish-grey in colour, and very dense and compact. Near the lower limit observed a few thin bands of mudstone conglomerate occur. They are apparently unfossiliferous, as, although diligent search was made for fossils, none could be found. They occur from a point 380 feet below the Arthur Track at Preolenna Creek, and continue downwards to the bed of the Jessie. Thence they extend to the top of the eastern side of the gorge, where they are buried beneath the overlying Tertiary clays and lignite. Traced to the south-west up the Jessie River, they are succeeded near the point of confluence with Nine-mile Creek by the overlying marine mudstones.

C.—Above these unfossiliferous mudstones occur a series of yellow, brown, and grey mudstones, which contain marine fossils, among which the following have been observed:—Fenestellidæ, Spirifer, Productus, Aviculopecten, Pachydomus, Eurydesma.

These are the Lower Marine series of the Permo-Carboniferous system.

They are shown in a small side-cutting on the Arthur Track near the 9th mile, about 30 feet below the lowest coal-seam. They are here replete with impressions of Fenestellidæ. Below the workings on Preolenna Creek the highest bed of the series is 40 feet below the lowest coal-seam. They here present an interesting assemblage of marine fossils. In North-Eastern Creek they appear to be 150 feet below the same reference-line. The thickness of the series also varies, being at its maximum about 140 feet. It would appear, therefore, that the overlying series has been deposited on the undulating and perhaps partially denuded surface of these Lower Marine beds. The series are dipping at an angle of about 13° to the west.

(10) *Vide* p. 63. (11) *Loc. cit.* (12) *Loc. cit.*

D.—This is a land and freshwater series, and contains the only coal-seams of the system as developed in this region. The sandstones comprise the greater part of the series. The lowest and highest members consist of a relatively coarse-grained yellowish-brown sandstone, whilst the intermediate beds—about 80 feet thick—which actually carry the coal-seams, are mostly soft, fine-grained, and generally contain mica and some argillaceous material. The colour varies from white through grey to nearly black. This latter colour is due to the large amount of carbonaceous matter impregnating the sediment forming the sandstone. In the tunnel at Preolenna Creek the sandstone is micaceous and argillaceous, and is finely laminated, showing alternating light and dark bands. No definite fossils can be recognised, although numerous indeterminate portions of vegetation are plentiful.

This series is shown on the Arthur Track near the 9th mile, at an elevation of, roughly, 1290 feet above sea-level. The beds outcrop on the western side of the Jessie Gorge, on the eastern face of the hill, continuously from a point 11 chains beyond the 9th mile to the 7th mile, in a direction practically parallel to the Arthur Track. Beyond the 7th mile they plunge beneath the basalt.

What are most probably the same series outcrop in both Coal and Main Creeks, in Sections 5965-M and 4967-M respectively; but it is impossible to see enough here to definitely determine the fact.

E.—Overlying these freshwater beds, occur about 50 feet of pebbly sandstones and brown to white mudstones, the former carrying fossils of Spirifera, Fenestellidæ, &c. They constitute the Upper Marine series.

These beds and those overlying the tasmanite and coal in the Mersey district, and also the Porter Hill beds near Hobart, are undoubtedly geologically cognate.(13) They can be seen on the descent from the Arthur Track to the coal-seams in Spirifer and Fenestella Creeks. They also occur on the western side of the Arthur Track, and about 8 chains distant therefrom in Fossil Creek.

F.—Overlying these Upper Marine beds conformably is a series of unfossiliferous yellowish to brownish sandstones, generally of relatively coarse grain. They are shown on the Arthur Track between the 8th and 9th mile, and continue over practically the whole of the gradually sloping country from this track to the foot of the Diabase Range, against which they abut.

(13) *Vide* Geol. Surv. Tas. Bulletin No. 11, pp. 19 and 49, *et seq.*

The whole of the beds of this system dip at an average angle of about 14° to the west or west-north-west, and the strike is approximately N.N.E.—S.S.W.

The upper members at least seem to have been subjected to lateral compression, which has bent them into slight undulations. The coal-seams form instructive indicator-beds which clearly show this folding. The most extensive fold observed shows a difference in level of 90 feet between the crest and trough, but it is impossible to say exactly how much of this is due to actual folding and how much to the original irregularity of the surface on which the coal was deposited. The amount of folding varies from this amount down to small undulations of 1 or 2 feet. A good example of these very small undulations can be seen in a heading driven on No. 1 seam in the tunnel at Preolenna Creek. The axis of the folds runs about north-west and south-east.

Although this folding seems to be so pronounced, no actual break of the strata can be observed as having taken place in the neighbourhood of the coal outcrops in the Jessie Gorge, but there is evidence of fracturing and displacement nearer the Diabase Range. Some movement within the coal-seams themselves seems to have taken place. This is evidenced by the occurrence of numerous bright polished slickensides in certain seams.(14)

The writer would ascribe the origin of these deformative movements as due to the intrusion of the diabase constituting the Diabase Range, which has compressed and slightly folded the strata in the region generally, and has actually caused a disruption in its immediate neighbourhood.

(2)—*Tertiary*.

There is only one development of this system here. This is shown on A. A. Harnett's block on the south-eastern side of the Jessie Gorge, where a considerable landslip has occurred. Beneath the basalt there is here exposed a bed of soft greasy claystone, light-grey in colour, which is overlaid by a bed of lignite. The clay rests unconformably on blue-grey unfossiliferous Permo-Carboniferous mudstone. The lignite shows very clearly the original structure of the wood; masses weighing up to 3 cwt., representing portions of the trunks of trees, having been liberated by the landslip, are now lying loose on the surface. The elevation is 1500 feet.

(14) *Vide* p. 30.

(3)—*Recent.*

Below North-Eastern Creek, and in the neighbourhood of the confluence of the Jessie River and Junction Creek, there is a belt of flat country not more than 5 chains wide. This is the flood-plain of the Jessie, and is composed of loose gravel and shingle. It continues from this point onwards to the confluence of the Jessie with the Inglis River. Loose pieces of coal occur in this alluvial deposit, which have been shed from the coal sections at higher levels.

(4)—*The Geological Sequence.*

Since this region and that surrounding Wynyard form a physiographical and geological unit, it would seem advisable to discuss the succession of geological events of the combined area rather than of either separately. The reader, therefore, is referred to the discussion under the corresponding heading in the "Geology of the Wynyard District."[15]

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[15] *Vide* p. 68.

V.—ECONOMIC GEOLOGY.

(1)—The Coal Outcrops.

Since the greater number of the outcrops of coal are met with in the beds or in the immediate vicinity of creeks, it seems most advisable, for the sake of clearness, to group the several occurrences under the heading of the name of the particular creek valley in which they are found. These groups of outcrops are indicated by the letters *a*, *b*, *c*, &c., consecutively from south-west to north-east, and the successive outcrops in each group are numbered from bottom to top. The analyses are given in Table I.

(*a*) *On the Arthur Track.*

(*a* 1).—About 11 chains beyond the 9th mile on the Arthur Track a seam of coal is seen where it has been exposed by the uprooting of a large tree. The seam is 15 inches thick as far as can be seen. No work has been done on it. The analysis shows a rather high percentage of moisture and ash, but this is not surprising when we take into account its mode of occurrence. It will most probably improve under cover to a first-class coal. The elevation here is 1294 feet.

(*b*) *Nine-mile Creek.*

(*b* 1).—Outcrops of a seam of coal are shown in cliffs on both sides of Nine-mile Creek which are undoubtedly the same seam. The thickness is 17 inches, the upper 13 inches of which is a clean bright coal, which from its analysis is shown to be high-grade, while the lower 4 inches is a hard stony coal of poor quality. The dip is 20° to the north of west. Both roof and floor are light-coloured micaceous sandstone firmly consolidated. The elevation at these outcrops is 1233 feet.

(*b* 2).—About 25 feet above the former seam are two outcrops of the second seam in this locality. It is 18 inches thick, and is nice-looking coal, which by its analysis is shown to be of first-class quality. The roof and floor are sandstone, but practically no work has been done on it to show the exact character of the strata above and below.

(*b* 3).—About 15 feet higher up the creek is an outcrop of coal very similar to the previous occurrence. The thickness is 9 inches.

ERRATUM

P. 17.—Analysis of outcrop No. *e*3, 2 ft. Bright coal, should read:—Moisture, 1 %; Volatile Hydro-carbons, 47·6 %; Fixed Carbon, 45·9 %; Ash, 5·5 %; Sulphur, nil.

Table I.

Analyses of Preolenna Coals.

No. of Outcrop.	Thickness.		Nature.	Moisture. %.	Volatile Hydro-carbons. %.	Fixed Carbon. %.	Ash. %	Sulphur. %.	Coke.	Analyst.
	ft.	in.								
a1	1	3	Weathered, crumbly coal	15·0	33·0	33·1	18·9	...	Powder	W. F. Ward
b1	1	1	Bright coal, upper portion	10·1	36·3	48·8	4·8	...	"	"
b1	0	4	Stony coal, lower portion	5·3	26·1	31·3	37·3	...	"	"
b2	1	6	Bright coal	1·0	41·7	52·3	5·0	...	Tender	"
c2	1	3	Stony coal	4·4	24·0	37·2	34·4	...	Powder	"
c3	3	6	Carbonaceous shale	5·6	25·4	33·2	35·8	...	"	"
c4	1	6	Bright coal	0·9	41·1	52·5	5·5	...	Firm	"
d2	2	0	ditto	1·3	45·7	48·8	4·2	...	"	"
e1	0	6	Kerosene shale	1·25	67·32	28·51	2·92	1·64	...	J. C. H. Mingaye
e1	0	6	ditto	0·5	75·5	21·0	2·0	1·0	Tender	W. F. Ward
e1	0	6	ditto	...	70·25	28·15	3·6	...	...	F. B. Jackson
e1	0	6	ditto	2·2	65·2	28·5	3·0	1·1	Tender	W. F. Ward
e1	1	2	ditto	1·1	71.6	23·2	4·1	...	Firm	"
e1	0	9	Bright coal	1·27	42·45	51·46	4·82	2·26	...	J. C. H. Mingaye
e1	0	5	Splint coal	0·92	43·40	50·61	5·07	1·92	...	"
e2	0	6	Bright coal	0·4	50·3	44·4	4·9	...	Tender	W. F. Ward
e2	4	6	Carbonaceous shale	3·7	10·8	18·0	61·5	...	Powder	"
e3	2	0	Bright coal	1·0	47·6	45·9	46·9	5·5	Firm	"
e3	1	8	ditto	0·7	45·9	46·9	6·5	...	Crumbly	"
f2	2	0	Carbonaceous shale	...	...	...	62·1	...	...	"
g1	1	6	Bright coal	1·2	31·85	58·0	9·15	...	Good	F. B. Jackson
g3	1	8	ditto	1·2	39·60	49·2	10·0	...	Spongy	"

Analyses of Preolenna Coals—continued.

No. of Outcrop	Thickness.	Nature.	Moisture. °/o.	Volatile Hydro-carbons. °/o.	Fixed Carbon. °/o.	Ash. °/o.	Sulphur. °/o.	Coke.	Analyst.
	ft. in.								
*g*3	[illegible] 4	Stony coal	...	...		48·7	...	...	W. F. Ward
*g*3	1 8	Bright coal	1·8	44·2	46·9	7·1	...	Tender	”
*g*4	1 2	ditto	1·3	39·42	49·05	10·33	...	Spongy	F. B. Jackson
*g*5	2 0	Bright coal, omitting band of kerosene shale	0·7	48·3	44·4	6·6	...	Crumbly	W. F. Ward
*g*5	2 0	ditto	1·1	47·9	42·2	8·8	...	...	”
*g*5	2 0	ditto	1·0	40·5	49·5	9·0	...	Spongy	F. B. Jackson
*g*5	2 0	Bright coal where cut in tunnel	0·5	47·3	46·2	6·0	4·4	Firm	W. F. Ward
*h*1	1 4	Bright coal	1·1	40·4	49·65	8·85	...	Spongy	F. B. Jackson
*h*2	1 9	ditto	0·8	47·2	41·7	10·3	...	Firm	W. F. Ward
*h*2	0 3	Stony coal	...	...	...	75·2	...	...	”
*i*1	1 6	Bright coal	1·4	40·1	48·65	9·85	...	Spongy	F. B. Jackson
*i*2	1 10	ditto	1·6	42·0	45·7	10·7	...	Firm	W. F. Ward
*j*1	1 10	ditto	1·22	40·68	50·1	8·0	...	Spongy	F. B. Jackson
*j*1	0 4	ditto	0·7	43·8	43·[illegible]	11·7	...	Firm	W. F. Ward
*j*1	1 10	ditto	1·2	39·2	48·2	11·4	...	Tender	”
*j*2	2 0	ditto	0·7	37·2	32·6	29·5	...	Firm	”
*j*2	1 0	Slaty coal	1·1	29·1	31·4	38·4	...	Powder	”
*j*2	2 0	ditto	1·32	31·43	49·15	18·10	...	Spongy	F. B. Jackson
*l*1	1 0	Dull coal	2·1	22·4	49·6	25·9	...	Powder	W. F. Ward
*m*1	...	ditto	2·7	21·3	53·1	22·9	...	”	”
*m*2	1 6	ditto	1·3	12·4	40·0	46·3	...	”	”
*m*2	1 6	ditto	3·3	14 5	47·6	34·6	...	...	”
*m*3	...	ditto	2·8	29·2	55·7	12·3	...	...	”

(c) Fault Creek.

(*c* 1).—On the northern side of this creek, in the face of a cliff, are shown about 3 feet 4 inches of carbonaceous shale. There are small bands of good coal in this seam from $\frac{1}{4}$ to 1 inch in thickness. The dip is 20° to the north-west. The roof and floor are both white micaceous sandstone, rather hard. This class of coal is valueless, but of course the seam may change in quite a short distance into good coal.(16) The elevation here is 1170 feet.

(*c* 2).—About 8 feet above this outcrop is a 15-inch seam of coal very similar to the lower portion of (*b* 1) in Nine-mile Creek, as is shown also by the analysis. It is most probably the same seam.

(*c* 3).—Seventeen feet above this seam occur 3 feet 6 inches of carbonaceous shale. The analysis shows it to be valueless for fuel purposes at this point.

(*c* 4).—About 8 feet above this latter seam is an occurrence of good, bright, nice-looking coal. The actual outcrop was not observable at the time of the writer's visit, having been covered over by vegetation and detritus washed down from above, but Mr. Twelvetrees in his report states that it is 18 inches thick. Numerous pieces were found lying in heaps. The analysis shows it to be a first-class quality coal. This seam is 1203 feet above sea-level.

(d) Spirifer Creek.

(*d* 1).—Outcropping on the spur between Spirifer and Fenestella Creeks a poor-quality seam is seen. This seam is composed of carbonaceous (sapropelic) shale, and is 5 feet in thickness. It is apparently a continuation of (*c* 3), but has here widened out from 3 feet 6 inches to 5 feet. It is about 17 feet below the level of the tunnel driven on (*d* 2).

(*d* 2).—This is a seam 2 feet in thickness which has been opened up by a tunnel 20 feet long, driven in a northerly direction. The seam is dipping at about 25° to the west, and consists of a full 2 feet of high-class gas coal. The roof is dark micaceous sandstone, and the floor consists of a light-coloured quartzose sandstone. The elevation at this point is 1168 feet.

(e) South Fork of Fenestella Creek.

(*e* 1).—An exposure of a coal-seam occurs in the face of a cliff on the southern side of this watercourse. The

(16) This question is discussed on p. 27.

elevation here is 1213 feet above sea-level. The seam has a total thickness of 20 inches, the upper 6 inches of which is kerosene shale, the middle 9 inches being a bright coal, while the lowest 5 inches consists of a splint-like coal, which, however, is higher in volatile constituents than typical Scotch splint, and is practically the same in composition as the middle portion. The dip is towards the north-west at 15°. The roof is a light-coloured, thickly-bedded, micaceous sandstone, and the floor consists of dark soft carbonaceous sandstone about 2 feet 6 inches thick, under which is lighter-coloured sandstone. This seam can be traced right down to the south fork of Fenestella Creek, the northerly component of the dip taking it to a lower level for the whole of this distance. After crossing the creek it starts to rise again, and is shown in the cliff-face on the spur between the north and south forks of Fenestella Creek. The seam at this point is 90 feet below the shale tunnel, or 1123 feet above sea-level. A tunnel has been driven into the cliff, on the seam, in a northerly direction for 20 feet. There are in this seam varying quantities of kerosene shale and coal. At the mouth of the tunnel there are 14 inches of kerosene shale and 10 inches of coal, the former constituting the upper portion of the seam and the latter the lower portion. At another point 9 inches of shale and 12 inches of coal are seen, while at another place there are 7 inches of shale and 9 inches of coal. The kerosene shale in this tunnel is crumpled and contorted. The roof is white quartzose sandstone, while the floor is dark micaceous carbonaceous sandstone. The dip is a little to the north of west at about 15°. A tunnel has been driven on the abovementioned seam to the south of this watercourse for about 13 feet in a south-westerly direction. This tunnel has been called, by Mr. Twelvetrees in his report, the "Shale Tunnel." It has not been extended since his visit. The angle of elevation from the Cliff Tunnel to the Shale Tunnel is 14°.

(*e* 2).—About 20 feet above this seam are 5 feet of carbonaceous shale with small bands of bright coal. This is a continuation of seam (*d* 1), and can be traced running parallel to the kerosene shale seam, towards the north fork. As can be seen from the analyses, some of this coal is of rather good quality.

(*e* 3).—This is an outcrop of good bright coal 2 feet thick. It is 8 feet above the former seam (*e* 2). Its analysis shows it to be a high-grade gas coal. The elevation of this outcrop is 1160 feet.

(*f*) *North Fork of Fenestella Creek.*

(*f* 1).—What is apparently the continuation of the seam shown in the Cliff and Shale Tunnels was observed by the writer in the bed of this creek. At this point it is about 20 inches thick, but the kerosene shale has decreased to a thickness of only 2 inches. The remainder of the seam is good bright coal. About a chain to the north-east of this occurrence is a seam of coal about 15 inches thick, but with no shale. This is on the same level as the previous outcrop, which itself is at about the same level as the Cliff Tunnel. It would appear, therefore, as if the kerosene shale peters out to the north-east. No work has been done on either of these outcrops.

(*f* 2).—About 20 feet above these latter outcrops occurs a 5-feet seam of shaly coal. The upper 3 feet is composed of a soft carbonaceous shale, but the lower 2 feet is a hard, dense, shaly coal breaking with a conchoidal fracture. As explained below,(17) its more correct designation would be "sapropelic shale." Its analysis, however, shows it to be valueless for fuel purposes at this point, although it may have some value when subjected to distillation.(18) This seam has been driven on for about 4 feet. It dips 18° towards the west.

(*f* 3).—Eight feet above this is a 17-inch seam of good bright coal. This is the same seam as (*e* 3). No work has been done on it.

(*g*) *Preolenna Creek.*

(*g* 1).—This seam is below the level of the mouth of the tunnel, and is at present covered by the mullock-tip. Mr. Max Graue, however, informed the writer that a little work was done on it, but not enough to show its exact thickness. It is stated, however, to be 18 inches thick, and the assay of a sample shows it to be a really excellent coal. It is here 1180 feet above sea-level.

(*g* 2).—About 10 feet above this is a 4-inch seam, shown in the mouth of the tunnel. It consists of nice-looking bright coal. It is dipping at about 24° to the west.

(*g* 3).—Ten feet above this small seam is another seam from 22 inches to 2 feet in thickness. The upper 20 inches is good bright coal, but the lower 4 inches are of poorer quality. The dip is about 17° to the west. Both roof and floor consist of very soft variegated micaceous sandstones. This point is 1200 feet above sea-level. This

(17) Page 40. (18) *Vide* p. 53.

seam has been cut in the tunnel at 66 feet from the mouth, and here shows the same characteristics as at the surface. The lower 4 inches of this seam show bright, highly-polished slickensides.

(*g* 4).—Twenty feet above this occurs a seam varying from 10 to 15 inches. It consists of bright, nice-looking coal. This seam was cut in the tunnel at 173 feet from the entrance. It is here shown to be of an average thickness of 14 inches. It was also passed through in sinking the shaft. It is contained in dark, soft, laminated, micaceous sandstone, strongly argillaceous.

(*g* 5).—Nine feet above this is a 2-feet seam of excellent coal. The middle portion of this seam contains from ½-inch to 1 inch of kerosene shale, and the whole seam would make a very high-grade gas coal. Both this seam and the previous one are seen at the surface to be dipping to the west at about 20°, but where they are both seen in the tunnel the dip has flattened to about 14°. This 2-feet seam was cut in the tunnel at 204 feet, and is here shown to be a very hard, bright-looking coal, slightly over 24 inches thick. Pyrites is clearly visible in this seam at this point, and the analysis has shown a rather high sulphur content. This fact will be more fully discussed at a later stage of this report.[19] This seam is at an elevation of 1240 feet above sea-level.

(*g* 6).—In cutting the wooden tramline up to the loading-station some particles of coal were met with in clay about 15 or 20 feet above the previous seam. It is therefore suspected that another seam exists near this point, but no systematic search has been made for it, and its existence must therefore be taken as problematical.

(*h*) *Tangle Creek.*

(*h* 1).—This is a seam of good coal 16 inches thick. The roof is light-coloured, soft, sandstone, and the floor is dark carbonaceous shale. This seam is 1200 feet above sea-level.

(*h* 2).—This consists of 2 feet of good bright coal, and is 20 feet above the former seam. The lower 3 inches of this seam is a rather stony coal, which exhibits the highly polished slickensides to a marked degree. The roof and floor are composed of dark micaceous sandstone. The dip is to the west.

(19) *Vide* p. 54.

(i) South Fork of North-Eastern Creek.

(*i* 1).—Here there are 18 inches of nice bright solid coal. The floor is dark carbonaceous shale and the roof is soft whitish sandstone.

(*i* 2).—Twenty feet above this seam are 22 inches of bright hard coal. The dip is to the north-west at 17°. The roof is dark soft micaceous sandstone. Very little work has been done on either of these seams.

(j) North Fork of North-Eastern Creek.

(*j* 1).—This is a seam of good coal, 22 inches thick. The roof and floor are both composed of dark soft micaceous and argillaceous sandstone. The lower few inches show the development of slickensides. The dip is a little to the north of west at 15°. This seam has been stripped of its roof for a few yards, and the seam can be seen to be swelling and contracting at different points, but the average thickness is from 20 to 22 inches. The elevation here is 1230 feet.

(*j* 2).—Twenty feet higher up this creek is a composite seam occupying a total thickness of 10 feet. The dip is 15° to the north-west. The upper 2 feet of this seam is a bright heavy coal, but its analyses proves it rather high in ash. Below this are about 6 feet of poor shaly coal with thin bands of sandstone. The bottom 2 feet of this composite seam consists of a rather slaty coal, which by its analysis is shown to be of relatively low grade, being very high in ash, but at the same time containing considerable volatile matter. Both floor and roof are dark micaceous sandstone. No work has been done on this outcrop.

(k) Seven Mile.

(*k* 1).—Mr. Twelvetrees records the occurrence of two seams of fair to stony coal in a creek below the 7th mile. The writer, however, was unable to locate this outcrop, but it doubtless represents the northern extension of the seams just described. The elevation here is 1360 feet above sea-level.

(l) Main Creek.

The occurrence of a seam of coal in the bank of this creek over 1 foot thick is recorded by Mr. Twelvetrees. Since his visit, however, no work whatever has been done in this locality, and the scrub has overgrown and hidden the outcrop, as although the writer searched for some considerable time, no trace could be seen of a coal-seam. A sample, however, obtained by Mr. Twelvetrees showed the coal to be of poor quality. The country here is so thickly overgrown with horizontal scrub that it is impossible to measure the dip of, or even see, the country-rock. This point is 1076 feet above sea-level.

(*m*) *Coal Creek.*

Mr. Twelvetrees mentions that there are several outcrops in this creek, but in this case, as in the one previous, it is almost impossible to locate the outcrops without cutting away the dense scrub. One outcrop was located by the writer and opened up for about 18 inches, showing dull-looking coal with several bright bands. Three occurrences were previously reported, all of inferior quality. The analyses are given of samples taken by Mr. Twelvetrees, who gives the dip as 30° to the north-west. The strata in the immediate neighbourhood of the coal-seams here is a white to yellow micaceous sandstone. The elevation is 1340 feet.

Several other outcrops have been recorded by Mr. Austin B. Brain, the composition of which is uncertain; but their positions are indicated in the maps accompanying this report.

It will be seen, therefore, that, with about four exceptions, these outcrops have had practically no work done on them to prove their exact value under cover. Although recommended to do so by Mr. Twelvetrees in his report on this field in 1903, no attempt has been made to prove, by surface-trenching down the face of the hill, exactly how many seams occur at different localities.

(2)—The Number of Seams.

Some certainty as to the exact number of seams actually existing is essential before any estimate can be made of the probable value of the Preolenna Coalfield. Opinions had been freely expressed that there existed here a very large number of seams, as many as sixteen being mentioned as a conservative estimate. The writer therefore spent some considerable pains and time in an attempt to finally determine this question. The solution proved one of some difficulty, as it was soon apparent that the area is one influenced by folding, and in the undeveloped state of the area closely contiguous to the outcrops this greatly increased the complexity of the problem.

In order to understand perfectly clearly what follows, the reader is referred to the diagram produced herewith, which must not be taken as an accurate section, but merely as a rough diagrammatic illustration of the structural features.

At the outset, however, it is essential for a perfectly clear conception to exist in the reader's mind, of the exact meaning, and method of measurement, of the dip of a bed. Most text-books on geology state that the dip must always be measured as the greatest angle of slope of the bed.([20]) This is quite true, but at the same time it is not always possible in the field to gain access to a position where the true dip or greatest angle of slope can be measured directly. Recourse, therefore, must be had to the measurement of two components of the true dip. These should be at right angles to each other, and if the amount and direction of each component is measurable the true dip can be computed. All angles and directions of dip mentioned elsewhere in this bulletin are those of the true dip, but for the purposes of the investigations included in this chapter the amount and direction of the components must be taken into consideration.([21])

It is necessary also to point out, at this stage, that there are three distinct and individual factors influencing the amount and direction of the true dip, as measured at any point in the Preolenna district. The first of these is the "pitch" ([22]) of the folds which have been clearly proved to exist in this field. The second is the inclination of the beds in the folds themselves; and the third is the general dip of the series as a whole, which is at right angles to the direction of the general strike.

The first question at issue is as to the number of seams carrying kerosene shale. The settlement of this point necessarily supplies us with valuable data bearing on the investigation as to the total number of seams of any description in the district.

([20]) *Vide* Chamberlin and Sailsbury's "Geology," Vol. I., p. 501, and W. B. Scott's "Text-book of Geology," p. 326.

([21]) For detailed descriptions of the methods adopted in measuring and calculating the true dip from the apparent dips, the reader is referred to: "Aids to Practical Geology," by Grenville Cole (p. 5 *et seq.*), and "Field Geology," by W. H. Penning, p. 119, *et seq.*

([22]) The "pitch" of a fold is the angle of inclination of its main axis.

Travelling in a north-easterly direction from the first outcrop on the Arthur Track, the first occurrence of kerosene shale met with is in the Shale Tunnel (outcrop *e* 1). The true dip here is 15° to the north-west. Dividing this dip into two components we shall have one which tends to take the seam deeper into the hill, while the second, being in a northerly direction, will carry the outcrop to a lower point on the surface in this direction. The trend of this outcrop downwards can be seen at several points towards the Cliff Tunnel, and the angle of elevation from this point to the Shale Tunnel was ascertained to be 14°, which agrees with the angle at which the seam is dipping in this direction, as measured at the several points on its outcrop. There can be no doubt, therefore, that the seams in these two tunnels are one and the same. Additional confirmatory evidence is given by the nature of the roof and floor, which are exactly similar. The kerosene shale, also, in both tunnels is of exactly the same composition.

At outcrop (*f* 1) this seam is running almost horizontally in a northerly direction, but here the kerosene shale has dwindled to 1 inch in thickness. About a chain further north the seam appears to be rising, and is here *totally devoid of kerosene shale*. This variation and gradual diminution of the thickness of kerosene shale is wholly characteristic of this class of coal.

E. A. N. Arber states: "Cannel often occurs in seams of humic coal, and nearly always in the form of lenticular bands." [23]

Dr. Walcot Gibson,[24] when discussing the same question, makes the following statement: "Of the different varieties of coal. . . . . , cannel coal is the most inconstant in its occurrence. Sometimes the whole seam is cannel, sometimes only a part; but in all cases it occurs as lenticles, either as a seam by itself, or forming part of a composite seam."

J. E. Carne [25] makes the following general statement: "Kerosene shale deposits, at their margins, frequently pass into bituminous coal or coaly shale, at other times into ordinary clay shales. In some instances the mineral is intercalated between thin coal-seams which form excellent holing; at both Hartley and Joadja, in certain directions, the coal-seams thickened as the kerosene shale

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[23] "The Natural History of Coal," by E. A. N. Arber, pp. 16 and 123.
[24] "The Geology of Coal and Coal Mining," by Walcot Gibson, D.Sc., p. 24.
[25] "The Kerosene Shale Deposits of New South Wales," by J. E. Carne, 1903, p. 48.

thinned, until the latter wedged out in a solid coal-seam. In another direction in the Joadja deposit, the roof and floor coal holing gave out, leaving the kerosene shale tight between sandstone roof and floor."

David White, the Director of the Geological Survey of the United States, an eminent authority on all matters appertaining to coal, in the article quoted at a later stage of this bulletin, also bears witness to this fact, as the following extract shows: "From a boghead or relatively pure alga rock, the coal may grade into a sapropelic [26] limestone or sapropelic shale, &c. Sapropelic deposits in the form of an alga cannel may occur in any part of a bituminous coal-bed. Under these circumstances, the alga-cannels or bogheads are horizontally continuous with the bituminous coals with which they intergrade."

It is not surprising, therefore, to find the kerosene shale behaving in such a manner as it does here. We should expect, moreover, that, when traced along the south-westerly trend of the outcrops, it would also disappear. As a matter of fact there is no visible occurrence of kerosene shale south of the Shale Tunnel. It is important, however, to decide, if possible, which of the outcrops, say in Fault Creek, represents the seam which carries the kerosene shale at Fenestella Creek. To help us in this investigation it must be fully realised that not only do seams of cannel coal vary in thickness and character in every direction, but that every class of coal is subject to such variation, though not to such a marked and invariable degree as sapropelic coals.

Dr. Walcot Gibson states: "Some seams, again, consist of good marketable coal from top to bottom, and retain this character for several miles; then locally bands of clay, shale, or sandstone become intercalated, and finally these bands become abundant, and the seam passes into a worthless mixture of foreign matter and thin layers of coal."[27] And again: "Many seams made up of layers of coal with partings of dirt, shale, clay, or sandstone, varying from a mere film to several feet in thickness, pass laterally into beds of almost pure coal." [28]

We need not, therefore, necessarily expect to find a seam containing either kerosene shale or even good humic coal as representing the continuation of the kerosene shale seam in any direction. Before, however, we can decide which outcrop in Fault Creek represents the kerosene shale

(26) For the meaning of this term "sapropelic," refer to p. 33.

(27) *Loc. cit.*, p. 23. (28) *Ibidem*, p. 34.

seam we must take cognizance of the higher outcrops in the immediate vicinity of the Shale Tunnel. Above this tunnel is seen a 5-feet seam of carbonaceous shale, and about 8 feet above this a 2-feet seam of good coal. A glance at the accompanying diagram [29] will clearly show the relation of this 5-feet seam to the upper 3-feet 6-inch seam (outcrop *c* 3) in Fault Creek. Outcrops (*c* 3), (*e* 2), and (*f* 2) belong to the same seam. Similarly, outcrops (*b* 3), (*c* 4), (*d* 2), (*e* 3), and (*f* 3) are also the one seam.

It naturally follows, from its position relative to the outlying seams, that (*c* 2) is part of the seam represented by the outcrops (*e* 1) and (*f* 1), that is, the kerosene shale seam; it has been shown previously that (*b* 1) is the same seam as (*c* 2). Outcrop (*b* 2) is, in the writer's opinion, an extension of (*c* 3), &c., although it is a high-class coal. This, however, is not surprising or unlikely, in view of what has been said previously as to the proneness of carbonaceous shales to quickly merge into good coal.

Correlating the outcrops at Preolenna Creek with those discussed previously, it seems most advisable to begin at the lowest known seams in this creek, and, say, Fault Creek. The latter outcrop (*c* 1) is a 3-feet 4-inch seam of carbonaceous shale. Outcrop (*g* 1) is 18 inches of good coal. We will assume that these are two particular developments of the same seam, since they are both at the same height above the underlying Lower Marine mudstones. Outcrop (*g* 3), therefore, is the continuation of the kerosene shale seam, and this deduction agrees with the observed respective heights of the outcrops above the lower seam. Further, (*g* 4) must be a continuation of (*e* 2) and (*f* 2), and this again is borne out by its distance above (*g* 3) corresponding with the difference in level of (*e* 2) and (*e* 3). Yet additional weight is given to this theory in the case of outcrop (*g* 5), which being 9 feet above (*g* 4) must correspond with *e* 3) and (*f* 3), which are 8 feet above (*e* 2) and (*f* 2) respectively. The development of kerosene shale in this seam is not surprising. It certainly cannot be the same seam as carries the shale at Fenestella Creek. Outcrop (*g* 2), which is only 4 inches thick, is simply a local thickening of apparently sporadic seamlets of coal, which at Preolenna Creek occur promiscuously in the carbonaceous sandstone in lenticles from $\frac{1}{16}$ inch in thickness upwards. A glance at the diagram will clearly show how the outcrops to the north-east are correlated with the other occurrences. Outcrops (*g* 5),

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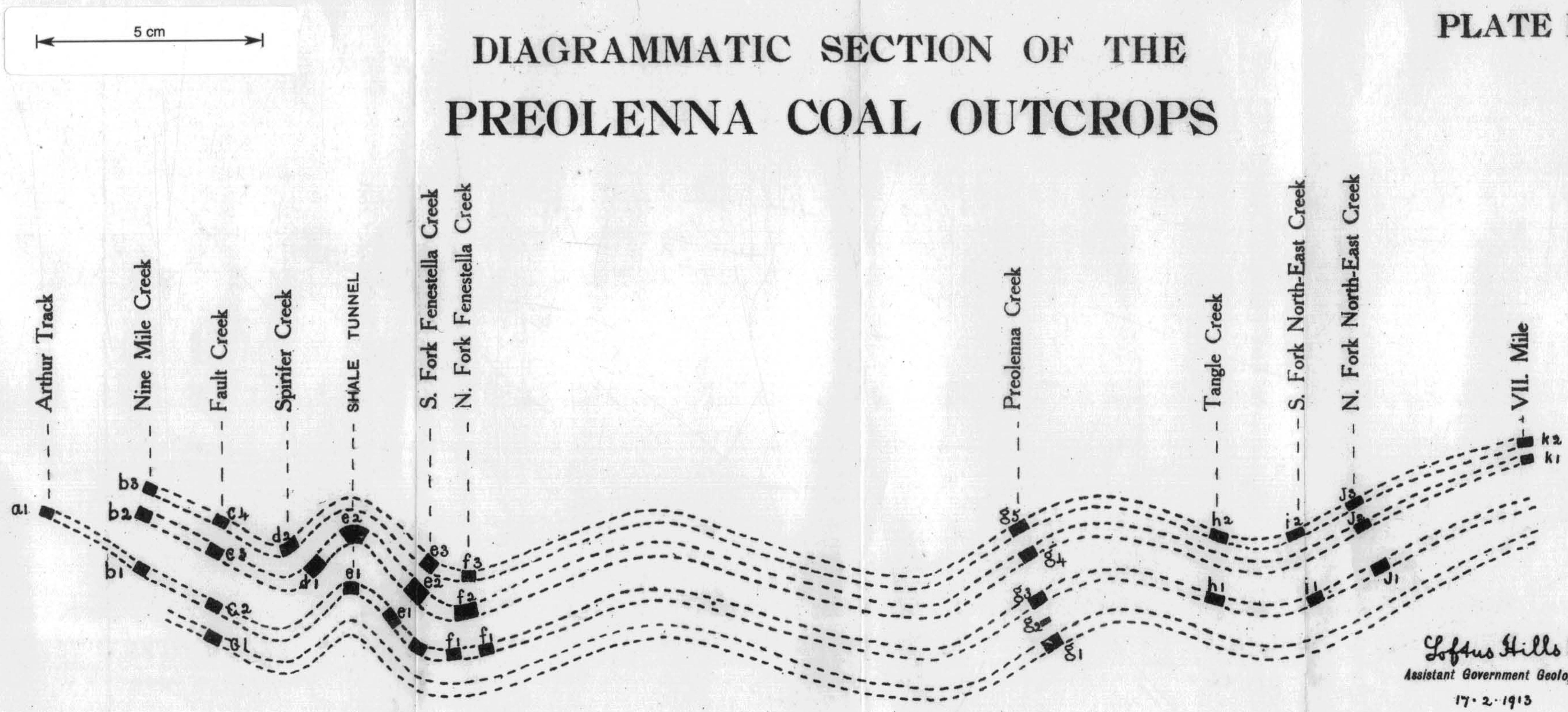
[29] Plate II.

PLATE II

DIAGRAMMATIC SECTION OF THE PREOLENNA COAL OUTCROPS



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17 · 2 · 1913

Photo Algraphed by John Vail Government Printer Hobart Tasmania.

(h 2), (i 2), (j 2), (k 3) must necessarily be the same seam, and it follows indisputably that (j 2), (k 2), and (h 1), (i 1), (j 1) correspond respectively with (g 4) and (g 3).

It is clear, therefore, that there are only four seams of any importance which represent the total number of outcrops already observed. There may be a seam higher up in the series at Preolenna Creek and elsewhere, but its existence is purely conjectural.

In order not to clash with the existing usage in describing the seams in the workings at Preolenna Creek, the writer would name the seams as follow:—

Seam No. 0 represented by outcrops (c 1), (g 1).
Seam No. 0a represented by outcrop (g 2).
Seam No. 1 represented by outcrops (a 1), (b 1), (c 2), (e 1), (f 1), (g 3), (h 1), (i 1), (j 1).
Seam No. 2 represented by outcrops (b 2), (c 3), (d 1), (e 2), (f 2), (g 4), (j 2), (k 1).
Seam No. 3 represented by outcrops (b 3), (c 4), (d 2), (e 3), (f 3), (g 5), (h 2), (i 2), (j 3), (k 2).

It will be clearly apparent from a study of the diagram (Plate II.) that the result of connecting the several outcrops, in the manner described, is to represent the beds as being bent into a series of undulations or folds. That this is the actual structure developed in the field is apparent after a consideration of several observed facts.

In the first place, as has been pointed out previously in this report,[30] there is evidence of crumpling and some relative movement in certain parts of the coal-seams, with the accompanying production of slickensides. The crumpling is well seen in the kerosene shale in the Cliff Tunnel. The shale here is in marked contrast to that in the Shale Tunnel, the former exhibiting curly structure, while in the latter the layers are parallel. The existence of this curly structure in the shale in the upper part of the seam would indicate the possibility that the seam at this point is situated in the trough of a syncline, which agrees with the deductions made below after a study of the dip of the seam at several points. This curly character of portions of seams is quite a common occurrence in shale deposits in other parts of the world, and in every case where such has been recorded its origin has been attributed to some compressive and crushing movement. Thus Dr. Ells, of the Canadian Geological Survey, says [31]: "The oil shales

[30] *Vide* p. 14.
[31] "The Bituminous or Oil Shales of New Brunswick and Nova Scotia," by R. W. Ells (Geol. Surv. Canada, Ottawa, 1909, pp. 48, 49).

of the district (Scotland) are known as plain and curly, the plain being flat surfaced . . . . . while the curly variety is somewhat curled or contorted . . . . The curly variety is usually richer in hydrocarbons, which have probably rendered it more easily crumpled than other poorer portions of the same bed associated with it."

Again, Mr. D. R. Steuart, chief chemist of the Broxburn Oil Company, says (32): "Some shale is 'plain,' that is, the laminæ are parallel with the stratification of the seam. Other shale is 'curly,' and the layers, as if by side-pressure, are crushed into wave-shaped, curled, irregular masses, with black, brightly polished surfaces. There are often plain and curly layers in the one seam, one layer having remained rigid while the other slid and folded itself in the places of reduced pressure."

The slickensided surfaces are well seen in the lower portions of outcrops (*g* 3), (*h* 2), and (*j* 2), and is accompanied by some crumpling and curling. The occurrence of these polished surfaces in the lower portions of these seams would indicate that the beds here occupy positions on the anticlinal folds. This fact is illustrated by the diagram.

In the second place, direct evidence of undulatory folding is given by an examination of the dip at the several outcrops. At outcrop (*b* 1) there is a northerly component of the dip which brings this seam to its lower level at outcrop (*c* 2), at which outcrop the same component is carrying it to a still lower level. At outcrop (*d* 2) there is a south-westerly component which is carrying the seam to a lower level towards the south. There must therefore be a syncline between Fault Creek and Spirifer Creek. This south-westerly component runs the seams upwards to the level of the Shale Tunnel, where a north-easterly component of the dip runs the seams downwards to the north-east. The Shale Tunnel is therefore on the crest of an anticline. At the Cliff Tunnel the seams are running almost horizontally in a north-easterly direction. At Preolenna Creek the seams are all dipping to the west, which gives a south-westerly component carrying them higher as they go to the north-east. In Tangle Creek there is a northerly component which takes them to a lower point between here and the south fork of North-Eastern Creek, where they again have a south-westerly component carrying them higher through the north fork to the 7th mile. There must therefore be the crest of an anticline between

(32) "The Shale Oil Industry of Scotland," by D. R. Steuart ("Economic Geology," Oct.-Nov., 1908, p. 587).

Preolenna Creek and Tangle Creek, and also a synclinal trough between the latter stream and North-Eastern Creek.

It will be seen, therefore, that there is undoubtedly a series of undulations in this district, the recognition and the plotting of which is essential to a determination of the total number of coal-seams.

In regard to the outcrops in Main and Coal Creeks, the writer is strongly inclined to regard these as belonging to the same series as the above, being in this locality thrown up by faulting due to the intrusion of the diabase. It has been suggested, after a consideration of their being at a higher level than the previously described outcrops, and their similarity in composition to the East Coast coals, that these seams belong to the Upper or Mesozoic coal measures of Tasmania. The writer, however, is disinclined to accept this view.

It is a peculiar fact that the Mesozoic sedimentary rocks have not been observed either in the North, North-West, or West Coasts, and it appears as if this part of Tasmania were a land-surface during the Mesozoic era. It is quite feasible to suppose that the intruded mass of diabase would lift upwards some of the strata, through which it was thrust, as this has so repeatedly been observed in other parts of Tasmania as having taken place.

However, in the absence of data of any kind, and particularly of palæontological evidence, it is impossible to come to any definite conclusion as to their geological horizon. They are marked in the accompanying maps as Permo-Carboniferous, as the writer is of the opinion that they will ultimately be proved to belong to that system.

(3)—The Composition, Physical Characters, and Nomenclature of the Preolenna Coals.

At the outset, in any discussion of the classification of these particular varieties of coal, it must be admitted that the classification of coals in general is an unsettled and much debated question. Various schemes have been proposed, but none as yet has been universally adopted. [33]

[33] For a concise and interesting account of the chemical and physical properties, classification, and varieties of coal, the reader is referred to "The Natural History of Coal," by E. A. N. Arber (Cambridge Manuals of Science, 1911, pp. 1-19).

The difficulties connected with the attempts made at a detailed classification are well illustrated by the following passage from David White (34):—

"The factors of most importance in the genesis of coals of all kinds relate chiefly to (*a*) the conditions of growth and the accumulation of the organic matter; (*b*) the kinds of organisms contributing directly or indirectly to the mass or accumulation and relative proportions of each; (*c*) the conditions, and duration of the initial process of organic decomposition or putrefaction; and (*d*) the nature and energy of the dynamic forces bringing about in varying degrees the subsequent alteration of the organic residues.

"The factors of these four classes combine, not only in infinite complexities, but also in constantly changing activities or values, the products of their combined influences, even throughout a single bed, at a given point being never exactly the same. Therefore it is not remarkable that there should be absolute and complete intergradation from extreme to extreme, or that no naturally separated groups can be found by which to illustrate the distinctions in a coal classification. The dividing-lines of the latter must accordingly be arbitrarily drawn. That classification will ultimately win most general acceptance and satisfaction in which the groups are perspectively formed with due reference to the optical and physical characters of the coals, as well as to their chemical and commercial qualities. Incidentally, such a classification will conform in a general way to the genetic relations of the coals."

It is beyond the scope of this bulletin to attempt any discussion of this matter, but at the same time it seems advisable to explain, to some extent, several terms which are usually adopted as generally descriptive or indicative of certain varieties of coal.

The word "bituminous" is one which is and has been widely used in coal terminology. It is, however, a most unfortunate term, as coal designated by this name *contains no bituminous matter*. David White, Newell Arber, and others have used the word "humic" to describe those coals ordinarily classed as "bituminous," and this nomenclature is adopted in this bulletin.

There is another distinct class of coals, of which cannel coal and torbanite are typical representatives. These coals differ from the humic coals, not only in the large pro-

(34) "Some Problems in the Formation of Coal," by David White ("Economic Geology," June-July, 1908).

portion of volatile constituents which they contain, which render them excellent for gas-manufacture, but also in physical properties. These coals have been specially studied by Professors B. Renault and C. E. Bertrand, who describe them as being formed of the remains of gelatinous microalgæ. Potonié, the German palæobotanist, after prolonged research work on the origin of coals and petroleum, arrived at the conclusion that the basic and fundamental constituent of the class of coal we are now considering consists of the gelatinous mass or slime, which represents the result of the maceration and partial bacterial decomposition and putrefaction of a former plankton,(35) both animal and vegetable, in stagnant or quiet water. He applies the term "sapropel" to this accumulating residuum of gelatinous slime, and it is this substance which forms the matrix in which the least destructible organs, such as spores, pollen, &c., finally become embedded. He therefore designates all coals of this class as sapropelic coals. This has met with considerable acceptance, and is adopted in this bulletin.

Sapropelic matter is, in general, characterised by its more distinctly bituminous composition, being relatively rich in hydrogen and low in oxygen. Sapropelic coals, therefore, are more legitimately worthy of the name "bituminous" than the so-called "bituminous coals," and it can thus be seen why it is necessary to adopt the distinctive terms "humic" and "sapropelic."

Up to this point there is not much room for discussion, but when we come to the interpretation of the microscopic structure of these coals, we are on very debatable ground indeed. Bertrand and Renault classify the bright orange-yellow patches, seen in sections of the Autun boghead, as thalli of the gelatinous alga *Pila bibractensis*, and similar patches in kerosene shale from New South Wales as belonging to the alga *Reinschia australis*. However, the algal nature of these bodies has recently been disputed by Prof. Jeffrey, of Harvard,(36) who states that they are the megaspores of vascular cryptogams.

Again, J. E. Carne, in his monograph on the kerosene shale of New South Wales, after discussing fully the relation between black cannel or ordinary cannel coal, brown cannel or kerosene shale or torbanite, and shaly cannel or

(35) This plankton consists chiefly of algæ, but diatoms, pollen, spores, and small animals are also present.

(36) "On the Nature of So-called Algal or Boghead Coals," by E. C. Jeffrey (Rhodora, Vol. XI., p. 61). Quoted by Newell Arber.

oil shales, comes to the conclusion that the former contain "a preponderance of thoroughly macerated vegetable matter," with a small amount of spores or pollen, whilst kerosene shale or torbanite contains a preponderance of spores or pollen, and oil shale contains a preponderance of mineral matter. Newell Arber, on the other hand, states that the black cannels consist of spores with very little or no alga-like thalli, and that boghead or torbanite consists almost wholly of thalli. These two apparently directly opposed conclusions would seem to be reconciled if Professor Jeffrey's results are confirmed.

Enough has been said, however, to indicate the impossibility, in the present state of knowledge of the subject, of the adoption of a system of nomenclature of the several varieties of sapropelic coals based on scientific principles.(37)

The Preolenna Sapropelic Coals.

In the Preolenna Coalfield we have a very interesting series of these sapropelic coals. It is not possible, in the present somewhat limited investigation, to attempt a complete description of the several classes of coal here represented, but the writer would like to point out that they offer a very interesting field for research, which will give some interesting and valuable information on the natural history of coal.

In general, "the sapropelic coals are macroscopically distinguished by their conchoidal fracture; a rather dull black surface, which in the purer samples have a satiny lustre; a greasy or waxy abrasion when scratched by some hard instrument; a more or less distinctly brownish tint when broken in thin edges, and often a golden-yellow colour in thin sections. Usually the coal is massive and unlaminated." (38) The specific gravity is also regularly low.

As previously stated, the most striking characteristic of sapropelic coals is their relatively high proportion of volatile constituents. This is clearly shown by the ratio of the "volatile hydrocarbons" to the "fixed carbon" which is included in Table II., which gives the proximate composition, &c., of a number of varieties of sapropelic and other coals, from different parts of the world, includ-

(37) For a description of the microscopic character of these coals and the relation of tasmanite to this series, consult Geol. Surv. Tas. Bulletin No. 11 ("The Tasmanite Shale Fields of the Mersey District," by W. H. Twelvetrees, pp. 43-48).

(38) David White, *loc. cit.*, p. 299.

ing representatives of the Preolenna coals. A study of this table shows that there exists a great variety of these coals when classified in accordance with this ratio. Other factors in connection with the volatile hydrocarbons are the chemical and physical characters of the products of distillation. Generally, it may be stated that sapropelic coals give on distillation hydrocarbons of the aliphatic series (olefines, paraffins, &c.), whereas the humic coals evolve members of the aromatic series (benzine, napthaline, &c.).

The term "kerosene shale" has been used throughout this bulletin to indicate the richest class of sapropelic coal which is represented at Preolenna. It is admitted at once, however, that this term is hardly a suitable one, but is adopted here for want of a better.(39)

The following are the chief characteristics of this mineral:—

Colour.—From brownish-black to black.

Streak.—Dark or brownish-black.

Lustre.—Sometimes dull, but generally showing a characteristic pitchy lustre.

Texture.—Very fine, almost amorphous, having a very close resemblance to pitch. Shows "curly" structure in some parts of seams, and at other times exhibits straight planes of stratification.

Fracture.—Conchoidal across the planes of bedding, being less pronounced when parallel thereto. There is always a tendency to break along the planes of stratification. The mineral is very tough and very difficult to break, giving out a characteristic sound when struck.

Sectility.—Very slight, breaking away easily before the knife.

Weathering.—Wonderfully resistant to atmospheric agencies, the shale at the surface differing but slightly from that under cover.

Specific Gravity.—1·13.

Fusibility.—When heated, swells and fuses, and bursts suddenly into a long smoky flame giving off a bituminous odour, continuing to burn freely when removed from the external source of heat. A hard, caked mass is left after the burning ceases.

(39) This question of nomenclature of the New South Wales mineral which bears close relationship with the above, is fully discussed by J. E., Carne in his memoir cited elsewhere.

Chemical Composition.—The proportion of volatile hydrocarbons is very high, being in the purest samples slightly over 75 per cent. The ratio of volatile hydrocarbons to fixed carbon, taking an average composition of four samples, each over 60 per cent. volatile hydrocarbons, is 2·7 : 1; the richest sample shows a ratio of 3·6 : 1. The ash is very low, averaging on the same four samples 2·8 per cent. There are bands carrying some iron pyrites, but the sulphur content is low.

The mineralogical analogues of this variety of sapropelic coal are the following:—Pelionite of Barn Bluff, Tasmania; kerosene shale of New South Wales; torbanite of Scotland; boghead of France; albertite of New Brunswick; and stellarite of Nova Scotia. Analyses of these minerals are given in Table II.

As compared with the Barn Bluff occurrence of cannel coal, the Preolenna kerosene shale is distinguished by the absence of the marked amorphous unlaminated character and well-developed conchoidal fracture of the former. There is a notable difference in the lustre of the two minerals also, the pelionite having more the appearance of vulcanite, as contrasted with the pitch-like aspect of the kerosene shale. The streak of the former mineral is black, whereas the latter has a tendency towards a brown streak; pelionite also exhibits marked sectility. In the matter of chemical composition, also, there is a distinct difference, for whereas the ratio of volatile constituents to fixed carbon is 2·7 in Preolenna kerosene shale, it is only 1·24 in pelionite.

When compared with the New South Wales kerosene shale the Preolenna mineral is seen to be very similar, but there are several properties which are appreciably different. The lustre of the New South Wales mineral more nearly approaches that of Barn Bluff cannel, and the same similarity also exists in regard to the sectile properties. Although both the Preolenna and New South Wales shales are exceptionally high in volatile constituents there is a difference in chemical composition, which is exemplified by the ratio of volatile to fixed carbon being 2·7, as compared with 4·9 (in the richest varieties the ratio is 14·2) and the markedly lower percentage of ash of the Tasmanian mineral. This low ash-content of the Preolenna shale differentiates it also from torbanite of Scotland.

From a study of the accompanying table, together with what has been said here, it will be quite readily seen that there is a strong family resemblance between all these varieties of sapropelic coals, but they all have certain more or less distinctive properties which prohibit their being grouped under one specific name.

The second class of sapropelic coals developed at Preolenna constitutes the class of "black cannels" as designated by J. E. Carne. Some of these coals have been described by G. A. Waller, who classed them as second-class cannel coals.

It must be stated here that, in the writer's opinion, *there are no representatives of true humic coals observed at Preolenna up to the present time.* The whole of the many varieties of coal, other than the kerosene shale, which is a distinctive mineral, occurring in this district are variations and intergradations of several species of these second-grade sapropelic coals. When the term "second-grade" is used it is implied that they are of lower grade than the phenomenally rich kerosene shale, but as compared with the general class of coals they are high grade.

The colour of these coals is jet-black; lustre, resinous or satiny to slightly vitreous; the streak varies from jet-black in some varieties to brown in others, but is generally brownish. Stratification is distinct, and the coals are made up of laminæ of slightly varying composition. The fracture is sub-conchoidal, and smooth to irregular and hackly; tenacity varies from slightly tough to brittle, and none of them soil the fingers. They are rather light, the specific gravity being on an average only 1·25. They burn readily, swelling up and fusing on the fire, and giving a long smoky plane having a *strongly bituminous odour.* Some of the varieties have the typical general appearance of black cannel coal, whereas others partake more of the general physical character of humic coal.

TABLE II.

Showing the Composition of Different Varieties of Sapropelic Coals, and also some Typical Humic Coals.

Description.	Locality.	Moisture. %	Volatile Hydro-carbons. %	Fixed Carbon. %	Ash. %	Sulphur. %	Ratio of the Volatile Hydrocarbons to Fixed Carbon.	Authority.
Richest kerosene shale	Joadja Creek, N.S.W.	...	89·57	5·27	4·98	...	16·1 : 1	T. Steel
Richest kerosene shale	Preolenna, Tas.	0·5	75·5	21·0	2·0	1·0	3·6 : 1	W. F. Ward
Richest torbanite	Scotland	...	71·17	7·65	21·1	...	9·3 : 1	Dr. Henry How
Stellarite	Nova Scotia	...	66·53	25·23	8·2	...	2·6 : 1	Slessor
Albertite	New Brunswick	...	54·39	45·44	0·1	...	1·09 : 1	Dr. Henry How
Pelionite	Barn Bluff, Tas.	0·2	52·8	42·4	4·3	0·7	1·24 : 1	Average analysis
Average of 11 samples of Scotch torbanite	Scotland	...	55·39	12·47	32·14	...	4·4 : 1	J. E. Carne
Average of 61 samples of N.S.W. kerosene shale containing upwards of 60 % volatile hydrocarbons	N. S. Wales	...	69·85	14·10	16·05	...	4·9 : 1	J. E. Carne
Average of 4 samples of Preolenna kerosene shale containing upwards of 60 % volatile hydrocarbons	Preolenna, Tas.	1·3	69·56	26·54	2·88	...	2·7 : 1	Ward, Mingaye, and Jackson

Average of 20 samples of Scotch oil shales	Scotland	...	26·17	5·15	68·68	...	5·0 : 1	J. E. Carne
Sapropelic shale	Preolenna, Tas.	3·7	16·8	18·0	61·5	...	0·9 : 1	W. F. Ward
Average of 14 samples of "black cannels"	Scotland	...	40·14	40·36	19·5	...	1·0 : 1	J. E. Carne
Average of 5 samples of "black cannels"	Ohio, U.S.A.	...	44·07	41·40	14·53	...	1·06 : 1	J. E. Carne
Average of 12 samples of "black cannels," bands in kerosene shale	N. S. Wales	...	36·29	36·81	26·9	...	1·0 : 1	J. E. Carne
"Black cannel"	Wigan, England	1·46	45·90	45·51	7·11	...	1·0 : 1	Liversidge
"Black cannel"	Preolenna, Tas.	0·4	50·3	44·4	4·9	...	1·13 : 1	W. F. Ward
Average of 5 samples of "black cannel"	ditto	0·9	45·5	45·4	8·1	...	1·0 : 1	Average analysis
Average of 11 samples of "black cannel"	ditto	1·17	40·46	50·79	7·58	...	0·79 : 1	ditto
Tasmanite	Mersey, Tas.	0·9	29·22	2·91	64·97	2·0	10·0 : 1	W. F. Ward
Humic coal for gas-making	East Greta, N.S.W.	1·89	41·35	50·51	6·25	...	0·81 : 1	Pittman
Humic coal for gas-making	Pelaw Main, N.S.W.	1·86	42·2	50·5	5·4	0·69	0·83 : 1	Pittman
Humic coal for steam-raising	South Coast, N.S.W.	0·71	23·65	63·98	11·66	0·470	0·37 : 1	Pittman
Humic coal	Mersey, Tas.	10·6	45·0	38·8	5·5	4·0	1·1 : 1	W. F. Ward
Humic coal (Mesozoic)	Mt. Nicholas, Tas.	5·7	34·3	48·4	11·6	...	0·7 : 1	Average analysis

From a study of Table II. it will be seen that the East Greta coal of New South Wales approaches remarkably closely to the average composition of a number of the Preolenna coals. This would lead one to believe that they are the same variety of coal, but as a matter of fact they are markedly different. The general physical characters are somewhat dissimilar, the Greta coal being harder, denser, and heavier (sp. gr. 1·31), and has a black streak in contradistinction to the brownish streak of the majority of the Preolenna coals. It is, however, when the two coals are burnt that an important distinction is apparent. The Preolenna coals give, when burning, a strong and distinctive odour of ignited oil or bitumen, whereas the Greta coal, in common with all humic coals, gives, under the same conditions, a characteristic tarry smell. The interpretation of this fact is that the Preolenna coals would give on distillation a considerable amount of burning, lighting, or lubricating oils. If the distillation were carried out at a high temperature with the object of producing illuminating gas, a product would be obtained which would be of exceptionally high candle-power. This is actually borne out by tests already made.[40]

In no case, in testing the Preolenna coals, could the absence of this characteristic be noticed, even the poorer quality coal from Main and Coal Creeks, which approaches so closely, in proximate composition, to our Mt. Nicholas coal, giving a marked bituminous odour on burning, thereby differentiating it at once from the East Coast coals.

All the coals of this class at Preolenna are caking coals, giving first-class coke in trials already made.[41]

The third variety of these sapropelites developed here are low-grade "sapropelic shales." These have been referred to previously as "carbonaceous shales." They represent impregnations of sand and clay by sapropel. They occur in relatively large seams (up to 5 feet), and vary considerably in quality. They are black in colour and streak, and the lustre is dull. The fracture is subconchoidal to hackly, the better varieties breaking with a characteristic crackling sound. The analyses show them to be high in ash, but at the same time they contain considerable volatile matter. When heated in air they emit the odour of burning oil.

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(40) *Vide* p. 52. (41) *Ibidem.*

In view of the lack of opportunity to further study these coals at present, the writer would recommend that the names "kerosene shale," "black cannel," and "sapropelic shale" be temporarily used to designate the respective varieties mentioned.

(4)—The Geological Horizon of the Coal Measures.

As shown previously, the coal measures are a series of land and freshwater strata, intercalated between the Upper and Lower Permo-Carboniferous Marine series.

Mr. Twelvetrees in his report mentions the finding by Mr. Austin Brain of a fossil frond of Glossopteris, but on the present occasion only obscure impressions could be observed. The occurrence of Glossopteris conclusively refers these measures to the lower coal measures of Tasmania, which are developed elsewhere at the Mersey, Port Cygnet, Adventure Bay, and Barn Bluff.

The lower or Greta coal measures of New South Wales are the geological homologues of the Tasmanian lower coal, being intercalated between the Lower and Upper Marine series of the Permo-Carboniferous system of New South Wales, and being characterised by the occurrence of Glossopteris.

It might be mentioned here that the upper or Newcastle coal measures and the middle or Tomago coal measures of New South Wales are absent in Tasmania, the upper coal measures of this State being placed in the Jurassic or Trias-Jura.

(5) Geographical Distribution.

Mr. Montgomery mentions the occurrence of the "Wynyard Formation" in the Arthur Gorge. Mr. G. A. Waller also refers to the occurrence of the Permo-Carboniferous system on the descent from the Campbell Range to the Arthur River. This would seem quite likely from observing the general trend of the system at Preolenna. The beds here appear, as stated previously, to be dipping to the west or slightly north of west, and striking north and south or north-north-east and south-south-west. It could be quite expected, therefore, to find the series outcropping further west and south than the coal sections. Mr. Waller, as a matter of fact, in his ideal section shows the coal measures outcropping on the fall to the Arthur River. He clearly states that the coal seams had not up to that time been found there.

Mr. Thos. Harris, one of the original discoverers of coal at Preolenna, stated to the writer that he had actually located the coal-seams on the southern slope of the Campbell Range. Mr. James Harrison, of Wynyard, also stated that he had discovered a coal-seam in the Flowerdale River. This is only what could be expected, and points to the need of, and probable important developments from, prospecting westwards and south-westwards of the present known coal area.

It is evident to the writer that the coal-seams do not extend far to the north. About 16 chains from the present loading-station at Preolenna Creek the coal measures are covered with basalt, but the prevailing general dip will about run them out under the basalt somewhere in Cashin's block. In the writer's opinion they need not be looked for any further north than this.

The area over which the coal-seams probably extend is marked on the map accompanying this report, but this prediction partakes to a great extent of the character of a geological speculation, and not of a definite pronouncement. The writer, however, would strongly urge prospecting to be undertaken in this direction.

It is undoubtedly true that the Barn Bluff coal above referred to, and the Preolenna coal measures, represent residual patches of a coal series once continuous over this part of Tasmania, but a great part of which has been removed by successive and prolonged cycles of denudation.

VI.—THE COAL-MINING SECTIONS.

When the first discovery of coal was made at Preolenna, a certain area was reserved by the Government as a coal-mining district. Subsequently six sections were applied for and surveyed, and as these apparently contained all the observed coal outcrops no additional sections have been taken up. Five of these sections, viz., 5964-M, 5965-M, 5704-M, 4970-M, 4967-M, are at present held by Messrs. W. D. Weston and A. L. M. Graue, and comprise a total area of 1440 acres, whilst the Section 4969-M, after being encroached upon by three agricultural settlements, thereby shrinking from 306 acres to 167 acres, is at present vacant.

When held by the North-West Coal and Shale Company the work done seems to have been confined to the outcrops in the neighbourhood of the 9th mile. Although a considerable sum is stated as having been spent by this company, there does not seem very much to show for it. In all, three short tunnels from 16 feet to 20 feet in length have been driven on the coal-seams, and several other outcrops have had a few shots put into them, and thus been exposed somewhat. There is no evidence, however, of any systematic attempt by surface-trenching to definitely determine how many seams really exist.

The present owners have confined themselves to the investigation of the outcrops on Preolenna Creek, in the south-eastern portion of Section 4967-M. Here a tunnel 6 feet by 4 feet 6 inches has been driven for 206 feet in a north-westerly direction, which has intersected four coal-seams, viz., Nos. (0 *a*), 1, 2, and 3 at the mouth of the tunnel, 66 feet, 173 feet, and 204 feet respectively. A shaft 6 feet by 4 feet has been sunk to this level, and passed through seams 2 and 3. Two headings have been driven on No. 1 seam, that on the left being 35 feet and that on the right 20 feet. No. 3 seam was cut while the writer was on the field, splendid progress in driving being made, as much as 4 feet per shift being accomplished with one miner and a trucker. The whole country here is good working ground. Some additional preparatory driving of headings remains to be done on both seams before coal can be mined, but when that work is completed a start will be made to extract coal by working to the rise on both sides of the tunnel. It is intended by the management to work at present only seams 1 and 3, which are both 2 feet thick.

Coal-bins have been erected at the mouth of the tunnel, and a wooden tramway constructed from these to a loading-station at the terminus of the road, 100 feet above the level of the tunnel. The length of this tramway is about 6 chains, and the average grade is 1 in 4. Haulage is done by horse.

Mr. Max Graue, the manager, informed the writer that he had received an order from the Government railways for 100 tons of coal for testing purposes, to be delivered at the Flowerdale railway-station. He hopes to be able to commence actually raising coal by the end of January, and has let a contract for the mining of 500 tons of coal from seams 1 and 3. The whole of this will have to be carted by bullock-wagon to Flowerdale. It would also be advisable, as explained later on, to place several parcels for purposes of trial with gasworks and others, but the management must regard the raising and placing on the market of this 500 tons more in the nature of an advertisement and large scale trial, than partaking of the character of a profitmaking transaction. Certainly it cannot be hoped to mine coal from 2-feet seams, haul it up a slope of 1 in 4 for 6 chains, and then cart it 19 miles by bullock-wagon to the railway.

As regards the future plans of working, it must be abundantly evident that these will depend on two main factors. The first of these is the achievement of conclusive proof that the seams do continue westwards to the foot of the Diabase Range. The second factor is the location of the most convenient point of egress from the sections on the way towards Wynyard.

To obtain indisputable evidence of the first requirement of the future prosperity of the field, the best means, from all points of view, is by means of the diamond-drill. The writer would recommend the putting down of three bores. The location of the proposed bore-sites is indicated on the map of Preolenna Coalfield (Plate IV.). One is in the northern portion of Section 4967, near the north side-line of that section and in flat country. The second bore-site is in the south-western corner of Section 4967. The third bore should be put down in the northern portion of Section 5965.

The data given by these bores as to the depth at which the coal-seams occur will, in addition to determining the western extension of the coal measures, enable calculations to be made as to the direction and amount of the true dip, which knowledge is essential to the laying-out of the workings in the most advantageous manner. It must be watched, however, that these bores are placed at the corners of a triangle, and not in a straight line.

Assuming a general dip of 14° to the west, No. 1 bore would cut the upper coal-seam at approximately 950 feet from the surface, No. 2 bore at 750 feet, and No. 3 bore at 500 feet. It seems very probable, however, that as the seams get further under cover the dip flattens. This is clearly seen where the upper seam has been cut in the tunnel at Preolenna Creek, where the dip has decreased to 14°. Assuming, therefore, that the average dip to the location of these bore-sites is 10°, the respective depths of the coal-seams at each bore would be 570 feet, 480 feet, and 380 feet. It will be the safest policy, therefore, to calculate on a total of 2200 feet of boring being necessary. The Goldfields Diamond-drilling Company Limited would undertake to put down these bores at 11s. per foot. The total cost would therefore vary according to the depth at which the coal-seams will be cut, being at a maximum about £1300. The writer would advise that this course be followed, as the drilling company in question, since it makes a speciality of such work, could carry it out efficiently and expeditiously, and in fact more cheaply than could be done privately by a hired diamond-drilling outfit.

When these bores prove the extension of the coal-seams to these respective points every justification would exist for laying out works on a fairly extensive scale.

The second factor controlling future schemes of operations is the situation of the terminus of the tram-line, which will provide means of transportation to the Flowerdale railway-station. This, as has been pointed out and discussed previously, [42] would be situated somewhere about the centre of Section 4967-M, and about 30 feet below the level of the Preolenna Creek tunnel.

The writer would therefore recommend the extension of this main tunnel in its present direction until it comes to the surface on the western side of the Arthur Track. This will take between 800 and 1000 feet of driving from the present end. As this would be a main haulage adit, it would certainly be advisable to make it of greater dimen-

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[42] *Vide* p. 8.

sions than the present tunnel. The driving of such a tunnel would cost approximately £1 per foot.

The writer would also advise the opening up of the area closely contiguous to the 9th mile, with the object of obtaining information as to how much kerosene shale exists, and also to see whether the 5-feet seam of sapropelic shale improves further in the hill, to a high-grade coal, as there is a possibility of this actually eventuating.

VII.—ESTIMATE OF QUANTITY OF COAL.

In attempting any estimate as to the quantity of coal available in the present undeveloped state of the properties, one must necessarily base all calculations on certain assumptions, and the degree of correctness of any estimate given will vary according to how near these suppositions are to the truth.

In this present case, as in all calculations as to the quantity of coal, the following data must be known or assumed:—

(1) The specific gravity of the coal.
(2) The area of the coal-seams.
(3) The number and thickness of the seams.

(1) The specific gravities of the several varieties of coal occurring in these seams vary from 1·13 to about 1·3. The specific gravity of the coal where it has been cut furthest from the surface is 1·25. This will be taken for the purposes of these calculations to be the average specific gravity of the coal.

(2) The total area of any one of the seams of coal depends on two factors. These are, firstly, the actual area on the map over which the seam extends, and, secondly, the angle of dip. In this case the first factor is really undetermined, but an assumption can be made which, in the writer's opinion, will be found to be not very far from the truth. It will be assumed, therefore, that the three bores, put down as suggested, have actually proved coal to exist as far as these points. The area included between the line of the eastern outcrops and the lines connecting these bore-sites will be taken as carrying the coal-seams. This area measures 750 acres. The true area of the coal-seam is given by the formula $A \sec \theta$, where A is the map area and θ is the angle of dip. In this case the angle of dip may be taken as 10°. The actual area of the coal-seam is therefore 761 acres.

(3) This question as to the number of seams has been discussed in a previous chapter. The conclusion was there arrived at that in all probability there will not be more than five workable seams. For purposes of this calculation we will assume that there are only four seams having an aggregate thickness of 6·5 feet, viz., two seams of 2 feet and two of 15 inches.

Making these assumptions we can calculate as follows:—

1 acre of coal-seam will contain 43,650 cub. ft.

$$\therefore \text{Number of tons in 1 acre of coal-seam} = \frac{43650 \times 1 \cdot 25 \times 62 \cdot 35^{*}}{2240}$$
$$= 1400 \text{ tons approx.}$$

A correction must be applied to this value to allow for losses in working, pinching out, &c. About 400 tons per acre will exhaust all general hindrances and losses in working, which will leave a net return of 1000 tons per acre 1 foot thick.

$$\therefore \text{The total quantity of coal} = 761 \times 6 \cdot 5 \times 1000 \text{ tons}$$
$$= 4{,}946{,}500 \text{ tons.}$$

In round numbers, therefore, the amount of coal available under the abovementioned circumstances may be taken as five million tons.

In the present undeveloped state of the seams carrying kerosene shale no attempt at an estimate of its tonnage is possible.

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* 62·35 is the weight of 1 cub. ft. of water in lbs.

VIII.—COST OF PRODUCTION AND VALUE OF PRODUCTS.

When discussing the influence of topography on mining it was pointed out that the conditions for adit-mining were not ideal at Preolenna. Yet at the same time the conditions may be described as certainly very favourable. There will, as far as present indications go, be no necessity for deep shafts. The character of the roof and floor of the coal-seams is very favourable, and is conducive to low mining costs. The smallness of the seams, however, must necessarily make mining more costly than is the case in working larger seams. The coal itself is easily broken, with the exception of the kerosene shale, which is tough, and is therefore rather more costly to mine than other varieties of coal.

It must be mentioned, at the outset, that the actual cost of mining coal will depend very largely on the manner in which the whole question is tackled. It is very easy to ruin an enterprise, which possesses all the factors essential to success, by inefficient and unsystematic work at the commencement of operations. The whole scheme of operations should be based on scientific and economic principles from the very inception of active work. The futility of starting operations in any other manner cannot be too strongly urged on those in authority.

Provided that work is carried out on the abovementioned lines, the hewing cost should not exceed 4s. per ton, or, at the outside, say 5s. in the skips. This would mean a cost of approximately between 6s. and 7s. per ton delivered into the tramway trucks.

Mr. John Watson, general manager of the Jumbunna Coal Mine, Gippsland, Victoria, who has recently visited and examined the Preolenna Coalfield, states that in his opinion the 2-feet seams can be mined for not more than 4s. per ton in skips, and the 15-inch seam for 6s. At Jumbunna, where a seam from 2 feet to 3 feet 6 inches is worked, the corresponding costs are from 3s. to 3s. 6d.

For purposes of comparison the following example may be given, from Wales:—

Welsh Bituminous Coal Colliery—([43])

Average thickness of seam: 2 feet 8 inches.
Dip of seam: 9° to 14°.
Method of working: Double stall.
Cost per ton: Hewing, 2s. 4·5d.; haulage, &c., 2s. 3·0d.; total cost in railway trucks, 4s. 7·5d.
Wages: Colliers average 7s. 2d. per shift.

The cost of mining the kerosene shale will of course exceed the above figure. Mr. Twelvetrees in his report on this field gives the probable cost at 8s. delivered at the tunnel's mouth. The whole question of mining costs of kerosene shale and allied minerals is discussed in Mr. Twelvetrees' bulletin on the "Tasmanite Shale Fields of the Mersey District,"([44]) and the reader is referred thereto for information and references on this point.

It is important at the outset to obtain some idea as to the probable selling-price of the coal when mined. It must be pointed out, however, that the only satisfactory way to settle this point is by actual experiment on a somewhat large scale.

There are several distinct directions in which the Preolenna coal promises to obtain good markets:—

Steam-generating Purposes.—Tests made of the calorific value or evaporative power of these coals show that they compare very favourably with, even if they do not surpass, the best New South Wales coal. The kerosene shale has an evaporative power of between 14 and 15, as determined with Thompson's calorimeter by Mr. W. F. Ward in the Government laboratories. The other class of coal developed at Preolenna, which will in future be sold for steam purposes in preference to the kerosene shale, gave, as tested in Sydney, an evaporative power of 13·9 lbs. of water per ton of coal. The average of the East Greta coal is 13·2, that of the Newcastle coal 12·7, and that of the Southern coalfield product 12·68 lbs. of water converted into steam per ton of coal. ([45]) Other tests of the Preolenna coal made by Mr. W. F. Ward gave an evaporative power varying from 12·1 to 14·0. It is thus seen that the balance is in favour of the Preolenna coal.

([43]) *Vide* "Colliery Working and Management," by Bullman and Redmayne, 1906, p. 276.

([44]) Geol. Surv. Tas. Bulletin No. 11, pp. 103-105.

([45]) Geol. Surv. New South Wales: "The Coal Measures of New South Wales," by Ed. F. Pitman, 1912, p. 26.

In the matter of ash percentage, also, the comparison is very favourable to Preolenna coal. The average ash content is 7·6 per cent., as compared with 8·71 for Newcastle, 7·03 for East Greta, and 11·66 for the southern coals of New South Wales. [46]

At the same time it must be remembered that its specific gravity being lower than that of the New South Wales steam coals, more space will be required for its stowage. Also it seems that this coal is rather brittle, and it probably will not carry as well as the hard humic coals; but this hardness and consequent carrying power will most probably improve as the seams are worked beyond the limit of atmospheric influences.

The trial lot of 100 tons which is to receive a thorough working test on the Tasmanian railways will give valuable, indispensable, and final data as to this application.

Household Purposes.—The same remarks may be applied here as in connection with the previous application, and the coal will undoubtedly prove an excellent one for range, grate, and general purposes—as good as, if not superior to, Newcastle coal.

Smithy Coal.—This coal, provided the sulphur content does not abnormally increase, will prove an excellent smithy coal.

Gas-manufacturing.—It is under this head, perhaps, that the coal will provide the most useful application.

In calculating the exact utility of any coal for gas-making, six main factors must be taken into consideration: (1) The amount of the gas per ton of coal; (2) the quality or candle-power of this gas; (3) the amount of nitrogen recovered as ammonia; (4) the sulphur contents; (5) the amount and character of the tar produced; and (6) the amount and quality of the coke produced. It will be seen, therefore, that to accurately predict the value for gas-making is impossible from any consideration of the results of chemical analyses. The only satisfactory way to establish a basis for commercial transactions would be to have a sufficiently large parcel tested under working conditions in some gasworks. Thirty tons would provide a three days' run at the Launceston Gas Company's works, and this would give all the abovementioned necessary data.

It may be stated at once, however, that from tests already made on a small scale, as detailed hereunder, the

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(46) *Ibidem*, p. 26.

Preolenna coal has proved to be superior for gas-making purposes to the best coal imported here from New South Wales.

Tests have been made of small parcels of both kerosene shale and black cannel coal at the Launceston Gasworks.

The kerosene shale gave on retorting 11,500 cubic feet of gas per ton. The candle-power of this gas was so phenomenally high that it extended beyond the limit of the photometric scale used. It was estimated at about 40 candle-power. The coke formed was reported as useless. This agrees with the results obtained from New South Wales kerosene shale, which has been widely used as a gas-enricher, rather than as a source of gas *per se*. Statements have been made that the price of the best export New South Wales shale for gas-enrichment purposes is 45s. per ton on the Sydney wharf. It must be remembered, however, that the actual price to be obtained for products such as these is not what they theoretically and on their merits ought to be worth, but what they will realise under the exigencies of commercial bartering.

From the following result it will be seen that the second class of sapropelic coal at Preolenna provides an ideal gas-making coal. Arthur Green, Esq., secretary of the Launceston Gas Company, reports as follows on the trials of this coal. ([47])

"December 6, 1902.—I have the honour now of reporting upon two samples of coal received, said to have been obtained from newly-discovered seams in the vicinity of Wynyard, on the North-West Coast. The first sample, a very superior bituminous coal, was tested in the retort-house for coke only, with the following results:—159 lbs. of coal yielded 62·89 per cent. of good, clean, hard, marketable coke, superior in quality to any yet obtained in these works from any other Tasmanian coal, and I think it would have been better if the charge had stayed longer in the retort. The second sample was tested fully for gas and coke, and the average of three very careful tests gave the following very satisfactory results:—Volatile matter, 47·19 per cent.; coke, 52·81 per cent. The coal yielded 12,030 cubic feet of gas per ton and 10 cwt. 2 qr. of excellent coke. I am very pleased to be able to report not only was the quantity of gas per ton greater than that from any other test of coal, either Tasmanian or New-

([47]) "The Kerosene Shale at Preolenna," by W. H. Twelvetrees, *loc. cit.*, pp. 11-12.

castle (New South Wales), made at these works, but the quality also was superior. Tested by the jet photometer (Kirkham and Sugg's patent) the illuminating power of the gas was twenty candles per gas referee's burner, and I have no hesitation in saying that if coal can be supplied in quantity equal to the samples submitted for tests, I should prefer it as a gas coal to any we have yet received from New South Wales."

The gas-yield from the best New South Wales coal (East Greta) used in Launceston is about 11,000 cubic feet per ton, and the candle-power 18 candles. The Preolenna coal is therefore distinctly superior both in the yield per ton and illuminating power.

The price paid for East Greta or Pelaw Main Coal, delivered in the Launceston Gasworks, is roughly 21s. per ton. If all the other factors are satisfactory the high yield and candle-power of the gas should bring for the Preolenna coal a higher price than this. The 30-ton trial parcel will exactly determine this.

Distillation for Oils.—There is a possibility in this direction, which only trials by qualified experts can finally decide.

In the first place there can be no doubt that the kerosene shale would give, on being subjected to distillation at a low temperature, a large number of valuable products, such as illuminating oil, paraffin, fuel oil, &c., in a very similar manner to the allied New South Wales and Scotch minerals. ([48]) The quantity of shale available, however, is at present too small to warrant any consideration of the erection of retorts.

There is a possibility, however, that the whole of the coal occurring at Preolenna will give, on distillation, some members at least of the aliphatic series. Kerosene shale and oil shale in general give the following products:—(1) Illuminating and lubricating oils, (2) gas, (3) ammonia, (4) tar and leaving, (5) a valueless carbonaceous residue. The relative amounts of oil and tar, *i.e.*, of members of the aliphatic and aromatic series respectively, vary in different kinds of shale, and their fractionising, when the aromatic series is in marked excess, is attended with some difficulty. In the case of the Preolenna coals there would certainly be tarry products evolved, but at the same time there

([48]) For full particulars see J. E. Carne's and Dr. Ells' works, both previously mentioned, and also "Petroleum and Its Products," by Sir Bovington Redwood.

would undoubtedly be some kerosene-like products formed. The exact amount and character of these products can only be proved by experiment, and the writer would advise the submission of a parcel of the kerosene shale, black cannel, and sapropelic shale to a qualified chemist for research in this direction. It must be understood, of course, that the results obtained at a gasworks under the conditions of high temperature retorting existing there could give no indication of what products would be obtained by distillation at the low temperature which characterises the treatment of oil shale.

If this investigation results in the indication of any special value along these lines, the advisability of erecting retorts on the mine and subjecting the whole output to distillation can then be gone into. This consideration of cost of erection of plant and retorting kerosene shale is thoroughly discussed by Mr. Twelvetrees in Bulletin No. 11 above referred to, and need not be entered into here.

The price of New South Wales steam coal (slack), delivered on the wharf in Launceston, is 23s. per ton; the cost at the colliery being about 10s. per ton. Large coal (New South Wales) is sold in Launceston at 25s. per ton delivered on the wharf, about 11s. per ton being paid for it at the collieries in New South Wales. Preolenna coal would certainly demand these prices, and in fact for all purposes this coal could command the highest market price.

There is one factor, however, which will have a bearing on the ultimate value of the coal, and that is the sulphur content. At the surface the sulphur content is remarkably low. Where No. 3 seam has been cut in the tunnel, roughly 50 feet below the surface, there appears to be an aggregation of pyrites which brings the sulphur content at this point in the sample taken up to 4 per cent. This is rather high, but it is characteristic of coal-seams that this sulphur content is specially concentrated at certain points, *e.g.*, the brassy tops at East Greta, and may not represent the general state of things. Even if this is the real sulphur content of the seams the coal will still bring a good market price. The exact value, however, can only be ascertained by the further opening-up of the coal-seams.

IX.—THE TIMBER RESERVES.

There is an abundant development of first-class milling timber in this district. The timber-belt seems to be situated west of the present road, from roughly the north side-line of Cashin's block to an undetermined distance southwards from this point. The distance to which the belt extends westwards is at least 4 miles, but no survey could be made to determine even its approximate extent. Mr. Windsor, the district surveyor at Wynyard, stated to the writer that he estimated the actual area covered with first-class timber to be at least 5000 acres in the area closely contiguous to the proposed tramway terminus. Whatever is the actual area there is certainly an immense quantity of valuable timber in this localty.

Stringy-bark of gigantic size occurs in extensive belts; blackwood and celery-top pine are also abundantly developed, while myrtle abounds in profusion.

The land which carries this gigantic timber is only second-class, although some undoubtedly is first-class basaltic soil occurring towards the north-western portion of the coal sections.

No exact conclusions could, owing to the limited time available, be drawn as to the influence of the rock-types on the character of the forest growth.

X.—CONCLUSION.

We have, therefore, at Preolenna a field in which are developed valuable deposits of coal and timber.

For over 11 years the district has lain dormant simply owing to the lack of proper communication with Wynyard. Several attempts have been made to open it up, but have all failed owing to this absence of an indispensable factor.

The present examination has conclusively established the fact that there exists only one seam of kerosene shale in the area closely contiguous to the 9th mile, whereas previously it was believed that there were two such seams; that there is another altogether separate seam which carries some kerosene shale at Preolenna Creek; and that the total number of workable seams is four, with perhaps one other.

As the result of his investigations the writer is convinced that in these coal measures there exists a high-class coal, the like of which is seen in no other coalfield in Tasmania, and which will be excelled for certain specific purposes by very few in the world, provided the sulphur content does not abnormally increase in amount. Even if this latter contingency eventuates the other excellent properties of the coal will still make it a very useful one. In any case, therefore, this coal is destined to prove of material benefit to Tasmania in general and the North-West Coast in particular.

The field is not a very large one, and the quantity of coal available (5,000,000 tons) does not compare with, say, the Newcastle or East Greta coalfields, yet the writer is sure that with careful, scientific, and efficient management a profitable and valuable industry can be initiated, provided that a tramway is available for transporting the products to market.

A valuable timber industry could also be initiated under the same conditions of transport facilities. The writer would therefore urge the necessity of a tramway from the Flowerdale railway-station to the coal-mining sections which would incidentally serve the settlers on the intervening rich agricultural land.

In the meantime, and to provide every justification possible for such tramway, he would advise the present owners of the property to carry out the work indicated in this report in respect to putting down bores and the placing of trial lots of coal for purposes of proving their most valuable commercial applications, thus enabling future operations to be based on scientific and economic principles. He would also strongly urge the desirability of prospecting the country west of the coal sections, with the object of finding the western extension of the coal measures.

The writer here wishes to place on record his appreciation of, and thanks for, the kindness shown him, and the assistance in the field rendered to him, by Mr. Max Graue, of Preolenna, and also his indebtedness to Mr. P. Doyle, Inspector of Roads in the Wynyard district, for valuable information concerning the proposed tramway route.

The Geology of the Wynyard District.

I.—INTRODUCTION.

The following report embodies the results of observations made from December 3 to December 10, 1912. The object of the examination was to ascertain whether there was any possibility of coal measures occurring in the immediate vicinity of Wynyard.

It has apparently been a current belief at Wynyard that coal existed at some depth beneath the surface of the neighbouring country. This belief has been freely expressed by men who had had coal-mining experience elsewhere in Tasmania and in England and Scotland. One of the first to express this opinion was Mr. John Bauld, who came to Tasmania under contract to carry out boring operations in the Mersey district, and who secured assistance from the Government at that time in the direction of the use of their boring plant. When this plant arrived from Hobart it was found to be in very bad condition and unfit to work, and in the face of this difficulty the scheme collapsed.

The belief in the existence of coal, however, has persisted up to the present time, and in July, 1912, Mr. James Harrison, of Wynyard, took the matter in hand, and, after making some investigations in the matter, convened a public meeting at which positive opinions were expressed on the subject. As a result of this meeting the Government was approached with a request for assistance in boring. Subsequently the writer received instructions to examine the district and report on the existence or otherwise of justification for any expenditure in this direction.

The area examined is bounded on the north by 17 miles of coast-line east and west of Wynyard, and extends back from here about 6 miles.

II.—PREVIOUS LITERATURE.

The Eocene fossiliferous limestones of Wynyard are described at some length in R. M. Johnston's "Geology of Tasmania." (49)

Mr. A. Montgomery, then Government Geologist, visited the district in 1895, and the result of his investigations is contained in the "Report of the Secretary for Mines," 1895-6.

Since that time no official report by an officer of the Geological Survey has been published. There have, however, at different times been published papers by eminent geologists on various occurrences of geological interest in the Table Cape district.

Mr. Thos. Stephens paid several visits to the locality, and was the first to recognise the glacial origin of the conglomerates; (53) Mr. A. E. Kitson, F.G.S., together with a party from the 1902 session of the Association for the Advancement of Science, examined the conglomerates exposed on the sea-beach near Wynyard (50); Professor T. W. Edgeworth David, F.R.S., the doyen of Australian authorities on glaciation, examined and fully described these boulder conglomerates, which are of absorbing interest as typical representatives of the deposits of undoubted glacial origin, which occur at the base of the Permo-Carboniferous system in the Southern Hemisphere (51); and Mr. W. H. Twelvetrees has examined and described interesting rock-types occurring in the vicinity of Table Cape. (52)

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(49) "Geology of Tasmania," by R. M. Johnston, 1888, pp. 258–265.
(50) *Vide* Transactions of Royal Society of Victoria, 1902, pp. 28–35
(51) *Vide* Transactions Aust. Assoc. Adv. Science, 1907, p. 274.
(52) *Vide* Transactions Royal Soc. Tas., 1902.
(53) *Vide* Proceed. Roy. Soc. Tas., 1869, page 17.

III.—TOPOGRAPHY.

The most prominent topographical feature of this district is the picturesque flat-topped escarpment known as Table Cape. This bold headland presents a scarred precipitous face towards the north, and drops a sheer 520 feet into the waters of Bass Strait, which lave the northern boundary of the area here described. This famous unmistakable landmark has been chosen as a site for a lighthouse, whose characteristic constant illumination guides the mariner for many miles along this sea-coast. The flat-topped surface extends with slight undulations towards the south-west.

The sea-coast westwards from Table Cape, bold, precipitous, and inhospitable, provides no shelter for ships, with the exception of the slight indentation known as Jacob's Boat Harbour, until Stanley is reached, about 27 miles distant. Eastward, however, are the smooth waters of Freestone Cove, which provides the best of shelter in all rough weather, and which is often crowded with storm-bound vessels. The eastern limit of the high land which provides this shelter from the prevailing storms is constituted by the Fossil Bluff, which is 160 feet high, and slopes steeply downwards to the flat country at the mouth of the Inglis River.

From the mouth of the Inglis River eastwards the shore is flat and uninteresting from the scenic point of view. There is almost a total absence of sandy beach, the strand-line being composed of the slightly-dipping beds of glacial conglomerate, which provide a rough, scarred boulder-strewn beach, most uninteresting to the average tourist, but of absorbing interest to the geologist. The Doctor's Rocks, however, is a picturesque little headland composed of black basaltic columns, eroded by wave-action, especially along joint-planes, which has evolved the present development of solitary columnar masses separated by patches of smooth yellow sandy beach.

There is on this coast a total absence of sand-dunes.

The town of Wynyard has been built on flat country known as the Wynyard Plain. This plain extends roughly from the right bank of the Inglis River southwards for an average distance of 1½ mile, and eastwards to the northern slope of Woody Hill. It is, in the writer's opinion, a plain of marine denudation subsequently occupied by a brackish lagoon, formed by the damming back of the Inglis River in Post-Tertiary times. In this lagoon were deposited the loams, white sands, and clays which now occupy the whole of the flat country from its western boundary to near Stinking Creek, which roughly represents the position of the former eastern shore of the Inglis Lagoon. Eastwards of this line the plain is covered for the most part with coarse shingle, indicating a raised beach.

Westward of this plain the country gradually rises towards the Sisters Hills, which run in a general north-and-south direction. The elevation of the highest peak on this range (the "Big Sister") is 760 feet. The elevation of the general surface of the country after the first relatively steep rise from the Wynyard Plain is 320 feet.

From the southern boundary of this plain the land rises somewhat sharply for a short distance, and then gradually and persistently until it reaches an elevation of 1800 feet at the summit of the Campbell Range.

The land is drained by three main rivers and numerous creeks. These all have a general northerly flow. The River Inglis is the main stream, receiving the waters of the Flowerdale and Calder Rivers and Camp, Big, and Blackfish Creeks. The points of confluence of these streams with the Inglis are 5 miles, 14 miles, 10 chains, $1\frac{1}{2}$ mile, and 3 miles respectively above the debouchure of the latter river, which for the last 5 miles of its course flows in a general easterly direction. Seabrook Creek flows in a northerly direction directly into Bass Strait.

All these streams have carved deep valleys for themselves, and the ridges between them are all approximately of the same height, at equal distances from the sea-coast, and on opposite sides of each valley.

Standing on the flat summit of Table Cape and looking inland, one cannot resist the conviction that there exists from this point eastwards, westwards, and southwards the remnants of a former peneplain, the surface of which at the sea-coast is now represented by the general level of the summits of Table Cape, Woody Hill, Fern Hill, and the more level country immediately east of the Sisters Hills. By a lowering of the strand-line this peneplained surface has been cut-up by the rejuvenated activities of the consequent streams and atmospheric agencies of denudation, together with the erosive action of the sea, into the present rugged configuration of successive high ridges and deep narrow gorges, with flat plains in the neighbourhood of the sea-coast.

The only marked protuberance above this general level is Mt. Hicks, which is a conical hill, rising to a height of 800 feet above sea-level. This is probably the residual core of a former volcanic cone.

The total difference in elevation between the flat top of Table Cape and the top of the ridge to the south of the Jessie Gorge is 1010 feet. This gives an average slope upwards in this direction of 59 feet per mile, which is continued at the same rate to the summit of the Campbell Range.

It is interesting at this point to consider this peneplain in relation to that on the Mt. Balfour Field described by Mr. L. K. Ward, ([54]) and especially in connection with one of the questions indicated by him as requirng further research before any correct answer can be given. In discussing this question Mr. Ward ([55]) says:

"These areas lying to the north and south of the Balfour field are quite clearly physiographically cognate. But when we turn to the country lying to the eastward, difficulty arises for want of hypsometric details. Questions that suggest themselves are these:—

> Does the coastal piedmont plain slope gradually upwards until it attains an altitude of 2000 feet at Waratah, so that the deeply dissected peneplain of that region is really one with that of the coastal belt which has been here described?
>
> Are the Long Plains part of this problematical unit?

A positive answer to both questions, however strongly may be the probability of its correctness, is hardly justifiable at the present time."

The total rise from Table Cape to the Bischoff Plain is 1480 feet. This gives the average rise as 41 feet per mile, which corresponds very closely to the rise per mile of the Balfour peneplain and the Wynyard peneplain above described. From the general view of the country to the south and south-east of Preolenna it would appear that the Bischoff Plain is a continuation of the Wynyard peneplain.

If, therefore, Mr. Ward's suggestion turns out to be correct, it seems as if these three peneplained surfaces can be correlated as parts of one physiographical unit. No more than this possibility can be indicated at the present.

([54]) *Vide* Geol. Surv. Tas. Bulletin No. 10: "The Mount Balfour Mining Field," by L. K. Ward, pp. 8-10.
([55]) *Ibidem*, p. 15.

IV.—GENERAL GEOLOGY.

(1)—The Rock-types Represented in the Field.

A.—SEDIMENTARY ROCKS.

(1)—*Pre-Cambrian.*

The eastern and western boundaries of the area examined are formed by members of this system. The two occurrences apparently do not belong to the same series, if any reliable conclusion can be arrived at which is based on petrographical character alone.

The eastern series is shown on the seashore about $4\frac{1}{2}$ miles due east from Wynyard, where the rocks form the eastern boundary of the Permo-Carboniferous conglomerates which unconformably overlie them. They consist of quartz-mica and sericitic schists and greenish felspathic quartzites, dipping at a high angle of 50° to 55° to the east and striking north and south. This series continues along the beach towards Burnie. They are highly contorted, and in places show splendid examples of folding into synclines and anticlines on both a large and small scale. Inland, to the south, they are covered by Tertiary strata and basaltic lava-flows, but outcrop in the beds of rivers or creeks at several points.

The western series is developed at the Sisters Hills, which are almost wholly composed of these rocks. Here the rock-types are dense white quartzites and fine-grained conglomerates. Occasionally the quartzites assume a pink tinge, but the prevailing colour is white. They are folded, but not to such a marked degree as the eastern series.

Mr. L. K. Ward has divided the Pre-Cambrian in Tasmania into two divisions: a lower highly contorted and altered series of mica-schists, and a less highly metamorphosed and generally more horizontal series of white and pink quartzites which unconformably overlie the former series. It seems probable that these two series are represented by the abovedescribed occurrences, but the writer had no opportunity, on this occasion, of making any thorough examination.

(2)—*Permo-Carboniferous.*

The only members of this system represented at Wynyard are the basal series of glacial conglomerates, which are here developed as a particularly interesting and instructive record of Permo-Carboniferous glaciation. They have been studied and described by Professor David and Mr. A. E. Kitson. Therefore, for the direct purposes of this report, there is no need to do more than give a short description, sufficient to prove that their geological horizon is at the base of the Permo-Carboniferous system.

This series is shown on the beach from about the centre of Freestone Cove to the junction with the Pre-Cambrian mica-schists, 4½ miles to the east. In Freestone Cove and at Fossil Bluff they are unconformably overlaid by Eocene limestone beds. At Doctor's Rocks they are covered by a flow of Tertiary basalt. They underlie the whole of the Wynyard Plain, being there covered with the Quaternary deposits of sands and clays. They are shown in most of the creek-beds and in the bottoms of wells sunk on this plain. They extend southwards, forming the bed rock on which the Tertiary deposits were laid down, and are here again shown in the beds of the creeks and in the bottom of wells, as at H. G. Stutterd's farm, where in a well 30 feet deep they occur 90 feet above sea-level. In Big Creek, below this point, they are seen 45 feet above sea-level. The outcrops of this series occur in the river beds constantly until Preolenna is reached, where the geologically higher members of the Permo-Carboniferous system are developed.

The series consists of alternating beds of slaty-coloured, shaly mudstones, mudstone conglomerate, conglomerate, pebbly sandstones, grits, and consolidated glacial till. This latter is perhaps the most striking member of the series. The blocks comprised in this consolidated boulder clay are composed of quartzites, different members of the porphyroid series, granite (always the red-felspar variety), limestone, &c., all belonging to rock series older than the Permo-Carboniferous. These erratics are of all sizes, from huge blocks of granite and quartzite 3 tons in weight downwards. They often show signs of grooving and striation, so characteristic of glacial deposits, and some splendid examples of ice-scratched boulders can be found. Professor David has recognised three separate striated pavements, which represent old surfaces over which the glacier moved. The total thickness as given by Prof. David is 1220 feet. They dip at from 5° to 10° in a general west to north-north-westerly direction.

The whole series provides a most interesting study, and is shown to especial advantage on the sea-beach, where the superior hardness of the included erratics has been instrumental in isolating large blocks which can be examined under ideal conditions at low tide.

They unconformably overlie the Pre-Cambrian mica and sericitic schists, the actual junction being clearly seen on the beach about three-quarters of a mile directly east of the Doctors Rocks.

They are unfossiliferous, and no trace whatever has yet been found of organic remains, in spite of the diligent search made for them.

These glacial conglomerates occur elsewhere in Tasmania in the Mersey district,(56) and at Adventure Bay in Southern Tasmania; and in both these localities they form the base of the Permo-Carboniferous system.

Their geological homologues are, (1) the Dwyka conglomerate of South Africa, (2) the Talchir conglomerate at the base of the Gondwana system in India, (3) the Orleans conglomerate of South America, and (4) the Bacchus Marsh glacial beds of Australia—all of which are geologically lower than the lowest coal horizon.

(3)—*Tertiary*.

There is an abundant development of strata of this system in the neighbourhood of Wynyard. Two series are represented, the Lower Marine series and the Upper Lacustrine series.

The Lower or Marine series are regarded as being of Eocene age by R. M. Johnston, who has furnished a complete description of them in his "Geology of Tasmania."(57) They consist of a horizontal series of beds of yellow arenaceous limestone replete with marine shells, and rest unconformably on the Permo-Carboniferous conglomerates. Their most pronounced development is at Fossil Bluff, where they are exposed in the sea-cliff for a thickness of about 80 feet, being covered by decomposed basalt, which forms the capping of the Bluff. They are subdivided by Mr. Johnston into two series, Upper and Lower, the latter being characterised by the genus *Crassitella* and the former by the small shell *Turritella*.

These Eocene marine beds occur again in Mitchell's Creek, about a quarter of a mile along the Stanley-road past the Inglis Bridge. They are here overlaid by red clays.

(56) Geol. Surv. Tas. Bulletin No. 11, p. 19, *et seq*. (57) Pages 258–264.

They may be correlated with the similar beds at Cape Grim and in the neighbourhood of Temma and Marrawah.(58) These occurrences are most probably residual patches of a once continuous series.

The Lacustrine deposits which form the upper members of the Tertiary sedimentary strata are classed by R. M. Johnston as Mid-Tertiary. They consist of claystones, mudstones, sands, gravels, and clays, with occasional seams of lignite.

They occur throughout the whole of the district examined, with the exception of the Wynyard Plain and the Sisters Hills. They do not always appear at the surface, being in great part covered by the basalt lava-flows of later age. Where, however, the streams have worn through this basalt covering, and subsequently downwards into these softer sedimentary rocks, they can be conveniently studied. They occur on the surface for some little distance from the southern boundary of the Wynyard Plain, until the rising slope comes to the level of the basaltic covering, the lower portion of which sheet varies, as it is traced southwards, from less than 200 feet upwards, until at Preolenna it is 1500 feet above sea-level. Southwards of this northern edge of the basaltic flow, this Tertiary series only occurs in the river valleys.

Immediately below the basalt is a bed of white quartz gravel, which occasionally carries payable gold. This gravel is generally lower towards the coast than further inland, and as it is found more or less all over the district under the basalt, at the same elevation approximately on each side of each spur, and on opposite sides of each valley, it is clear that previous to the basaltic eruptions there was an extensive area of country sloping gently seawards, covered more or less with gravel.

Under this gravel there usually occurs a bed of lignite or brown coal. The thickness varies, being sometimes 5 feet, but generally less. In T. Harris' block the seam is seen at 330 feet above sea-level, and numerous outcrops of the seam occur all over the district in the river valleys.

Beneath the lignite occur alternating beds of clays, claystone, mudstone, &c., which rest unconformably on either the Pre-Cambrian mica-schists and quartzites or the Permo-Carboniferous mudstone conglomerate or mudstone, which are seen outcropping in the beds of the rivers and creeks.

(58) Geol Surv. Tas. Bulletin No. 10, pp. 39-40.

The lignite is the typical occurrence, so common in Tertiary deposits throughout Tasmania. It is at present of no commercial value whatsoever.

(4)—*Quaternary.*

There are rocks belonging to this system represented in this district, but it is impossible to separate the Pleistocene from Recent sediments.

The whole of the Wynyard Plain is composed of Post-Tertiary clays, sands, and gravels, resting unconformably on the Permo-Carboniferous mudstone conglomerates. A good section is shown in the railway-cutting east of Big Creek. Unconsolidated sands and gravels are here shown overlying a crumbly sandstone full of partially lignitised leaves and twigs together with fragments of sea-shells. This series is evidently a lagoonal deposit laid down in a brackish lagoon, formed by the damming-back of the waters of the Inglis River.

Eastward of Stinking Creek occur beds of coarse shingle, which undoubtedly must represent a former strand-line.

B.—IGNEOUS ROCKS.

There are three varieties of igneous rocks developed in this district, all of which are mutually related, but whose exact connection has not as yet been definitely determined.

(1)—*Trachydolerite.*

This is the rock constituting the Table Cape Bluff itself. It is a relatively coarse-grained doleritic rock containing labradorite, augite, olivine, titaniferous iron, and magnetite, together with abundant apatite and a colourless mineral determined by Professor Rosenbusch as analcime. It is classed by Rosenbusch as a trachydolerite. No detailed examination was attempted for purposes of this present investigation, but a description by Mr. Twelvetrees has been given in the form of a paper read before the Royal Society of Tasmania on December 1, 1902.

(2)—*Limburgite.*

This rock has not yet been found *in situ*, but occurs in the road-metal used in the district. It is the basic felsparless facies of the normal olivine basalt.[59] Further

[59] Rosenbusch regards limburgite as the basic effusive facies of the theralitic magma, essexite being its plutonic representative.

research is needed to determine its exact relationship with the normal type.

(3)—*Olivine Basalt.*

This is the normal variety of basalt so common throughout Tasmania. It occurs throughout the whole district, generally capping the ridges and higher land. Its distribution can be seen by a glance at the accompanying geological map.

(2) The General Sequence of Events Leading to the Present Geological Structure.

The geological history of the region began with the laying down of the sediments which now are represented by the Pre-Cambrian quartzites and mica-schists. The floor on which these sediments were laid down has not yet been recognised in Tasmania. It would appear, if L. K. Ward's prognostications are correct, that there are two periods of sedimentation represented by these Pre-Cambrian rocks, between which a considerable uplift, folding, and metamorphism took place, followed subsequently by a subsidence of these already folded and metamorphosed rocks, which formed the sea-floor on which the overlying quartzites were laid down as sands and gravels.

This latter period of sedimentation was followed by an uplift, caused by diastrophic movements of the earth's crust, which must have brought about to some extent the present metamorphic character of this series, although it is impossible to say to what extent the subsequent movements in Cambro-Ordovician time were instrumental in this regard.

There is an enormous stratigraphical break between this system and the next following. We must assume that this area, previous to the deposition of the Permo-Carboniferous glacial tills, &c., and after most probably a succession of oscillatory movements, sank beneath the ocean-level. On this sea-floor were deposited the lower series of the Permo-Carboniferous system.

An uplift of the whole region followed, and brought about lacustrine or estuarine conditions, when *the coal measures were formed*. This was succeeded by a positive movement of the strand-line, [60] which again brought about marine conditions, under which were deposited the upper members of the system.

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[60] The "strand-line" is the beach or space between tide-marks where the sea is constantly cutting into the land.

An uplift then supervened, converting the area into a land surface, and there ensued *a prolonged period of denudation sufficient to erode, in the neighbourhood of Wynyard, the whole Permo-Carboniferous system with the exception of the basal conglomerates.* The amount of this denudation decreases as we travel southwards towards Preolenna, until at the latter place the coal measures still remain.

At the beginning of the Tertiary era the coastal region sank beneath the sea, and the Eocene marine beds were laid down as typical littoral deposits. This was followed by an uplift, with a subsequent conversion of the whole region into an inland sea or lake, in which were deposited the beds of clays, mudstones, and lignite.

Again there was a renewal of dry land conditions, during which some considerable denudation was effected. We find lava-flows filling river valleys and basalt resting directly on the Permo-Carboniferous strata without any intervening Tertiary sedimentary representatives, so that the denudation must have been considerable.

The next important geological event was the eruption of the basalt, which overspread the whole area. This was followed by a prolonged period of denudation, during which the abovedescribed peneplain was formed by base-levelling, and the sea eroded the flat floor on which the Wynyard Plain sediments rest, which must have been deposited at the latter end of this period as the result of some minor movement.

A negative movement of the strand-line brought about the rejuvenated activities of the streams, as the result of which they have cut their present valleys.

The estuarine mouth of the Inglis River must have been caused by a downward movement in comparatively recent times.

V.—THE RELATION OF GEOLOGY TO GENERAL INDUSTRIES.

The district of Wynyard is essentially a farming one, and it is important to know in this connection how the geology of the district affects the value of the soils.

Undoubtedly the richest land is that formed by the basalt and trachydolerite, which by their decomposition give rise to the fertile chocolate soil for which the North-West Coast is so famous.

The sediments of the Wynyard Plain form sour sandy soil, which supports very little vegetation, and is absolutely unfit for farming.

The Tertiary sediments give good soil, but as a whole the areas in which rocks of this system occur are designated as second-class land, which is especially suitable for orcharding purposes.

The first-class land is therefore on the ridges, while the second-class lands occur in the valleys.

The Sisters Hills, being composed almost wholly of quartzites, are covered with very barren white sandy soil, which is unfit for general farming purposes. Patches of basalt, however, overlie part of this series, and at these spots farming flourishes.

The basalt is used for road-making, and serves this purpose excellently.

In making the breakwater some years ago, the arenaceous limestone from Fossil Bluff was used, but it proved absolutely unsuitable for the purpose, being far too soft.

VI.—CONCLUSION.

It is apparent, therefore, when we consider that all the coal measures of Australia and Tasmania occupy a higher geological horizon than the glacial conglomerate, that there are no coal-bearing strata in the immediate vicinity of Wynyard.

What have been taken for indications of the close proximity of coal measures are the following:—

Pieces of coal have been found on the banks of the Inglis River. These have been derived from the coal-seams of the hinterland, having been brought into their present positions by means of floods, the lightness and toughness of the kerosene shale making this quite an easy operation.

Lumps of coal have been dug up on the Wynyard Plain and also discovered in the Eocene limestones. These occurrences are only to be expected when we consider that these strata are partially, at least, composed of the products of the denudation of the Permo-Carboniferous rocks, which would provide detached pieces of coal in addition to the accompanying sands and clays. It would, in fact, be surprising if we did not find fragments of coal in these later sediments.

A study of the accompanying cross-section in the vicinity of Wynyard will show the character and position of the strata underlying that town.

The coal measures most probably did at one time exist where Wynyard now stands, but they have long since been removed by denudation.

Although fully realising the importance to Wynyard in particular, and Tasmania in general, of the existence of workable coal in this district, the writer cannot, in view of the indisputable geological evidence to the contrary, recommend the expenditure of public money for boring.

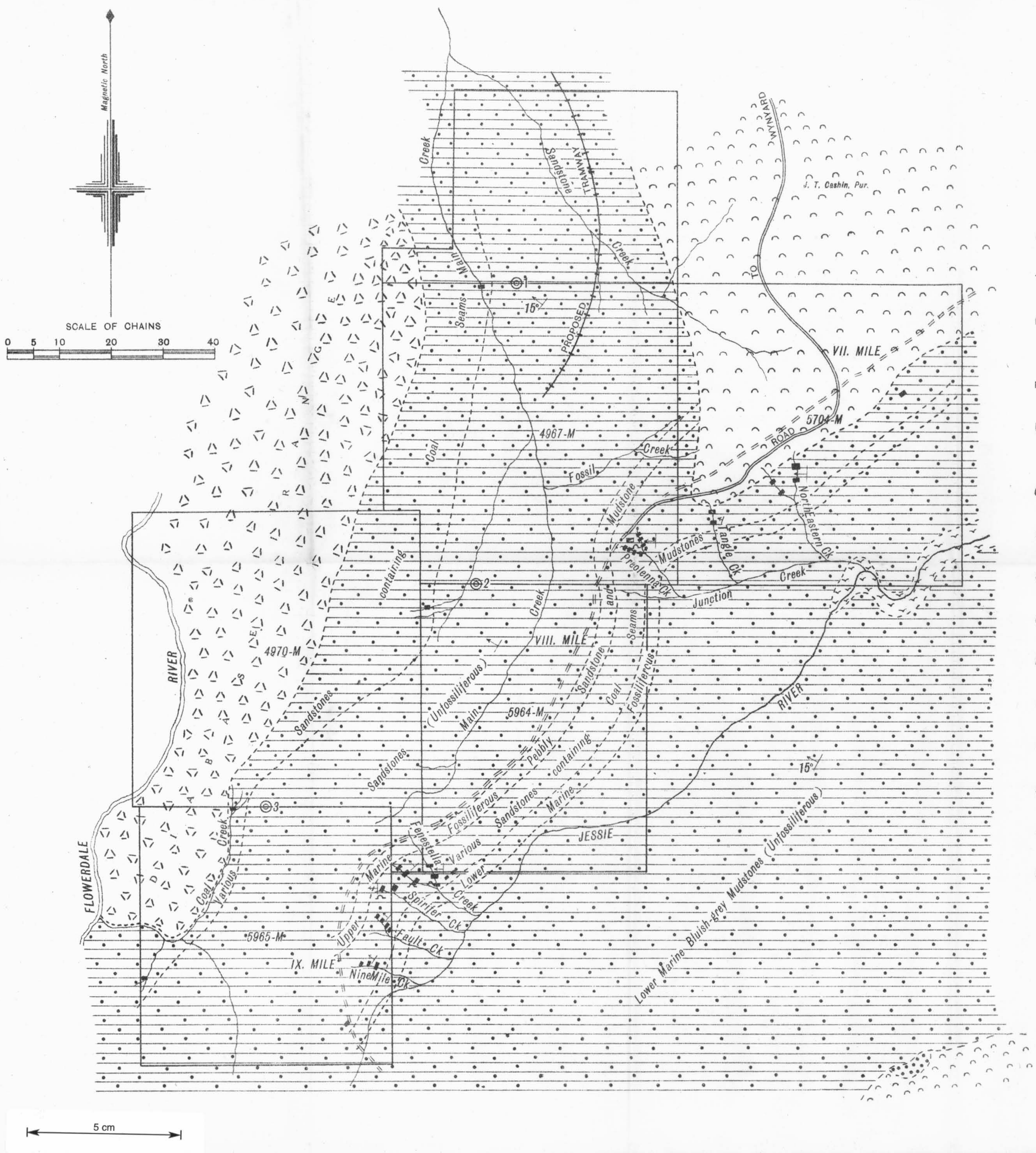
The writer must here express his appreciation of, and thanks for, the hospitality tendered to him by the residents generally, and particularly the invaluable assistance rendered to him while in the field by Mr. James Harrison, of Wynyard, whose intimate knowledge of the district was really indispensable.

LOFTUS HILLS, M.Sc.,
Assistant Government Geologist

Launceston, 17th February, 1913.

PLATE III

GEOLOGICAL SKETCH MAP OF THE PREOLENNA COAL FIELD



LEGEND

SEDIMENTARY

RECENT

TERTIARY

PERMO-CARBONIFEROUS

IGNEOUS

BASALT — *Lava Sheets of Tertiary Age*

DIABASE — *Intrusions at the close of Mesozoic Era*

Geological Boundaries

Boundaries of Coal Sections

Strike and Dip of Strata

Outcrops of Coal

Shaft

Adits

Proposed Bore Sites

Arthur River Track

Proposed Tramway

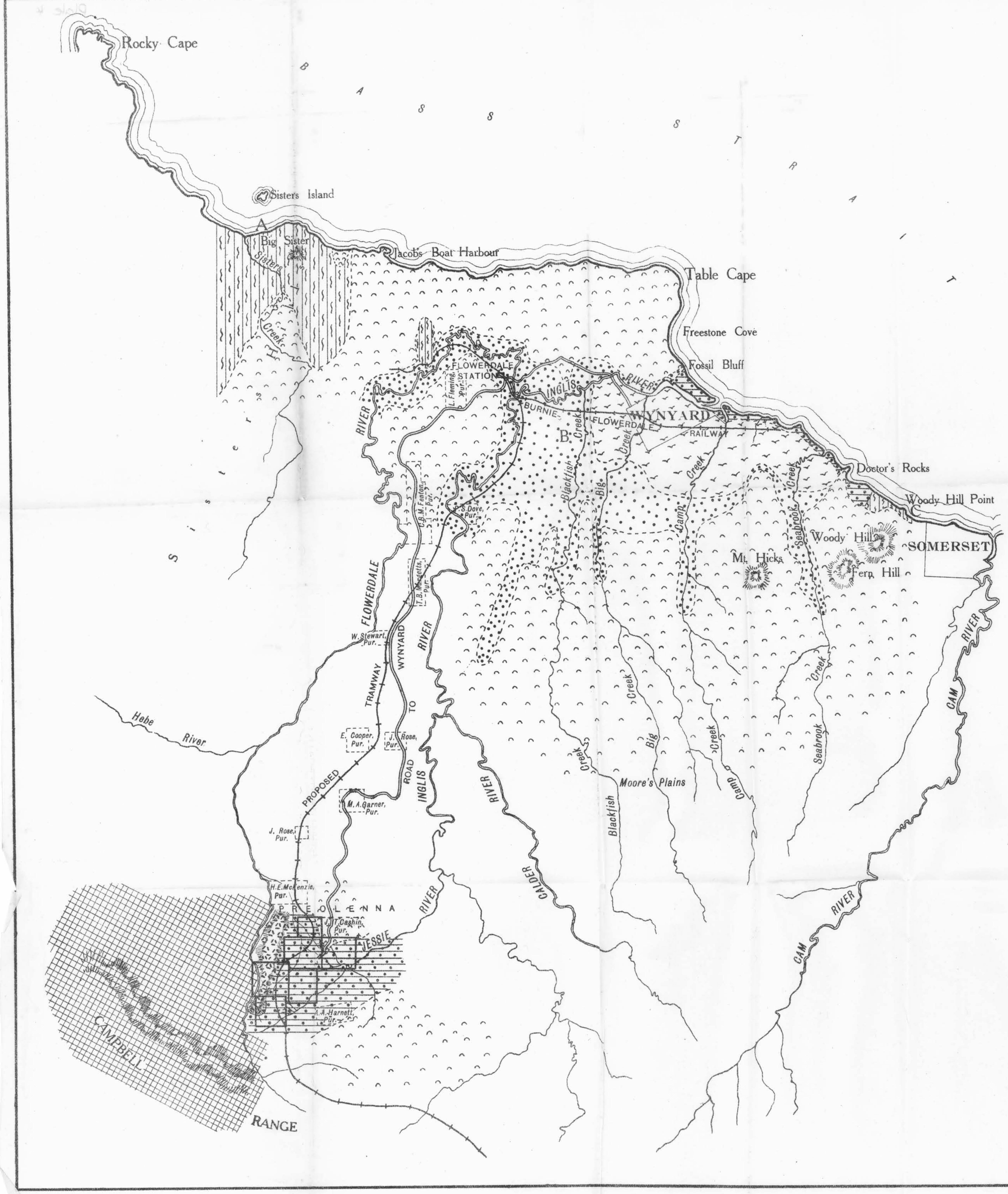
Present Road to Coal Sections

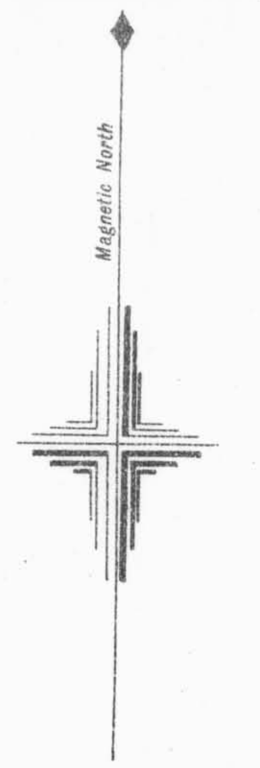
KEY TO NUMBERS OF COAL SECTIONS

Number of Section	Acres	Lessee
4970-M 4967-M 5704-M	320	W. D. Weston
5964-M 5965-M	240	A. L. M. Graue

Loftus Hills M.Sc.
Assistant Government Geologist
17 · 2 · 1913

Photo Algraphed by John Vail Government Printer Hobart Tasmania





SCALE OF MILES

0 1 2 3 4

GEOLOGICAL SKETCH MAP OF THE WYNYARD-PREOLENNA DISTRICT

LEGEND

SEDIMENTARY

QUATERNARY	Sands, Clays and Shingle
TERTIARY	Clays, Mudstones and Gravels with Lignite
PERMO-CARBONIFEROUS	Glacial Conglomerates, Mudstones and Sandstones
PRE-CAMBRIAN	White and Pink Quartzites and Mica-Schists

IGNEOUS

BASALT	Lava Sheets of Tertiary Age
DIABASE	Intrusions at the close of Mesozoic Era

Geological Boundaries

Boundaries of Coal Sections

Boundaries of Agricultural Land Purchased

Present Road to Coal Sections

Proposed Tramway Route

Probable Extension of Coal Area

5 cm

Loftus Hills M.Sc.
Assistant Government Geologist

17·2·13

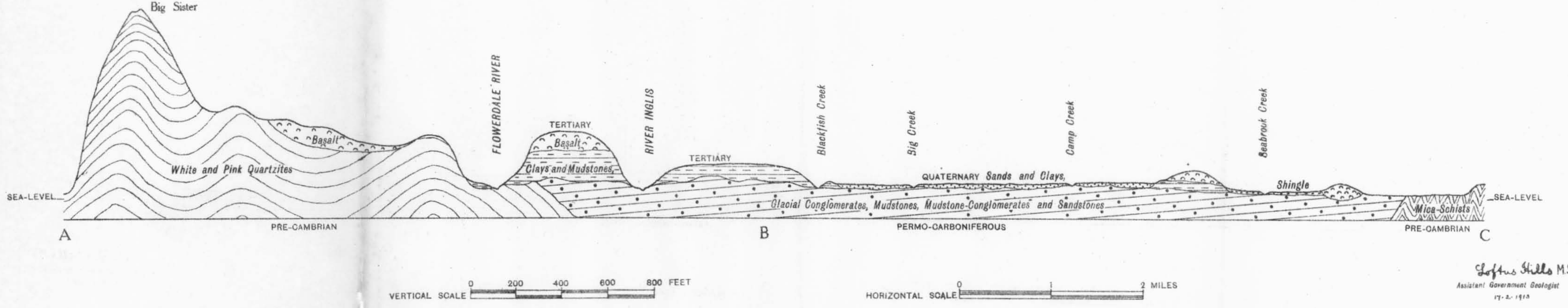
Photo lithographed by John Vail, Government Printer, Hobart, Tasmania.

GSB 13
Plate V

5 cm

PLATE V

SKETCH GEOLOGICAL SECTION ON THE LINES AB-BC
WYNYARD DISTRICT



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17-2-1913

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