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GEOLOGICAL SURVEY BULLETIN

No. 20

The Catamaran and Strathblane Coal Fields

AND

Coal and Limestone at Ida Bay

(SOUTHERN TASMANIA)

BY

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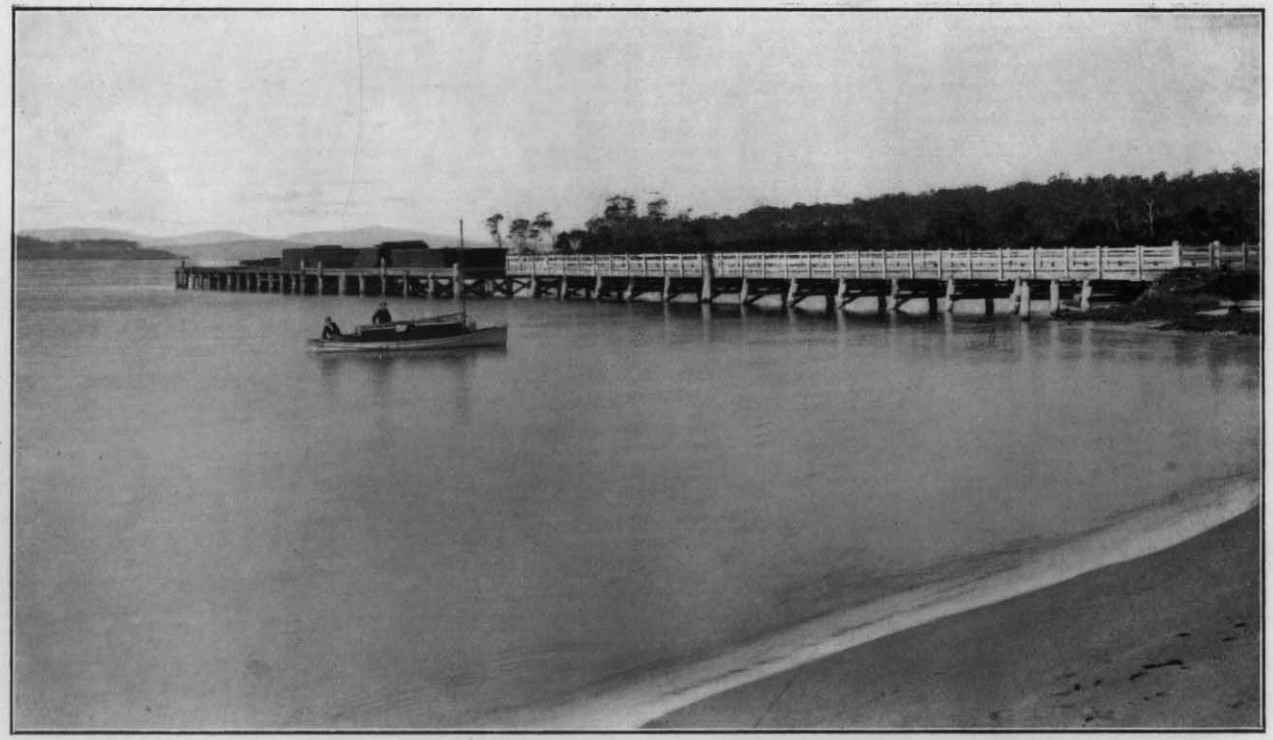


Frontispiece.

PLATE I.—DEEP HOLE JETTY, SOUTHPORT.

The Catamaran and Strathblane Coal Fields and Coal and Limestone at Ida Bay, Southern Tasmania.

I.—INTRODUCTION.

Coal seams in the extreme south of the island have been known for a very long time, and prospecting work was carried out on some of them at an early date. In the forties the Government sank through a coaly shale at Southport ; and the Southport Coal Company put down some shafts on the east side of Recherche Bay. About the same time that company also did a little prospecting work at South Cape Bay, where several seams of coal are exposed along the sea front. The principal seam is known as the 4-feet seam, but the coal is rather inferior in quality. Coming down to more recent times, the seams at Strathblane, Ida Bay, Hastings, Recherche Bay, and Catamaran have at intervals attracted attention, but in no instance has work been carried out on a scale proper to a productive colliery.

Lately investors have been attracted by the properties at Strathblane, Ida Bay, and Catamaran, and the likelihood of developments of more or less importance to the State led to the present examination of the properties in question. Although some of these have been inspected previously, fresh work and new inventions have opened up possibilities which before were practically beyond reach. But for the general dislocation of finance in consequence of the war, there is hardly any doubt that the present year would have witnessed a great revival of interest in these southern fields.

One of the enterprises of greatest importance, inasmuch as it means laying the foundation of a new industry for Tasmania, is that at Ida Bay. It is fundamentally a cement proposition, and the coal will be principally used

for the kiln-burning of the cement mixtures in the production of clinker. The undertaking has the great advantage of having both seams of coal and beds of limestone, as well as clay, on its property, besides a deep-water shipping site available on the Southport harbour near by. The limestone is highly suitable for the purpose in view, and everything seems favourable for a well-planned enterprise.

The coal seam at Catamaran was first seen in 1900, and has been prospected along its crop by the present owners for a considerable distance. It has been shown by shafts, bores, and drives to be of a good workable size. Its quality is that of an excellent steam coal. It is rather friable in its nature, but this is a character which is expected to disappear as depth is gained on the dip of the seam: at any rate, with care in handling and proper arrangements for delivery, a good trade should be easily opened up. The enterprise is in the hands of a Broken Hill syndicate, and once the property is opened up, the prospects ought to be bright.

The coal deposit at Strathblane, discovered about six or seven years ago, offers a fair scope for work on a moderate scale. The seam consists of a firm coal of good East Coast quality, and invites the introduction of a limited capital for the purpose of prospecting and opening up the seam without launching into too heavy expenditure at the start. The property is connected with the water at Esperance by means of a timber company's tramway. If active operations ensue, the colliery company should take steps to possess its own line, or, alternatively, secure cheap running rates over the existing line. The present tramway route is connected with the water in between 4 and 5 miles. A road to junction with the main Hastings-Dover road in a little over a mile could be constructed with no difficulty.

With an increasing population and the general progress of this part of the island, and a growing readiness to embark capital in sound industrial undertakings, it may be anticipated that the southern coalfields will experience a revival of interest and public favour, and will eventually furnish permanent contributions to the coal output of the State.

The writer is indebted to Mr. S. J. Dawson for the Ida Bay photographs appearing in this bulletin, and to Mr. R. C. Young for the plan and sections of bore-holes on the Catamaran property; and to both of these gentlemen, as well as to Mr. Wm. Anderson, for much useful information and valuable assistance on this journey.

II.—PREVIOUS LITERATURE.

The earliest published reference to coal in the extreme south of the island is in a report by J. Hobbs on a boat voyage round Tasmania in 1824. (See House of Assembly Paper, No. 107, 1881.) He describes coal as being visible in the cliffs at South Cape Bay, where he was detained for 10 days by bad weather. He noticed three seams resting on beds of sandstone. The carriage of coal by sea would be prevented by the heavy surf which prevails, but he thought a canal might be cut for half a mile through a swamp at the back to a rivulet which runs into an inlet of Recherche Bay.

The next mention of this coal is found in a report by J. Hobbs, 25th October, 1826. (See Legislative Council Paper, No. 16, 1861.) He states that the nearest harbour where vessels could anchor is in the bay called Rocky Bay (La Baie des Roches), which forms the south-west part of Recherche Bay. The coal is 5 miles south-west from here. An inlet of salt water extends for a mile inland. From the head of this inlet a swamp or marsh extends for 2 miles, bounded on each side by high barren rocky hills. The coal cliff extends about 2 miles along the sea-coast. Specimens of coal were brought to Hobart from a seam 3 feet 4 inches thick, dipping $1\frac{1}{2}$ inches in the yard towards the north-east. Stony matter predominated in the whole of the 3 feet. The coal was dry and uninflammable, but after driving 7 feet on it the quality improved somewhat. The seam could not be worked profitably owing to the rugged nature of the country and the distance from a port.

The next reference is found in Dr. Joseph Milligan's "Reports on the Coal Basins of Van Diemen's Land," contained in the Proceedings of the Royal Society of Van Diemen's Land, Vol. 1, Part I., May, 1849. In Report No. 2, on Whale's Head and South Cape (1848), the author refers to Southport and Recherche Bay (pp. 17, 18, and 19). He mentions the occurrence of black carbonaceous shale in the sandstone cliffs at Southport and fossiliferous sandstone and clay $\frac{3}{4}$-mile west of the Southport station. An abortive shaft was sunk by the Government in the forties, $\frac{1}{2}$-mile from the station. He refers also to a couple of shafts sunk about the same time on the east side of Recherche Bay, and to some inferior coal existing there. The same report describes seams of coal on South Cape

Bay, the principal one being estimated to be capable of yielding not more than 2 feet of useful coal. It is highly carbonaceous and pyritous, and is stated to be inadmissible for domestic purposes, though perhaps useful for blacksmiths' forge work. Dr. Milligan says that two shafts had been started in the diabase rock 500 or 600 yards inland from the bay, with the idea of sinking through it to the 4-feet coal seam seen in the sea-cliff, but sinking was suspended before reaching the coal, which he estimated to lie at a depth of upwards of 400 feet from surface. A fruitless attempt was also made to sink to the coal upon the marshes between Recherche Bay and South Cape Bay.

Mr. R. M. Johnston, in his " Geology of Tasmania," 1888, gives a synopsis of Dr. Milligan's report on the Southport and South Cape Bay coal measures.

Mr. Johnston, in a paper entitled " Further Contributions to the Fossil Flora of Tasmania, Part I.," published in the Proceedings of the Royal Society of Tasmania for 1893 (pp. 171-172), describes the geology of Southport and Ida Bay, with special reference to the fossil plant remains which occur in the coal measures at those places.

In 1902 the Mines Department published two reports by the present writer on the Recherche field, viz. :—

(1) Report on the Occurrence of Coal near Catamaran River, Recherche Bay, 20th February, 1902.
(2) Report on the Coalfield in the Neighbourhood of Recherche Bay, 1st May, 1902.

These two reports embrace descriptions of coal measures at Catamaran, Recherche Bay, Ida Bay, and Southport.

III.—PHYSIOGRAPHY AND GEOGRAPHY.

The indented coast-line, which makes the shores of D'Entrecasteaux Channel so picturesque, is due to this remarkable passage being an outlet of the great drowned valley of the Derwent. A subsequent warping of the land surfaces has brought about in recent times an elevation of the coast.

This southern corner of Tasmania consists of a high rocky range from 10 to 15 miles from the coast, culminating at intervals in lofty peaks—the Hartz Mountains, Adamson's Peak (4015 feet), La Perouse (3800 feet)—and forming an irregular mountain mass with a roughly north-south linear direction. From this high land various streams flow eastwards into D'Entrecasteaux Channel and the South-West Passage—the Dover Rivulet, the Esperance River, Creekton Rivulet, the Lune River, D'Entrecasteaux River, and the Catamaran River. Some of the largest timber in Tasmania clothes the flanks of these mountains, and the slopes of the foothills, and nourishes an important industry.

The D'Entrecasteaux Channel, a noble sheet of water 35 miles in length, flowing between the mainland and Bruny Island, indents the coast in a highly picturesque manner, producing harbours of great capacity and surpassing beauty. The South-West Passage, which forms the outlet of this channel, opens into the Southern Ocean outside Recherche Bay. The smooth-water passage to Hobart, with a depth of 40 to 50 feet, sheltered from stormy weather, possesses the highest value for industries along this southern shore-line.

The rivers in their lower reaches invariably flow through level, treeless, or lightly-wooded plains, partly flood plains, and partly consisting of vestigial deposits of Pleistocene or late Tertiary age. The settlements along the coast are at the mouths of the rivers or on the shores of the natural harbours which exist at intervals of every few miles down the channel.

Dover is prettily situated on the shore of Port Esperance, in sight of Adamson's Peak, a lofty cone-shaped mountain, 10 miles inland. This symmetrical cone, which adds so much to the beauty of the view, assumes quite another form when seen from the road further south on the way to Hastings. Three well-known islands in the bay enhance its picturesqueness—Faith, Hope, and Charity—the largest of them being Hope.

Dover itself is rather a straggling township, extending in various directions. To the north it stretches up the narrow valley of the Dover Rivulet along the Hobart-road. To the east, small farms fringe the northern shore of the bay at the foot of the wooded hills as far as the reserve on the promontory at the entrance to the bay. To the south the settlement extends towards Hopetoun and Strathblane. Besides the established timber industries, orchards are springing up; good accommodation is attracting tourists, and although the summer season is somewhat short, the climate is mild in spring and autumn. A good motor road connects with Hobart and the rest of the island, and there is a constant steamship service. The main road connects all the settlements further south with one another, traversing the comparatively level country near the sea. It is of easy grade, and can be kept without difficulty in good condition, though it cannot be said that responsibilities in this respect are always realised. A good highway runs 11 miles from Dover to Hastings; just before reaching the latter place, the road turns off to the Lune River settlement, and continues to Ramsgate. Once the Lune River township is passed the only habitation along the road is the manager's cottage at the Ida Bay Coal Mine, Fazackerley's and Donnelly's farmsteads, lying on the shores of Ida Bay about a mile east of the road. The next settlement on the Ramsgate-road is reached at Leprena, with sawmills at the head of Recherche Bay. A few settlers' residences are met with in approaching Catamaran, where, at the bridge, a cluster of houses, including store and school, marks the small settlement which has grown up round the sawmill.*

A few miles further south is Rocky Bay, where, at Cockle Creek, a few houses form the *ultima thule* of settlement in Southern Tasmania.

The prevailing winds in this southerly region result in an ample but not excessive rainfall, as the following statistics will show:—

			Inches.
Port Esperance ...	Oct. 1, 1908, to	Sept. 30, 1909	38·78
	,, 1909 ,,	,, 1910	37·08
	,, 1910 ,,	,, 1911	34·52

* Since this journey, a bush fire has destroyed the mill, with disastrous results to the township.

					Inches.
Southport	Oct. 1,	1908,	to Sept. 30,	1909	44·33
	,,	1909	,, ,,	1910	41·05
	,,	1910	,, ,,	1911	38·15
	,,	1911	,, ,,	1912	37·56
	,,	1912	,, ,,	1913	31·71
	,,	1913	,, ,,	1914	40·90

Naturally, this is in excess of the average rainfall at Hobart, which is stated by Mr. H. A. Hunt, the Commonwealth Meteorologist, at 23·57 inches annually. It is sufficient to foster a luxuriant vegetation. Snow in winter caps the high mountains, but rarely lies on the ground at sea-level.

IV.—GEOLOGY.

The geological systems represented by stratified rocks in the region under review are the Silurian, Permo-Carboniferous, Jura-Trias, Tertiary, and Quaternary. The igneous rocks are diabase of late Mesozoic age and Tertiary basalt.

Silurian.

The oldest strata seen on this journey were some quartzite and quartzite conglomerate occurring in the hills north of Ida Bay Caves. A cut has been put in these beds by prospectors across white siliceous quartzites running north-north-east, and dipping apparently in a north-westerly direction. This work has been carried out under the impression that the occurrence was that of a reef, and a report was to the effect that it carried gold. The samples taken from this spot have been assayed by the Government Assayer, Launceston, who reports only traces of gold.

Further west a cut has also been put into a white quartz conglomerate, which seems to belong to the same system. This rock contains angular and sub-angular stones of quartz. It dips west-south-west at an angle of 40°. Further west it is capped by the diabase which crowns the crest of the range.

These quartzites may be of Silurian or Pre-Silurian age. They have not undergone the metamorphism of the Pre-Cambrians, but are probably Silurian, somewhat earlier than the limestone. They are the most ancient rocks developed in this district, and if they had been in a granite region they would probably have been traversed by metalliferous lodes.

The limestone of which the Sugar Loaf and the Ida Bay Caves hill are composed is a dense grey rock, abundantly seamed with calcite, and rising high above the plain in massive beds dipping east-south-east at a low angle. No fossils have been discovered in it, but lithologically it is identical with the limestones of Zeehan, Mole Creek, Gordon River, and other parts of the island. These limestones have been, on the evidence of their organic remains, referred by the New South Wales palæontologists to the Silurian, and probably low in the system. It is not often in Tasmania that such limestones rise into hills of this height. Whether the same rock underlies the level country immediately north of the Sugar Loaf cannot be determined without further work.

Permo-Carboniferous.

The mudstones and mudstone-conglomerates which are assigned to this system, *i.e.*, to a system which embraces an assemblage of beds of late Carboniferous and early Permian age, are developed round the shores of Port Esperance and north of the Sugar Loaf near Ida Bay.

At Esperance, east of Dover, the shore is fringed with almost horizontal beds of soft arenaceous mudstone and sandstone, which contain, sparsely scattered through their mass, stones of quartzite, silicified shale, &c. They appear to be non-fossiliferous. The lower beds which form the beach pavement are coarser and more sandy than the upper ones, which are of a more pronounced mudstone character. Vertical divisional lines in the flat beds on the beach suggest an incipient tesselated pavement structure. Round the shore-line, west of the jetty, in the road-bank 30 feet above the water, are exposed edges of light-bluish mudstone beds weathering white and yellow; these rise into the promontory 50 and 60 feet above the water. Descending to the water's edge, the beach pavement is seen to consist of grey mudstone, a little more massively bedded than the upper strata. Vertical joints traverse the beds in the direction of their strike. The general strike of all these beds is apparently a little east of north, and the dip, when there is any present, to the west of north. The beds continue all round the head of the bay past Hopetoun and across the Narrows, but disappear further on in the Creekton Rivulet basin, where at the coal mine they are evidently replaced by exposures of Trias-Jura strata.

South of the Lune River, towards the Sugar Loaf and half a mile south of the tramway reserve huts, is a low hill of Permo-Carboniferous mudstone-conglomerate, containing numerous stones of granite, granite-porphyry, quartzite, hornstone, &c. These fragmentary constituents have been derived from some distant source, as rocks which could have supplied them are unknown in the neighbourhood. The conglomerate belongs to the Lower Marine beds of the system. These basal beds may be correlated with the boulder bed, speckled sandstone, and lower productus sandstone of the Salt Range, N.W. India, with the India Talchir conglomerate and the South African Dwyka.

The Permo-Carboniferous of Australia comprises *étages* which can be correlated with the Upper Carboniferous (Uralian) and Lower Permian (Artinskian) of Europe,

though somewhat incompletely. The Artinskian horizon may be slightly below that of the Rothliegendes of Northern and Central Europe.

Modern opinion tends towards regarding the use of the term Permo-Carboniferous in Australian geology in the light of a temporary expedient, and indications are not wanting that its elimination is only a matter of time. As matters stand at present in Tasmania, the term, if used at all, is applicable only to:—

(*a*) The basal glacial conglomerates and Lower Marine mudstones.
(*b*) The Lower Coal and Tasmanite measures, and
(*c*) The Upper Marine beds which succeed the preceding.

It is not beyond the bounds of possibility that the system may be extended upwards to include the Knocklofty and Domain sandstones, though for the present these are retained in the Lower Trias.

Once, however, the term "Permian" is used, whether by itself or in its compound "Permo-Carboniferous," the nomenclature becomes involved in the inconclusive discussions which rage round the use of the term in other parts of the world.

Waagen's adoption of the term "Anthracolithic" was designed to unite the Permian and Carboniferous in one system, and this or an equivalent term would allay much of the present controversy. In such a scheme, the divisions would be as follow:

Upper Anthracolithic—
Newcastle beds of New South Wales.

Middle Anthracolithic—
Upper Marine beds.
Lower Coal measures of Tasmania.
Lower Marine mudstones.
Glacial conglomerates and boulder beds.

Lower Anthracolithic—
Carboniferous of New South Wales, not represented in Tasmania.

The middle division can be correlated with the Talchirs in India, the Dwyka in South Africa, with the Salt Range boulder bed, speckled sandstone, and Lower Productus limestone, but there is no necessity for attempting to cover

it with any European name, such as Permian. The Australian forms of marine life such as *Spirifera vespertilio*, *Spirifera avicula*, *Martiniopsis darwini*, *Productus brachythaerus*, *Conularia*, *Aviculopecten*, and *Eurydesma*, are repeated in the Salt Range of North-West India, but an extension of the correlating process beyond the limits of India, South Africa, and South America leads to conclusions which are lacking in certainty and precision. For the present, the term " Permo-Carboniferous " is retained provisionally.

The promontory on the north side of the entrance to Southport is composed of diabase rock, skirted at the water's edge by Permo-Carboniferous mudstone. The curious pillar of mudstone beds called the " Stack of Bricks," off the bluffs at the entrance, is a striking product of the process of marine erosion. Near the hotel there is a hidden junction of the mudstones with overlying coal measures, which dip at low angles to the south-west below red sandstones. Cliffs show exposures of soft buff sandstone, passing downwards into thin beds of light-coloured sandstone, the whole resting on dark shale at water-level. The shales carry impressions of thin, jointed or branching stems, which Mr. R. M. Johnston has referred to *Vertebraria*. The only other plant recorded from this place is *Pecopteris lunensis* (R.M.J.). Mr. Johnston regards these Southport beds as uppermost Permo-Carboniferous in Tasmania.

In July, 1893, a diamond-drill bore was put down for the Southport Coal Prospecting Association to a depth of 612 feet, at 70 chains north of the Narrows and 1 chain west of the beach, about 30 feet above sea-level. The following boring register will show the nature of the strata passed through in the bore: —

	ft.	in.		ft.	in.
Surface shaft	18	0	...	18	0
Blue shale with small sandstone bands	6	6	...	24	6
Grey argillaceous sandstones	9	0	...	33	6
Grey quartzose sandstone with mica	24	0	...	57	6
ditto with a little coal	0	3	...	57	9
Blue shale	7	9	...	65	6
Grey sandstone and blue shale	28	8	...	94	2
Black shale	0	10	...	95	0
Grey sandstone and black shale ...	5	1	...	100	1
Black shale with plant impressions	10	6	...	110	7

	ft.	in.		ft.	in.
Black shale and dark sandstone ...	5	0	...	115	7
Grey sandstone and fossiliferous black shale...	19	1	...	134	8
Coal	0	3	...	134	11
Hard black shale with plant impressions	5	11	...	140	10
Hard blue shale and grey sandstone...	41	0	...	181	10
Hard grey sandstone and grit... ...	38	11	...	220	9
Hard, grey, fine-grained sandstone	212	0	...	432	9
Coarse rubbly sandstone	0	6	...	433	3
Hard, grey, fine-grained sandstone	64	0	...	497	3
Hard conglomerate	10	1	...	507	4
Hard, grey, fine-grained sandstone with pebbles, marine shells, and bands of blue shale	104	10	...	612	2

At this depth the drill approached the limit of its working efficiency and began to run heavily. Boring was then suspended without passing through the whole of the beds of the system.

The appearance in the bore of the conglomerate and the pebbly fossiliferous sandstone showed that beds of the Lower Marine division were being intersected.

All these strata plunge to the south-west in the direction of Ida Bay, where they are interrupted by the diabase round its shores. On the other flank of the diabase intrusion the Upper Coal measures make their appearance, and no more is seen of the Lower Marines till the Lune-Sugar Loaf tramway is reached, as mentioned earlier.

Trias-Jura.

Strata belonging to this system extend from the Strathblane coalfield, interrupted at intervals by diabase and basaltic rock, through Ida Bay and Recherche to the south coast.

The lithological aspect of the sandstone in places corresponds closely with that of the Fingal and East Coast coal measures, similar felspathic components being present in each. The sandstone is that of the Upper Coal measures in Tasmania.

The extent of each coalfield is as a rule conditioned by the bounding igneous rock. At Strathblane the igneous

rock is basalt, at Ida Bay both basalt and diabase, while at Recherche diabase is the rock which will eventually limit the field. The investigator who is seeking to ascertain the extent of the natural stores of coal has to pay the greatest attention to the effect likely to be produced by any occurrence of igneous rock. If this rock is in the form of a simply superficial lava sheet, seams of coal may pass below the overlying sheet without suffering any solution of continuity; if, however, it is intrusive in the surrounding strata, the seams of coal are liable to be cut off and the whole coal-bearing basin to come to an abrupt ending. Such intrusions exist all along the line referred to, so that the permanent prospects of each coal-basin depend upon the local geological conditions.

Taking Strathblane first: no diabase is visible near the colliery, but boulders of basalt on the top and upper flanks of the hill ridge into which the seam is plunging are suggestive of solid igneous rock on the crest. The question to be solved is whether this basaltic rock assumes the form of a dyke, rising through the mountain like a wall or backbone, or whether it is a sheet which merely caps the high land and beneath which the seam continues without interruption. In favour of the latter state of things is the report that the same rock prevails on the top of the next ridge across the valley to the west. However, on the most unfavourable view, there is a considerable distance north and south over which the coal beds are developed; and they no doubt exist also under the large plain to the east, continuing in that direction until they feather out on the mudstones of Port Esperance, or abut against the diabase of the sea-coast.

Going south from Strathblane, the next openings on coal seams are near Hastings, but from what is known of this coal, it is not a clean variety, but mixed with band stuff which requires separating.

On the north side of the little creek at the Lune River settlement, shales are seen on the road underlying beds of white sandstone, and dipping west. Some dark carbonaceous shale outcrops on Hitchen's land here, and suggests the possibility of a seam of coal existing not far off. On the west side of the road in a paddock is a conical hill of basalt, and as the creek also flows in basalt rock, it would be useless searching for coal to the south or south-west, but any exploration should be in a northerly direction.

South of the creek in question, diabase country is entered along the main road, and continues till the Ida Bay Trias-

Jura beds are met with, covering an area bounded on the east by the diabase which fringes the coast, and on the west by a long dyke of Tertiary basalt which extends practically from near the Lune River settlement across the plains, and then southwards at the back of the coal property to beyond the Half-way Creek, a north and south distance of about 4 miles, with a maximum width at one place of 1½ mile. Where it sinks to the plain in a southerly direction, the grass probably conceals Trias-Jura strata, which eventually rise to skirt Recherche Bay, and, with some interruption by diabase rock south of the Catamaran River, continue to the cliffs on the south coast. The sea-front in South Coast Bay exposes seams of inferior coal, on which some work was done in the forties by the Southport Coal Company.

Backward to the west of Recherche these strata extend apparently to La Perouse, where they abut against diabase towards the summit of the mountain.

Age of These Beds.

They are the Upper Coal measures of Tasmania; they admittedly succeed the Permo-Carboniferous sediments, and that system forms their inferior limit. Upwards the sedimentation may range through the whole Triasso-Jurassic period. On the whole, the facies of the fossil flora is Rhaetic, and the weight of evidence seems to be slightly in favour of a Rhaetic age, so that perhaps the term Trias-Jura is the one which has the most justification in the present state of our knowledge.

The plant remains which are relied upon as evidence of the age of the beds are the following:—

1. *Phyllotheca australis*, Brongn. Occurs at Ida Bay and in the Recherche and South Cape Coal measures. This is an equisetaceous plant, the genus of which was founded by Brongniart on specimens from the Hawkesbury Triassic sandstone, New South Wales. The genus occurs in the Permo-Carboniferous and Trias-Jura of Australia, India, South Africa, and South America; also in the Italian Jurassic. It has often been confused by authors with *Schizoneura*, and the determinations generally are somewhat uncertain, owing to the fragmentary nature of the remains available for examination.

2. *Zeugophyllites elongatus*, Morris; now *Phœnicopsis*, Heer. Occurs at Catamaran and Ida Bay. The type specimen of Morris came from the Jerusalem (Colebrook) basin. According to Newell Arber, it is a plant belonging to the class Cordaitales: other authors regard it as allied to *Baiera*, one of the Ginkgoales. Seward considers its position doubtful. This species occurs in the Rhaetic beds of the Stormberg series, South Africa. Similar leaves are recorded from the Rhaetic of China and Tonquin, and from the Arctic Jurassic rocks.
3. *Thinnfeldia odontopteroides*, Morris. Occurs at Catamaran and South Cape Bay. The genus is highly characteristic of the Upper Trias, Rhaetic, and Jura, and is met with also in the Permian of America and Russia. This species also occurs in the Trias-Jura of Queensland, in the Hawkesbury and Wianamatta beds of New South Wales, and in the Jurassic of Victoria. It is met with in Rhaetic beds in South Africa and Tonquin.
4. *Thinnfeldia superba*, Johnston. Occurs in the shale on the east side of the hill, on the Strathblane coal property. J. Shirley ("Additions to the Fossil Flora of Queensland," 1898) denies its specific value, and remarks that it is a form which is common among Queensland specimens, and is connected with the normal form of *Thinnfeldia odontopteroides* by a regular series of protean forms.
5. *Cladophlebis australis*, ~~McCoy~~ Morris; formerly *Alethopteris australis*. Occurs in the seam at the shaft at Ida Bay and in the Recherche and South Cape Coal measures. The plant is considered by palæobotanists as a representative of the existing Osmundaceae (*Osmunda*, *Todea*, &c.) It is abundant in the Jurassic and Triasso-Rhaetic of Eastern Australia, and is common in Rhaetic and Jurassic rocks throughout the world.
6. *Baiera tenuifolia*, Johnston. Recorded by Mr. Johnston from the Recherche and South Cape Coal measures. The genus is met with in the Victorian Jurassic and the Ipswich Trias-Jura of Queensland.

7. *Sphenopteris lobifolia*, Morris. This plant is also recorded by Mr. Johnston from the Recherche and South Cape Coal measures.
8. *Pecopteris lunensis*, Johnston. Occurs solely at Ida Bay and the black shales at Southport.

It is a singular thing that the critical plant for the Australian Jurassic rocks, *Tæniopteris daintreei*, is absent from the Tasmanian beds, which yet contain so many of the Eastern Australian plants. Mr. W. S. Dun, Government Palæontologist in New South Wales, considers the Tasmanian Upper Coal measures as integral members of the Eastern Australian Jurassic; while Professor David proposes to class them provisionally as Upper Trias or Passage beds into the Jurassic proper. English and French authors refer to the Australian Jurassics as being characterised by a Rhaetic flora. The Rhaetic flora of the Stormberg series in South Africa is closely allied to the Jura and Trias-Jura of Australia and Tasmania. The difficulty of distinguishing between Jurassic and Triassic plants is well known. Seward, in his work on "Fossil Plants" (p. 492), remarks with reference to the genus *Tæniopteris* that it is hopeless to attempt to draw a satisfactory distinction between the numerous *Tæniopteris* fronds from Triassic and Jurassic rocks.

For a long time the coal-bearing beds at Ida Bay have been looked upon as being slightly lower in the system than those of Recherche, principally owing to the occurrence in them of *Pecopteris lunensis*, a plant which they share in common with the older shales at Southport. But, taking into consideration the other plant remains which have come to light, and which connect the beds plainly with the Recherche measures, it would seem that the Ida Bay coal will have to be assigned to the Recherche horizon, which is that of the Fingal series, or that of the Clarence-Talbragar series of New South Wales.

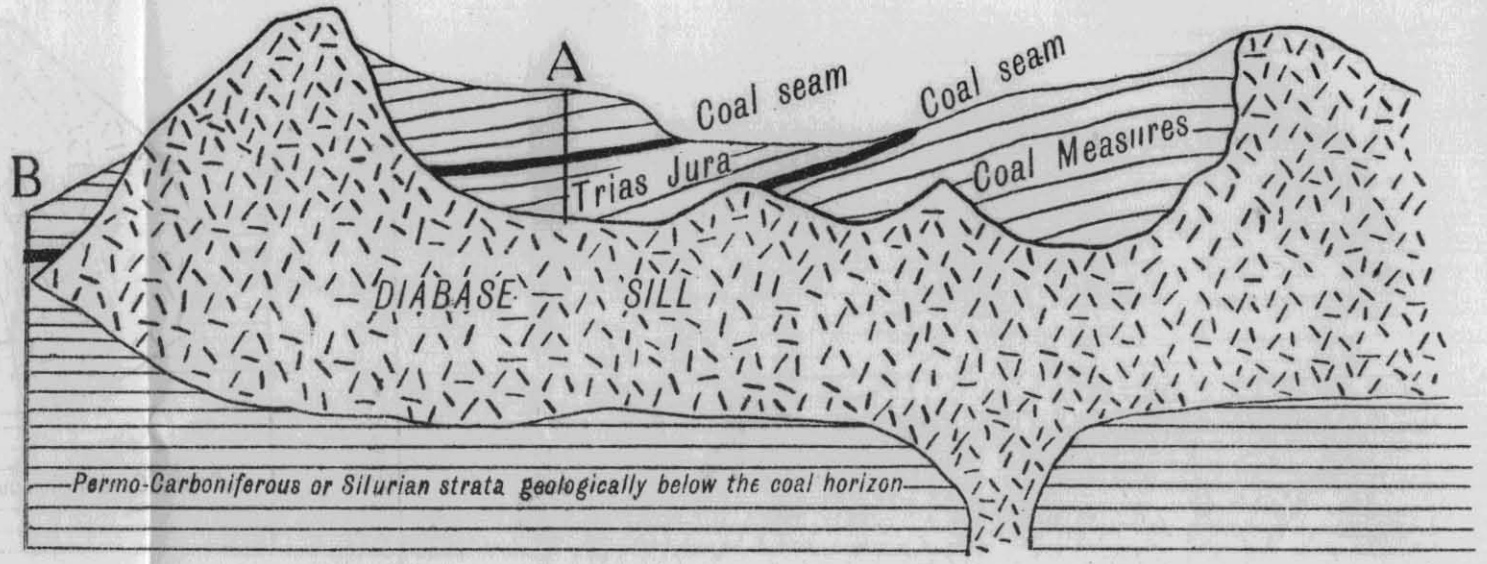
Mesozoic Diabase.

The intrusion of this rock magma, which occurred subsequently to the deposition of the Trias-Jura strata, has almost everywhere left its impress on the physiography of the southern coal measures. It is the rock known in Tasmania under different names in different localities—greenstone, bluestone, ironstone, trap, basalt, &c. It is generally of the texture called hypabyssal by petrologists, *i.e.*, not so coarse as that of the deep-seated granite, nor so fine as

5 cm

PLATE II

IDEAL SECTION OF COAL MEASURES AND DIABASE SILL



A. *Bore penetrating diabase beneath coal measures*

B. *Bore outside diabase intrusion and descending through stratified rocks*

Photo Algraphed by John Vail Government Printer Hobart Tasmania.

that of the effusive rock basalt. In places, however, the texture closely approaches these extremes, and when the rock is very fine in grain, as happens sometimes on the west side of Recherche Bay, the resemblance to a basaltic rock is very great, and microscopical examination is necessary for proper identification.

It is essentially composed of the minerals pyroxene (augite and enstatite-augite) and lime-soda felspar. The general absence of olivine is one of the most useful criteria in the field for distinguishing it from Tertiary basalt, though this character cannot be always relied on, for some Tasmanian basalts do not contain porphyritic olivine. Other differences in doubtful cases are a somewhat lighter or greyer shade of colour, a more granular texture than that of basalt, and an almost indefinable difference in its fracture, the latter being a little more hackly in basalt With constant handling in the field, these slight differences make themselves perceptible.

The coastal cliffs and headlands from Port Esperance south-westwards to Southport, Ida Bay, and Recherche, consist of this rock, and for the most part it forms the summits of the main ranges inland to the west. It also fringes the south coast where the promontories jut out into the ocean.

It is now fully recognised that the occurrence of this rock in Tasmania, where it is widely spread, covering half the island with its exposures, is that of a gigantic sill or intrusive sheet. It penetrated the Permo-Carboniferous and Trias-Jura strata, insinuating its way slowly and laterally between the beds. It is older than the Tertiary basalt, in which fragments of it may be found, entangled in the outpoured lava. The faulting of large blocks of country has produced differences of level in the various areas of this rock, ranging from that of the highest mountain summits of the island down to and below sea-level. In addition to this, minor inequalities have been caused by weathering and also doubtless by the original unevenness of the upper surface of the sill, as indicated by the varying depths at which diabase is struck in boring operations.

The overlying sedimentary beds which at one time covered the diabase sill at places which are now mountain summits, have long been removed by erosion, except where survivals of them exist on the high saddles and the hill flanks. The sill rock still exists at various depths concealed below the Permo-Carboniferous and Trias-Jura strata of the low country.

Several diamond-drill bores have been put down in Tasmanian coal fields from time to time, and have in depth encountered a floor of diabase rock underlying the basins, except where presumably the intrusive sill has thinned out locally, in which case the bore has gone down into Silurian strata.

The geological mode of occurrence of this rock has long been a subject of controversy, but it must be correctly understood before the prospects of the coal fields can be gauged. According to one view, the igneous rock ascended as a vertical intrusive mass, cutting off the coal seams in its ascent. On the other hypothesis, the rock forms a covering sheet, below which the seams pass without interruption. Both these views are expressed in too bald a form to be of much assistance in solving the problem. Certainly at some point or other there must have been an uprising column of igneous *magma*, but such points are few and far between; it is straining possibilities to urge that the diabase on every mountain summit is part of an ascending pipe restricted to each mountain. The laterally intrusive sheet or sill must hypothetically have a floor as well as a roof, and if the floor is exposed to view anywhere, no doubt the stratified rocks will be seen passing beneath it. But from what is known of the thickness of the great sill, it is probable that these lower strata will be below the geological horizon of the coal seams.

The coal basins now existing in Tasmania are superior to the upper surface of the sill, and it is this upper surface which has been revealed by the diamond-drill bores.

The correctness or otherwise of this hypothesis is of importance in attempting to forecast the behaviour of coal seams and the extent of the individual coalfields. If the view is correct, it follows that the measures are limited laterally and in depth, and the first necessary task of anyone inspecting a coal basin is to take account of surrounding outcrops of diabase and their probable underground extension. In addition to the great general sill, minor intrusions in the form of dykes must not be lost sight of.

The view above propounded is put forward in the hope that it may be tested by observations in the field by colliery managers and other interested in Tasmanian coal fields. It is believed to accurately reflect the geological conditions, and is calculated to throw useful light on much that has been hitherto perplexing. Plates II. and III. show an

PLATE III

IDEAL SECTION OF BLOCK FAULTED COAL MEASURES

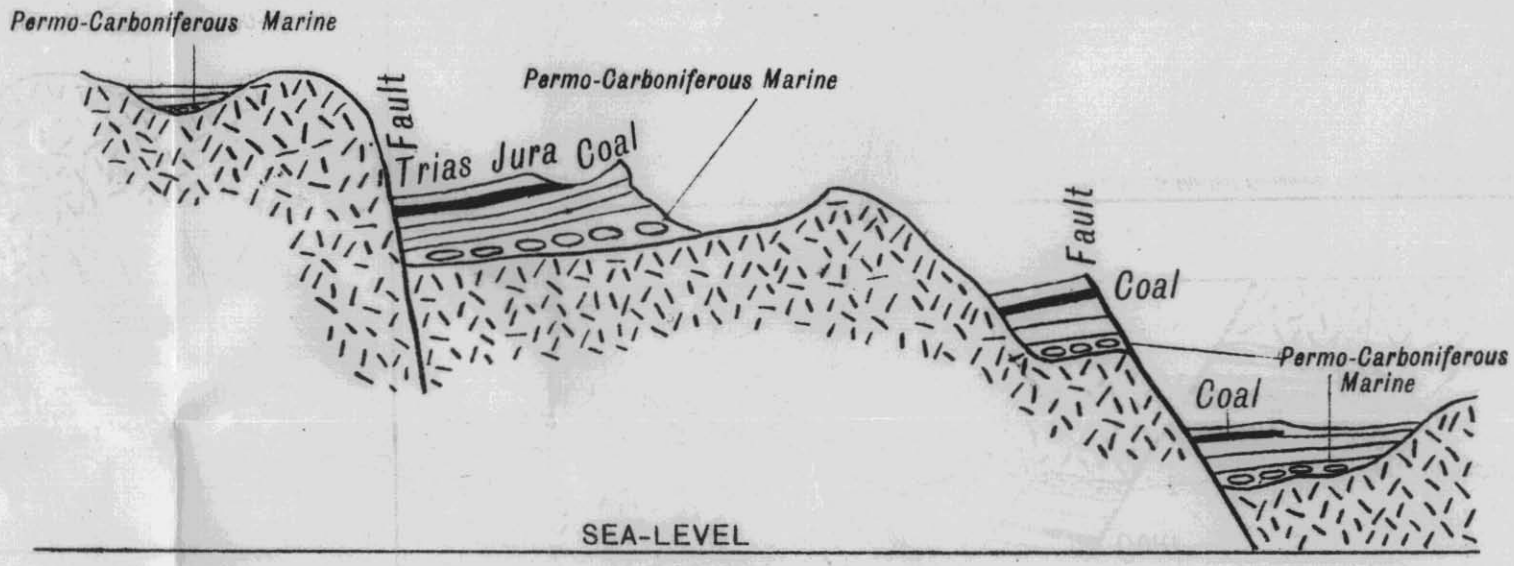


Photo Algraphed by John Vail Government Printer Hobart Tasmania.

5 cm

attempt to represent diagrammatically the mode of occurrence of the diabase sill and its relations to the coal measures.

Tertiary and Quaternary.

The oscillations of the land during this period of time are difficult to follow. Until they have been worked out in detail, they can only be referred to in general terms. The plains which exist near the mouths of the Esperance, Lune, and D'Entrecasteaux Rivers consist of sediments of this age; these skirt the base of the hills the whole way to Recherche, and unconsolidated deposits with shingle prevail on the rising ground north of the Catamaran River.

Scattered colours of gold have been washed from the gravels in different places, and such discoveries have occasionally raised unwarranted hopes. The writer was informed by the late Mr. John McDougall that a little tin ore had been found on the Catamaran flat 2 miles west from the mouth of the river. It is difficult to surmise what may have been its source unless it was derived from the disintegration of erratics. It is said that pieces of granite have been picked up in this locality, and probably these were washed out of glacial beds which, as we know, form the base of the Permo-Carboniferous.

Basalt of Tertiary age occurs on Hope Island at Port Esperance, on the Strathblane property, on the Lune Plains, and on a line passing behind the coal mine at Ida Bay southwards along the road to Recherche. North of the creek at the Lune River settlement is a small hill of basalt by the side of the road with a conical shape, suggestive of a volcanic vent; but all the other occurrences are indicative of what were perhaps fissure eruptions. The basalt on the summits of the hills at the Strathblane coal mine may possibly be of the nature of a superficial flow, but at Ida Bay the dyke form seems pronounced. The quarry reserve, north of the Half-way Creek, between Ida Bay and Recherche, furnishes supplies of basaltic rock for road-mending. The rock contains no useful mineral, and the dykes, from the mining point of view, are objectionable features, as they are apt to interrupt the continuity of any seams of coal.

V.—MINING PROPERTIES.

Three properties upon which active operations are to be started were visited on this journey, viz.:—The Strathblane Colliery, the Tasmanian Portland Cement, Lime, Brick, and Coal Company's property at Ida Bay, and the Catamaran Colliery at Catamaran.

(*a*) The Catamaran Colliery.

This property comprises the following leases west of Recherche Bay and north of the Catamaran River:—Section 6658M, 1274 acres, F. C. Howard; Section 6884M, 128 acres, F. C. Howard; Section 6137M, 319 acres, F. C. Howard; Section 6136M, 320 acres, F. C. Howard. The ground extends westwards on the north side of the river for about 3 miles up stream, and northwards for about a mile and a half, forming a block of sufficient size to justify development work on a large scale. The main shaft is situate $1\frac{1}{4}$ mile west of the coast-line at the mouth of the river.

The Catamaran River empties into the northern part of Recherche Bay, a sheet of water from 4 to 5 miles from its north end at Leprena to its southern extremity at Cockle Creek. The Ramsgate promontory separates the northern part of the bay from the southern. Small steamers and barges, drawing up to nearly 9 feet of water, can enter the mouth of the Catamaran River at high tide; and inside the bar the depth near the bridge is a couple of fathoms. Mr. R. C. Young, the company's engineer-in-charge, informed the writer that his soundings showed a depth of between 4 and 6 fathoms in the northern part of the bay, near Bennett's Point, on the eastern side of the inlet.

From this side of the water a general view of the topography of the coal field and its surroundings is obtainable. The land rises gently from the shore to form a low coastal range, behind which Mt. Leillateah presents a striking form 2630 feet above sea-level (as determined by Mr Young), and in the distance to the west La Perouse (3806 feet) and its ranges close in the view.

Recherche Bay is named after one of the ships in which the French Admiral, Bruny D'Entrecasteaux, visited it

PLATE IV.—VIEW OF RECHERCHE BAY.

in 1792, searching for the missing navigator, La Perouse, whose ships had previously proceeded from New South Wales (Botany Bay), visited Tasmania, and disappeared into the Pacific, never to return.

A sparse population is settled on its shores, dependent mainly on the timber mills at Leprena, Catamaran, and Cockle Creek. The timber industry has made some inroads on the heavy growth of eucalyptus which clothes the mountain sides, though to the casual glance no great impression on the mantle of forest trees seems to have been effected; and the dense cutting-grass, tea-tree, and other scrub almost defies pentration, and offers a formidable obstacle to prospecting and to geological observations. The timber tramways afford practically the only facilities for getting into the country west of the bay.

In the Records of the Royal Society of Van Diemen's Land already in 1848 there is mention of two shafts and a drive put in during that decade by a company in search of coal, on the eastern side of Recherche Bay. The writer is informed that some work was also done on the west side. These measures are visible along the shore-line for about three-quarters of a mile north of Bennett's Point, and softened, perished coal can be detached here and there. The dip of this seam is westerly, which would bring it below the water of the bay.

The Moss Glen seams, north of the Catamaran property, were discovered in 1900; and the Catamaran seam also in the same year. South of Catamaran, coal was already opened upon between Whale's Head and South Cape on the shore-line, in the thirties. All this goes to establish the existence of a rather extensive coalfield, though the area is cut up by intrusions of igneous rock into separate basins.

The Catamaran basin first attracted public notice in 1900, when Mr. Major Lloyd Hood took up leases and started some work on the seam. The property came into the possession of Mr. E. C. James in 1910, but during the whole of the decade work was carried on only intermittently. The present syndicate took over the mine at the end of 1912, and has spent a good deal of time and money in establishing the continuity of the seam along its line of outcrop by means of bores and pits, and sinking a main shaft, from which to work the coal to the dip. The outcrop has been traced in this way for a distance of over 4000 feet.

Description of Work.

The old workings comprised two shafts and tunnels, and exploited the seam to the rise from no great depth, 30 or 40 feet. The total quantity of coal reported to the Government as raised to date from this mine is 3497 tons, viz., as follows:—

	Tons.
1905	1224
1906	1303
1911	370
1912	600

It would be safe to say that the actual aggregate has not exceeded 4000 or 5000 tons.

The seam was worked for a thickness of 4 feet 10 inches or 5 feet, about 3 feet of inferior coal, which forms the upper part of the seam, being left unworked. A few feet above this seam is a 3-feet seam, which has not yet been worked. Eight feet below the main seam a third seam used to be reported as existing. Mr. Young informed the writer that he bored 15 feet below it, and only struck 3 feet of inferior coal, with 17 per cent. ash, outside the old tunnel workings On the other hand, he bored 20 or 24 feet from the sump in the main shaft, but only passed through clay; and he also endeavoured to find this alleged lower seam along the outcrop on the south side of the hill, but without success.

Several old pits exist at intervals for some distance west of the old main shaft, and show indications of coal, but if these outcrops are solid, they would seem to be precluded by their position from having any connection with the seams which have been opened up. Evidently some kind of a seam outcrops in that direction, but some exploration is needed before its relations can be understood.

The old main workings are rather irregular. The seam is in soft ground near the surface, and work could not have been continued much longer on the same lines.

In 1902 some diamond-drill boring was started by the Mines Department, with a view of testing the Recherche coal basin, but the work was relinquished after four bores round the outer boundaries of the field had been put down. Convenience of transport appears to have influenced the decision to try these sites first: the remaining bores which were recommended were not put down. The boring registers are annexed for information to the present report. (See Appendix.)

PLATE V.—CATAMARAN RIVER.

The two bores along the tramway south of the Catamaran River are outside the outcrop line of the Catamaran seam, and were designed to test the strata on the Manuka Plain, 2 or 3 miles from the mouth of the river. It was thought that as seams are present north of the Catamaran, all along the west side of Recherche Bay, and occur also on the south coast, this plain, which contains beds with impressions of coal plants, might likewise cover other coal seams. The result, however, was disappointing, as only coal-markings were passed through, and the shale and sandstone beds gave place in the two bores to igneous rock (diabase) at 230 feet and 695 feet respectively. These bores indicate the presence of a diabase floor at no very great depth below the field, but also illustrate the striking inequality of the surface of the floor, the most westerly bore being the deeper, and the two only three-quarters of a mile apart.

A third bore was put down in the Moss Glen basin, on the western shore of Recherche Bay, about 10 chains north of Mr. Herbert Smith's house. This was in sandstone and shale, and after passing through several beds with coal and coal-markings, struck the diabase floor at 456 feet. This result also indicates that the diabase outcrops on the various promontories and ridges along the coast-line are not merely separate, isolated dykes, but are upward irregular protrusions of the massive igneous sheet which underlies the stratified rock everywhere.

Sooner or later the coal seams will be found to abut against this rock, and thus one of the most important tasks which a mining company can set itself before committing itself to extensive operations is to assure itself that it has an adequate area of seam for its undertaking.

A fourth bore was put down by the Government on the Moss Glen property about 200 feet above sea-level through shales with seams of coal, but was discontinued at 152 feet before the whole series of these beds had been tested.

The present owners have recognised the importance of preliminary test work, and have put down a long series of shallow bores and pits with the view of tracing an uninterrupted outcrop of seam. This line extends from the north shore of the Catamaran River and past the old workings in a north-easterly curve for a distance of 4300 feet.

A remarkable feature was disclosed by these operations. The sandstone-bed rock was found to be plentifully bestrewn with boulders of diabase, in some cases so close together that the drill could not pass between them. This

was specially the case towards the northern end of the line. These boulders and stones are scattered at all horizons through the superficial deposit of clay covering the sandstone down to a depth of 20 or 30 feet. Many of them have the appearance of being water-worn, and it is not improbable that they have been sea-borne. It does not seem at all likely that they originated in the high mountain land to the west, for diabase outcrops in that direction are unknown until the slopes of Mt. Perouse, at least 5 or 6 miles distant, are reached. On the other hand, solid diabase exists at and above sea-level on the shores of Recherche Bay.

Some of the bores put down by the syndicate have reached a depth of nearly 60 feet, but while most of them have passed through the coal seam, none of them have encountered diabase, and it is not probable that this rock will be met with until a depth of several hundred feet is attained.

Until a bore has been put down through the coal measures series to the igneous floor, the actual depth at which the latter exists cannot be stated.

Plate 16 represents sections of several of the bores as delineated on a plan prepared by Mr. Young.

It was promptly found that the old workings were useless for the proper development of the seam, and after some exploratory work a suitable site was chosen for a shaft. A three-compartment shaft has been sunk 130 feet, 13 feet by 6 feet in the clear, lined throughout with 3-inch timber. This has passed through a light greenish-grey felspathic sandstone, lithologically identical with that of the East Coast coal measures. At 109 feet, a seam of coal was cut and the shaft continued in it for 19 feet.

A chamber has been cut at the bottom of the shaft, from 8 to 12 feet in height, and 16 feet by 13 feet wide. In this the seam is well exposed, and the coal is solid and good-looking. Higher up in the shaft the upper part of seam can be seen behind the timber. The upper part is considered of inferior quality to the lower. The lower 6 or 7 feet are the best, and form the part which will probably be worked.

The first 3 feet above the clay floor are absolutely without any band. The first band then makes its appearance. It is from 2 to 3 inches thick and fairly constant. Small 1-inch bands recur above this at intervals of about 9 inches, 1 foot, and $1\frac{1}{2}$ feet, but appear to be inconstant. The coal

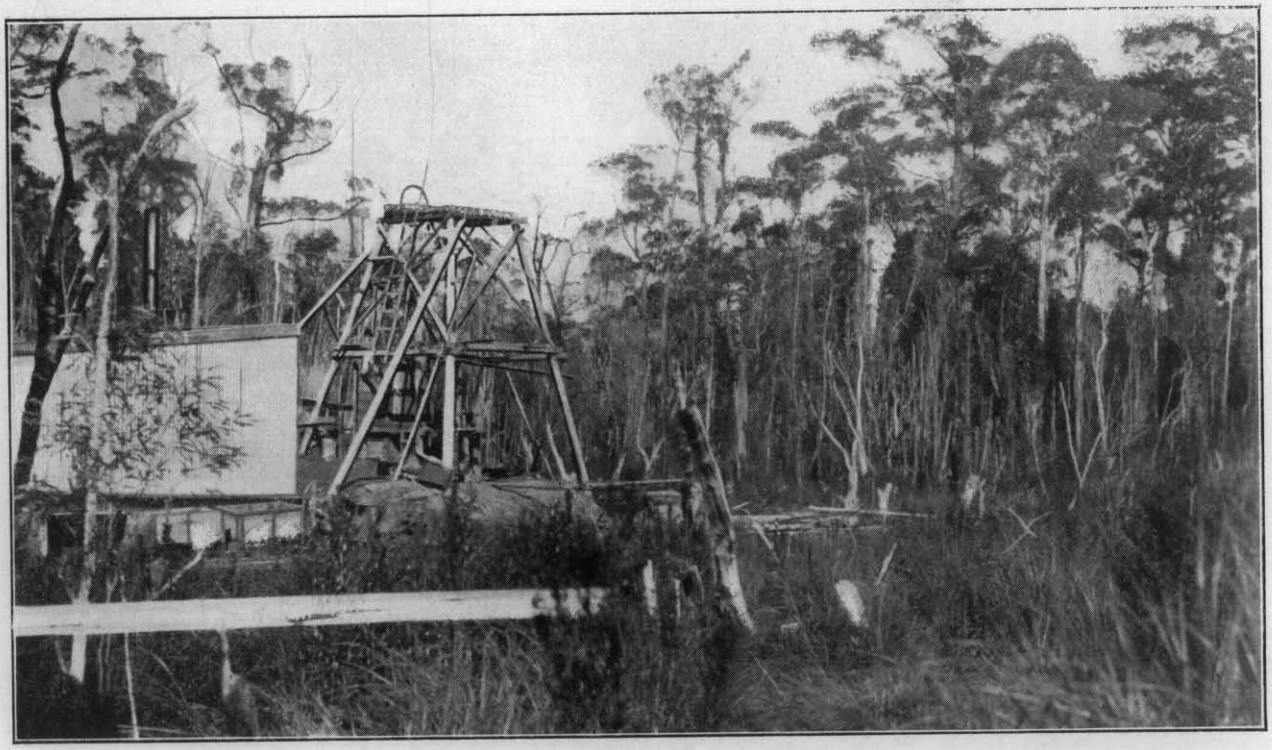


PLATE VI.—SHAFT AT CATAMARAN COAL MINE.

at the very top is bright, but the seam is said to contain several bands in that part. This upper part will form the working roof. Below the seam is a floor of clay.

This shaft shows the coal seam at the deepest point at which it has yet been seen, and it is perhaps significant that its thickness is here at a maximum.

In a prospecting shaft, 5 chains north-east of the main shaft, the seam was found to be 9 feet: and a couple of hundred feet further in that direction the boring register shows the thickness as 10 feet 6 inches. Mr. Young calculates the average thickness of coal in the seam, as proved by the shafts and bores, as about 11 feet: the upper 2 or 3 feet being of good quality, and the bottom 4 to 7 feet being also good, while the central portion, 1 foot 6 inches to 3 feet, is worthless.

The thickness shown in the new main shaft is a new feature, and would appear to indicate that the different seams or portions of seams reported in the old workings from time to time have come together in descending at this point. This increase in size may be a function of depth, for the thickness shown in several bores between 9 and 40 feet deep in this part of the field varies between 7 and 11 feet.

The dip of the seam is that of the enclosing strata, 10 and 11 degrees from the horizon and towards the north-west (1 in 5). The shaft has proved the continuity of the seam on the dip for about 10 chains from the outcrop. A complete exploration programme, though costly, would include diamond-drill boring still further in the direction of the dip, with a view of testing the downward continuity of the seam, a feature which is intimately related to the inequalities of the bedrock floor of diabase. While no reliable estimate of the depth of this floor can be made without such boring, the geological indications, scanty and inadequate as they are, suggest that it might be possible, and more especially if the upper surface of the igneous rock is level, to follow the seam down on its dip (assuming no faults exist) for nearly three-quarters of a mile before approaching the diabase contact. This calculation might, however, be entirely upset by any rise in the floor, and would also be affected by any change in the degree of the dip of the seam. The data at present are insufficient for any reliable forecast.

However, from a geological point of view, the Catamaran field must not be interpreted as one which is traversed by

various dykes of igneous rock running back from the headlands on Recherche Bay and intersecting the coal measures in various directions, but rather as a basin filled with stratified rocks resting in depth upon the upper uneven surface of a sill of diabase which has intruded into them, and below which at some indefinite depth stratified rocks again exist. The vertical, roughly columnar structure of the diabase, which must be at right angles to the bounding surfaces, indicates that the intrusive sheet is more or less horizontal. The coalfield is apparently situated in a deep part of the basin.

From the western Government bore, on the south side of the river, which struck diabase at 695 feet from the surface, it may be concluded that a deepening of the basin takes place in a south-westerly direction, and as several miles of sandstone country extend from here to the La Perouse ranges, in all probability the stratified rocks continue to very considerable depths. This is not inconsistent, however, with local inequalities.

The most northerly prospecting shaft has been put down close to the timber tramway which ascends from the Catamaran sawmill through the north-eastern portion of the property. It is on the outcrop line, but at 30 feet was suspended on account of water, and did not reach the seam. It has been sunk in yellow, ferruginous, clayey soil, and a shingle of water-worn stones. The appearance of the surface here suggests that all this coastal margin has emerged from the sea with its floor of boulders. It is intended to run an electric cable across here and continue sinking the line of shafts. There is hardly any doubt but that the coal measures continue right through this part of the property, for the Moss Glen seams occur just outside the northern boundary.

On Crown land, at the terminus of the tramway, about 400 feet above sea-level, large boulders of diabase are profusely strewn on the crest of the ridge, in a way suggestive of the proximity of the solid rock, but no exposures are visible.

Following the outcrop line along the north side of the Catamaran River, at about 5 chains south-west from the old workings, a new tunnel has been driven on the dip of the seam into the hill. After driving this for a distance of 150 feet it was found that the strata forming the roof and overhead up to the surface consisted of a soft yellow ferruginous clay, which would seem to have taken the place of

PLATE VII.—TRAMWAY TO CATAMARAN COAL MINE.

the denuded sandstone. With such a bad roof for the workings, it was considered advisable to give up the idea of making this the principal entrance to the mine, although otherwise the position was well chosen. At the time of the present visit the tunnel was full of water, and the seam could not be seen. The writer was informed by Mr. Young that a bore from the surface to the face of the tunnel passed through 68 feet of surface soil before striking the seam, and that the seam as proved by the tunnel was thinner than usual, but was increasing in size as the adit advanced.

About 25 chains further west are two short tunnels, which have been driven into the hill above the river to expose the seam, which then crosses the Catamaran.

Geological Age of the Coal.

From the fossil impressions found in the shale overlying the seam (*Thinnfeldia*, *Phœnicopsis*, *Phyllotheca*, and *Strzleckia*), it is evident that the coal belongs to the upper measures in Tasmania which are to be correlated with the coal measures of Eastern Australia of Jurassic or Triasso-Jurassic age. The precise position which the Tasmanian Mesozoic seams occupy in this great series is still somewhat unsettled. Until this is more definitely established, the series will have to be referred to as " Trias-Jura."

Quality of Coal.

Several analyses have been made of the Catamaran coal from time to time from different parts of the seam, so that its composition may be taken as fairly well established. There is this, however, to be borne in mind, that the samples taken are from shallow depths, at which some at least of the coal has been exposed to deterioration from meteoric influences. Still it is surprising what a little difference this makes in the average results; it is evident that the coal, though decidedly tender on the whole, has properties which enable it to withstand water and weathering to a considerable degree. Its composition at the bottom of the new main shaft, 130 feet from the surface, does not greatly vary from that of the outcrop coal in the old workings. Nevertheless, it may be anticipated that it will shows an increase in hardness and purity as greater depth is attained.

The Mines Department has sampled the seam on various occasions, with the following results, as per Government Analyst's report:—

	1902.	1902.	1905.	1905.
	Per cent.	Per cent.	Per cent.	Per cent.
Fixed carbon ...	65·8	66·7	67·8	65·6
Gases, &c.	21·0	20·3	24·5	27·7
Ash	8·2	8·6	3·7	3·9
Moisture...	5·0	4·4	4·0	2·8
	100·0	100·0	100·0	100·0

Dr. Noetling, who inspected the colliery in 1912, reported analyses made by the Government Analyst as follows:—

	Sample No. 1.	Sample No. 2.
	Per cent.	Per cent.
Fixed carbon	69·6	66·20
Gases at red-heat...	24·0	25·72
Ash	5·0	3·84
Moisture	1·4	4·24
	100·0	100·00

Samples taken by the writer on the present visit and assayed in the Government laboratories, Hobart, yielded the following results:—

	New Main Shaft.	Electric Shaft.
	Per cent.	Per cent.
Fixed carbon...	61·2	69·3
Volatile matter...	24·9	24·7
Ash	10·1	3·8
Moisture	3·0	2·2
Sulphur	0·8	—
	100·0	100·0

Calorific value ....12·430

It has a higher fixed carbon yield than the other Trias-Jura coals of the East Coast. The assays of these show generally between 55 and 57 per cent. fixed carbon, and 25 to 30 per cent. volatile matter. Near Eden, on the West Coast, are some small seams of coal of trivial importance in the Permo-Carboniferous sandstones, the assay of which corresponds very closely with that of the Catamaran coal, namely:—Fixed carbon, 61·6; volatile matter, 26·5; ash, 10·5; moisture, 1·4.

The Catamaran coal assays agree also pretty closely with the average composition of the Upper Coal measures in the southern coalfield of New South Wales. Mr. E. F. Pittman states the latter as follows:—Fixed carbon, 63·98; volatile hydro-carbons, 23·65; ash, 11·66; hygroscopic moisture, 0·71; sulphur, 0·4.

Taking between 20 and 25 per cent. as the upper limit of gas content for a semi-bituminous coal, and the lower limit for a bituminous coal, it would appear that the Catamaran coal is on the arbitrary boundary-line between the two classes. Its moderate proportion of volatile matter causes it to emit very little smoke, while its amount of fixed carbon, combined with low sulphur value, would lead one to suppose that it will be found to be a coal highly suitable for steaming purposes. The small sulphur content, of course, implies a small iron content, precluding clinkering and enhancing its value as a steam coal.

Its calorific power expressed in evaporative units is 12·87, which is equivalent to 12,430 British thermal units, determined by Mr. W. F. Ward by means of a Thompson's calorimeter. This is much higher than the result usually obtained by the Trias-Jura coals in Tasmania. It indicates that with proper boilers and ordinary good furnace management the heat value will be found to be highly satisfactory. The low proportions of ash and hygroscopic moisture add to the value of the coal. On an open hearth it burns freely, cakes quickly, gives out a great heat, and emits very little smoke. It cokes in the laboratory, but whether it will make a marketable coke can only be ascertained by trials.

The only drawback which it seems to possess is that it is rather tender and apt to make slack; this softness, however, may be due to the outcrops lying in a basin with a cover of superficial mud, which is holding a good deal of water. This water trickles slowly down through the coal, and must certainly exert some effect on its physical condition. With greater depth and systematic drainage the coal may be confidently expected to become harder. In the meantime, during the initiation of the industry, the arrangements for handling the output can be such as will overcome any difficulty on this score.

From time to time small working tests have been made, and the output placed on the open market, with very gratifying results. The experience of steamers which have tried the coal in Channel trips has been highly satisfactory.

In 1902 the writer obtained very favourable reports from some shipping firms and trading companies who had made a trial of small parcels; for domestic use in Hobart it has also given satisfaction. Mr. Young informs me that he has used it on the steam yacht " Preana " regularly for trips between Recherche and Hobart, and found it to have excellent steaming qualities. He says there is no clinker whatever, only a fine ash, which falls through the bars. The coal burns quite away and leaves the bars entirely bare.

Probable Quantity of Coal.

In the present undeveloped character of the property any calculation must partake of the nature of an estimate based on insecure and necessarily partial data. The outcrop line, as far as verified by bore-holes and shafts, is what calculations have to be based on. In projecting this line underground in the direction of the dip as far as the boundary of the property, it has to be assumed that no fault or igneous intrusive rock will interrupt the continuity of the seam. The calculation of the area of the coal seam in this way gives a result of 800 acres, to which must be added the probable area existing in the four leases outside the verified line, which is about 700 acres, making a full total of 1500 acres, from which deduct 20 per cent. for breaks, &c., and the net area remaining would be 1200 acres of seam.

The seam appears to vary in size at different points, so that an average must be struck for the purposes of calculation. In the old mine, 4 feet 10 inches to 5 feet 3 inches used to be the thickness worked, or say an average of 5 feet. In the bore-holes, thicknesses have been met with ranging from 5 to 11 feet, but these bores have been drilled with the auger, and give uncertain information as to the proportion of workable coal. Where the seam attains its greatest thickness—in the main shaft—a considerable proportion of it must be allowed for in calculating, as being of inferior quality. Making this allowance, however, there still remains 6 or 7 feet of good coal, which will undoubtedly be worked. The writer thinks it absolutely safe to anticipate an average size of 5 feet throughout as workable coal; and quite reasonable to calculate up to 6 feet. In all probability, a good deal of the upper part of the seam will also prove to be of a quality fit to work, though this will be largely governed by mining considerations.

PLATE VIII.—COUNTRY AT CATAMARAN.

Making one-third allowance for loss in working, the seam, if 5 feet thick, should contain about 7 million tons, and if 6 feet thick, a little over 8 million tons: but of course this estimate must be considered as subject to the structural conditions of the field alluded to above.

Port of Shipment.

Hitherto what coal has been sent away has been conveyed by the mine tramway to the north bank of the Catamaran River, near its mouth. The present line is a 2-feet gauge, with steel rails, and is 1½ mile in length. Small craft can enter the river at high tide, drawing 8 or 9 feet of water, and this shipment site would perhaps suffice for a purely local trade. But the present owners will probably aim at capturing wider markets, in which case other harbour arrangements would have to be devised.

In this respect there are two possibilities which present themselves. By doubling the length of tramway a site on Cockle Creek Bay could be reached, with ample water for anything that would be required. The tramline, however, would have to be carried across the Catamaran River, and the port of shipment would be a few miles farther from Hobart.

Another plan would be to carry a jetty in Recherche Bay into deep water at some distance from the western shore of the bay. This would necessitate a tramline of not more than a couple of miles from mine to jetty. The latter would have to be rather long. On the opposite side of the bay is a well-shelterd harbour. In any case the colliery is favourably situated in this respect, more so, indeed, than the generality of collieries in Tasmania. Within such a short distance of the coast, and not much more than 50 miles from Hobart through a virtually smooth-water channel, the mine has advantages possessed by few others.

Concluding Remarks.

It will be gathered from the foregoing that the Catamaran property may be regarded as one which justifies vigorous development. The seam has been shown by the exploratory bores and other works to have a long and persistent outcrop and to be of full working size. No indications of faulting are present, though of course in every coalfield these disturbances are apt to occur. The igneous rock which underlies the field, and which exists always in

Tasmanian coal-bearing areas, nowhere outcrops, and is probably devloped only at a considerable depth below the surface. The quality of the coal is such as to render it valuable in a high degree for steaming and domestic purposes. Its somewhat friable nature can be neutralised by careful handling, and may be expected to disappear to a very great extent when depth is attained and the workings are beyond the influence of the water-bearing stratum which forms the superficial cover. The hygroscopic moisture in the coal itself is low, its ash is inconsiderable and inert, its calorific power satisfactory, it is almost smokeless, and possesses all the qualities of a good industrial, marine, and household coal. Unless any of those dislocations occur, which, though impossible to foresee, have always to be accepted as among the risks of coal-mining, sound commercial handling of this property ought to result in founding an important industry here.

(*b*) Tasmanian Portland Cement, Lime, Brick, and Coal Company Limited, Ida Bay.

This property is situated about 50 miles south of Hobart, and immediately south-west of Ida Bay, which is a part of the sheet of water communicating through the Narrows with the bay of Southport, on the shore of D'Entrecasteaux Channel, opposite South Bruny.

The following leases have been taken up:—6974-M, 1280 acres; 6975-M, 1280 acres (not yet surveyed); and 5993-M, 40 acres—all in the name of Percy Douglas.

The intention of the owners is to take advantage of the great development of pure limestone on their leases, and initiate a Portland cement industry, utilising the coal on the property in the manufacture of cement. As there is a large and increasing consumption of cement in the State and throughout the Commonwealth, most of which has to be imported, the proposed manufacture of it at Ida Bay close to a deep-water port, with coal for the kilns available on the property, and with cheap freight to the capital city of the State through a sheltered deep-water channel, must appeal to all who are interested in the full utilisation of our mineral resources.

The limestone is situate in the centre of the property. The ground here rises into a hill range, extending eastwards into what is known as the Sugar Loaf or Limestone

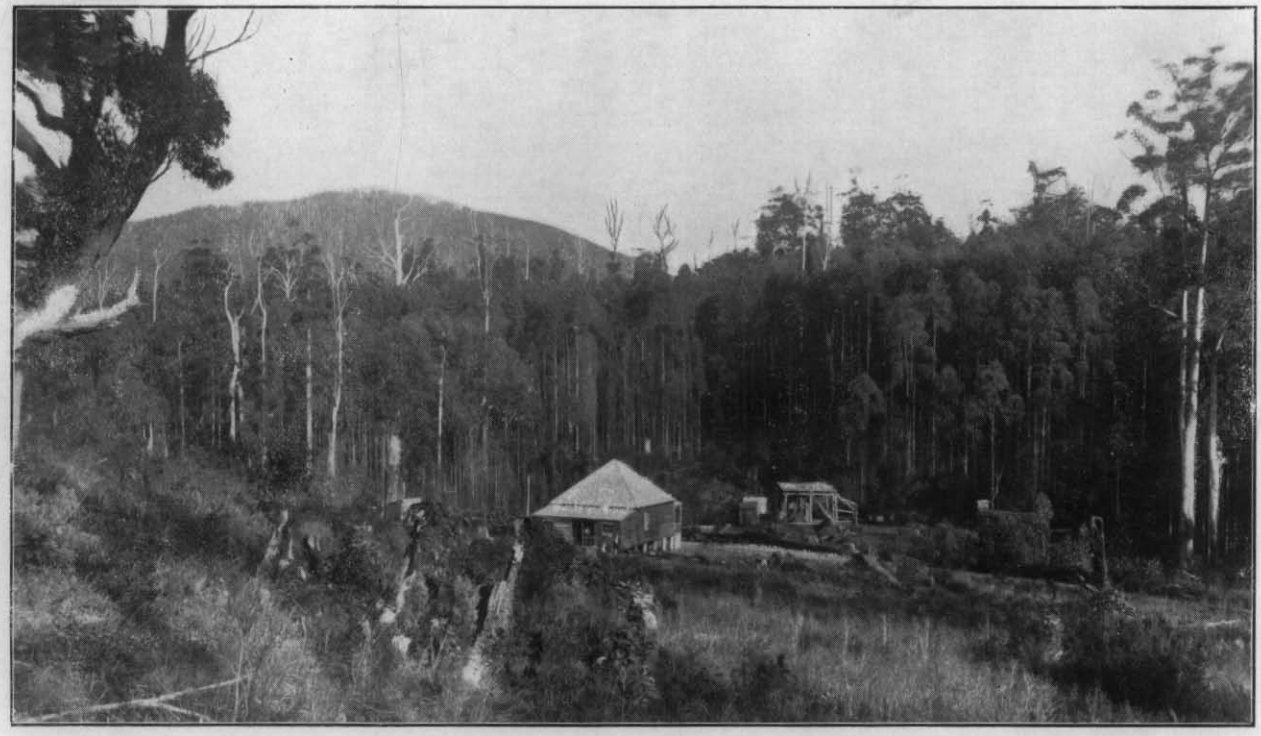


PLATE IX.—IDA BAY COAL MINE.

Hill, a dome-shaped eminence with steep sides, which forms a commanding object in the landscape, viewed from various directions. The extension of the beds westwards originates the celebrated Ida Bay caves. These caves, though exhibiting pronounced effects of solvent agents, are not famous for their scenic architecture, stalactites of beauty being rare. The caves in the limestone hill on the Cement Company's property occur along the course of an underground stream channel, and have a general height of from 5 to 10 feet, except where occasionally a deep vertical fissure has widened its walls, and an excavation some 50 feet in height has been created. The limestone beds dip into the hill at a very low angle—about three degrees—and are massively stratified. The rock is dense in texture, grey in colour, and is traversed by seams of calcite. It corresponds in every respect with the Silurian limestone of the Gordon River and Mole Creek, but the writer could not detect any fossil remains in it.

A timber tramway from the Lune settlement runs to the base of the Sugar Loaf, skirting, as it approaches the hill, a low wooded range on the east, and passing over level country, gradually rises as it reaches the base of the limestone range. Without any trials it is difficult to say how far the limestone extends north under this level country. It may extend for some distance from the base of the hill. The wooded range, however, consists of Permo-Carboniferous country; and its mudstone conglomerates contain a variety of stones, granite, quartz-porphyry, quartzite, &c., derived from different sources unknown in the vicinity. These are evidently the Lower Marine glacial beds of the system.

The works will probably be erected somewhere in the immediate vicinity of the Sugar Loaf, where the raw material can be delivered rapidly and economically to the mill, either by cable or tramway. The distance of the quarries from Ida Bay will be about 2 or 3 miles, and from Ida Bay to the shipping port (Deep Hole Jetty) another 3 miles. There are no particular engineering difficulties to be overcome in constructing the tramway. The country affords a fairly level route, and is either open or thinly timbered.

At the back of the jetty, level sandy ground covered with bracken, honeysuckle, and boobyalla, runs back a few chains to the low wooded hills, and makes a good site for the erection of buildings in connection with the enter-

prise. It is said that 8000-tons steamers have loaded hardwood for foreign ports at this jetty. A depth of 30 to 35 feet of water is available, and even more will be secured when the contemplated lengthening of the jetty is accomplished. Absolute protection exists from the south and south-east winds, and the Channel steamers, which run regularly to Southport, are in the habit of crossing over and lying here, for safety. The jetty is not more than 3½ miles from the coal mine, and would be utilised for the coal if any shipping trade sprang up in connection with the undertaking. It is probable, however, that the coal will form a subsidiary element in the enterprise, and be used principally for the purposes of cement manufacture.

Fresh water is available from sundry small creeks, but will have to be conserved to ensure an adequate continuous supply.

Portland cement is an artificial hydraulic cement mixture, which sets firmly under water to a substance resembling Portland stone; hence its name. The mixtures existing in different brands do not greatly vary in chemical composition. Given the raw material, the task of the manufacturer is to adjust the proportions of the essential ingredients so as to obtain a standard mixture. If there is too much clay in it, it fuses too readily, and the cement is too friable. If the mixture is too rich in lime, the cement is a slow-setting one, and is apt to swell.

The essential components of Portland cement are lime, silica, and alumina. Therefore, a cement property should have on it beds of limestone on the one hand, and clay to supply the silica and alumina on the other.

Limestone.

The Ida Bay property has on it an elevated area of beds of limestone, occupying the greater part of 800 acres, on the leases which have been taken up. The survey was not completed at the time of the writer's visit, but the apex of the Sugar Loaf, or Limestone Hill, appeared to be towards the centre of the property. The hill in descending to the west covers with its flank nearly the whole of the northern part of one lease. Its apex is a little over 2 miles horizontal distance from Ida Bay jetty, in a south-westerly direction. Its height by a single aneroid reading is said to be 1000 feet above the sea. Owing to inclement and snowy weather, the writer was unable to make the ascent, but from angular

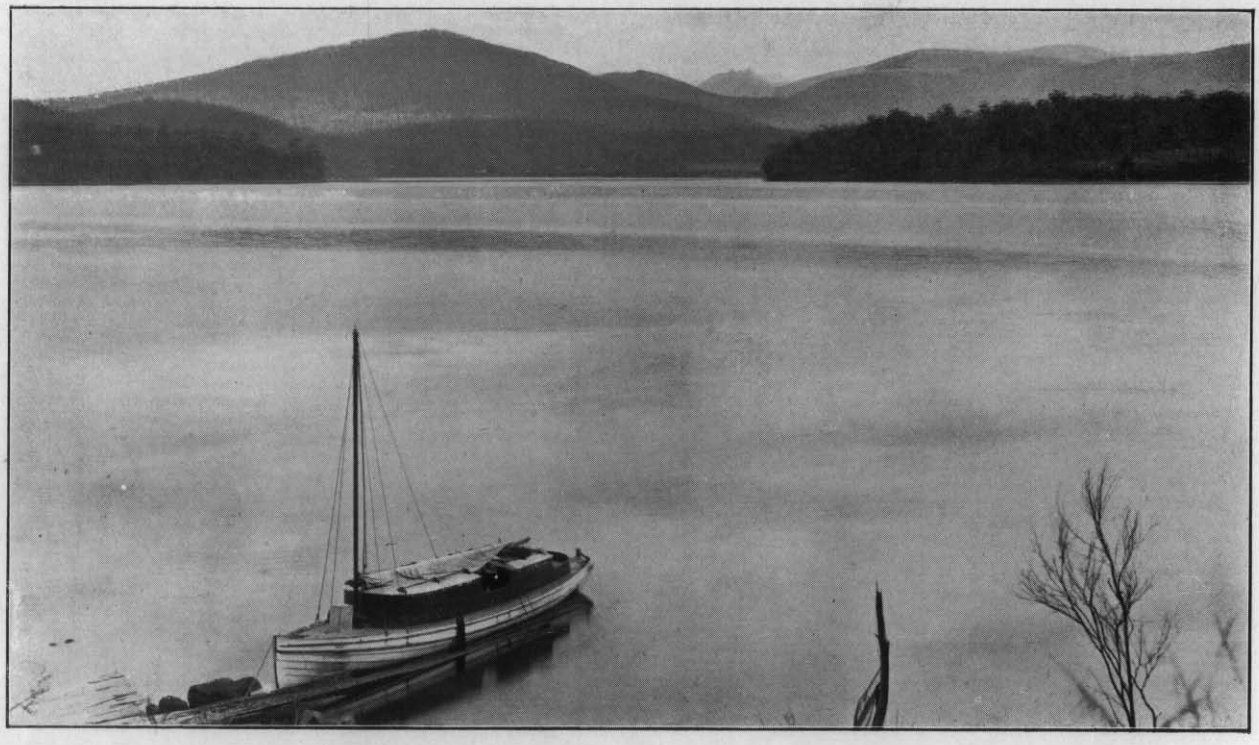


PLATE X.—IDA BAY, WITH LIMESTONE MOUNTAIN (SUGAR LOAF).

measurements with an Abney level, the height appeared to be about 1500 feet above the plain. Igneous rock (diabase or basalt) is said to occur at the summit, but its extent and mode of occurrence are not known.

Sufficient, however, is known of the mountain to warrant the statement that it largely consists of limestone. The steep cliffs of this rock can be followed with the eye for a great distance up the hill-side, and it is probable that a survey would show the area of it on these leases and claims to be upwards of a square mile. Assuming the limestone area to comprise 1 square mile, and assuming a loss of one-third of the gross weight during manufacture, each foot thickness would suffice for 17 years for a plant putting out 500 barrels per day.

The mountain is very steep on its northern side, showing precipitous bluffs and faces of limestone, and is thickly wooded to the very summit. A proportion of the water in the streams descending its sides sinks into the limestone and emerges again at the foot of the hill.

Quality of the Limestone.

This limestone is a high-grade rock, free from deleterious constituents, and thoroughly suitable for the objects of the proposed enterprise.

At the same time, it may be mentioned that some misapprehension often exists in the minds of prospectors and others with respect to the purity of the limestone required for a Portland cement proposition. They seem to lay great weight on the stone found on their claim carrying a maximum lime content. A little reflection will show that a rather impure limestone is the most welcome to the cement manufacturer, because its composition approaches more nearly to that of the mixture proper for cement-burning. If the correct mixture contains, approximately, 75 per cent. of carbonate of lime, and the manufacturer owns deposits of limestone containing as much as, say, 90 per cent. of the carbonate, he has to mix clay or shale with it, in order to preserve the proper proportions of lime, silica, and alumina. The selection is a matter of good judgment, and may have important consequences. Beyond a certain lime limit, the chief matter for consideration is whether the rock is devoid of objectionable elements. In this respect the limestone under review is unexceptionable.

Physically, the Ida Bay limestone is a compact, firm, micro-crystalline rock of remarkably uniform texture.

The analysis of samples taken on the present visit, made by Mr. W. F. Ward, Government Analyst, is as follows:—

	Per Cent.
Lime	52·00
Magnesia	1·50
Alumina	1·00
Silica, &c., insoluble in acid	3·70
Loss on strong ignition	41·80
	100·00

The published analysis of samples taken by Mr. F. Danvers Power from over a wide area with the view of being as representative as possible, is as follows:—

	Per Cent.
Calcium carbonate	91·6
Magnesium carbonate...	2·8
Silica	3·4
Iron oxide	0·8
Alumina	1·6
	100·2

Analysis made by Mr. A. J. Willcoxson, of the Ida Bay limestone yielded the following results:—

	Per Cent.
Calcium carbonate	92·67
Magnesium carbonate	1·83
Iron and alumina	0·91
Siliceous matter	4·02
Moisture...	0·21
Organic matter, sulphur, &c.	0·36
	100·00

PLATE XI.—CLIFF OF LIMESTONE, SUGAR LOAF, IDA BAY.

The lime content in Mr. Ward's analysis would be equal to a carbonate of lime percentage of 92·77. The above figures show a stone rich in lime, low in sulphur and magnesia, and with not too much alumina. Selected samples of the rock taken by Mr. S. J. Dawson for the purposes of the Limestone Reward claim, and assayed by the Government Analyst, gave still better results:—

	Per Cent.
Calcium carbonate	97·3
Magnesium carbonate	1·2
Silica	0·8
Alumina and oxide of iron	0·4
Moisture	0·3
	100·0

From these analyses it is clear that the limestone on the property is of a nature which will satisfy the requirements of the industry in the highest degree.

Deposits of Clay.

The ratio of clayey materials to carbonate of lime in the manufacture of Portland cement is standard when it is about one to three. The silica, alumina, and iron oxide, which are essential ingredients of the mixture, are practically supplied by the addition of clay or shale. A high-class fireclay is unnecessary for the purpose; in fact, it is prejudicial, from containing too much alumina and favouring too quick setting of the cement, besides possessing too little iron flux. The rule governing the alumina and silica contents is that the quantity of silica divided by the quantity of alumina ought not to be less than 2·5 nor greatly exceed 3·5.

It will be readily understood that the selection of the clay on a property is a matter of crucial importance, and has to be subject to proper technical control. Adequate physical tests are desirable before expenditure is incurred in installing the manufacturing plant.

The Ida Bay clay or shale is intimately associated with the seams of coal existing on the property, beds occurring both above and below the seams. These beds are no doubt co-extensive with the coal seams. In the present

undeveloped state of the colliery, and with the thick uncleared scrub, very little can be learned of their extent, and samples are practically only available from outcrops. A good deal of useful work remains to be done in clearing away the forest growth and exposing clay outcrops. Some of the clay deposit may be seen at surface above the main tunnel; and again above the seam in the upper shaft.

Samples taken by the writer from the open cut above the tunnel were assayed by the Government Analyst, and yielded as follows:—

	Per Cent.
Silica	55·6
Alumina	14·8
Iron peroxide	3·6
Magnesia	0·5
Loss on ignition	25·5
	100·0

A published analysis by Mr. F. Danvers Power from the same bed of shale is as under:—

	Per Cent.
Ignition loss	16·4
Silica	53·8
Alumina	28·1
Iron oxide	1·1
Lime	0·7
Magnesia	trace
	100·1

Further analyses by Mr. Power of shale from the upper shaft are:—

	A. Per Cent.	B. Per Cent.
Ignition loss	22·8	21·4
Silica	48·6	47·7
Alumina	23·2	25·6
Iron oxide	1·2	2·1
Lime	1·4	1·2
Magnesia	1·1	1·0
	98·3	99·0

Mr. A. J. Willcoxson, of Sydney, has made analyses of clay from the beds above and below the coal seams on this property, with the following results:—

		Calculated to Dry Material.
	Per Cent.	Per Cent.
Silica	45·22	53·30
Iron and alumina	29·29	34·52
Lime	1·22	1·44
Magnesia	1·93	2·28
Organic matter, combined water, &c.	7·02	8·27
Moisture at 105° C.	15·15	0·00
	99·83	99·81
Alkalies & undetermined	0·17	0·19
	100·00	100·00

	Per Cent.	Per Cent.
Silica	58·90	63·47
Iron and alumina	22·00	23·71
Lime	0·85	0·92
Magnesia	1·00	1·08
Organic matter, combined water, &c.	8·76	9·44
Moisture at 105° C.	7·21	0·00
Alkalies & undetermined	1·28	1·38
	100·00	100·00

These analyses in the aggregate show a general correspondence with the composition of clays used for Portland cement-making in other parts of the world, notably with English Medway clays, Hamburg clay, and many American clays.

Eckel, in his bulletin on "Portland Cement Materials in the United States," states that each barrel (380 lb.) of cement requires the use of approximately 450 lb. of limestone and 150 lb. of clay or shale.

The present owners of the Ida Bay property have published an estimate by their engineer (Mr. Willcoxson), based on an output of 2500 tons of cement per month.

This is equivalent to the capacity of a plant producing 500 barrels per day, which, as cement works go now-a-days, is one of moderate size, some large plants putting out 3000 tons per day. On this basis about 125,000 cubic feet of shale, or 11,000 tons, would be used each year. Assuming a minimum of 20 years' supply of raw material in sight as being necessary, it is necessary to establish, for a plant of the above size, the existence of 2,500,000 cubic feet of shale or clay.

There is little doubt of the existence of adequate quantities of clay or shale on the leases. Its location and economical working will be matters for study once the deposits are better known in their extent and occurrences.

Coal.

The question of coal supplies is always an important one for manufacturers of Portland cement, seeing that for every barrel of cement made about 2 cwt. of coal is consumed for power and burning. According to theory, only 30 lb. of coal ought to satisfy the burning requirements, but Bleiningen states that this is always exceeded in practice, and a consumption of 90 to 100 lb. per barrel is common. Newberry's calculation of fuel consumption in the rotary kiln with a coal having a calorific power of 13,400 B.T.U. is that in practice the actual amount used when burning a dry mixture is 110 to 120 lb. per barrel; and when the wet process is adopted and the kiln is charged with slurry, 150 to 160 lb. of coal per barrel are consumed.*

Taking 2 cwt. per barrel for power and burning in the kilns, 18,000 tons of coal will be required per annum for an output of 30,000 tons of cement; or, say, for a 20-years' period, 360,000 tons.

The coal seams on this property are situated on the eastern 1280 acres (once No. 6975), and on the 40 acres (Lease No. 5933). The latter lease is traversed by the main-road from the Lune to Ramsgate, and the principal openings on the lower and main seams are about 100 yards west of the road. Diabase country skirts the eastern boundary of this lease, and extends all over the area between here and Ida Bay. To the west of this line coal

* "The Manufacture of Hydraulic Cement," by A. V. Bleininger, 1904, p. 294.

measure country extends for a distance which cannot be exactly stated owing to the dense bush and absence of tracks, but which is certainly half a mile, and may be three-quarters to a mile, in that direction. Its extension north-west to south-east is probably from three-quarters of a mile to a mile, expanding southwards indefinitely towards the D'Entrecasteaux River. The southern portion of the 1280-acres lease will be found to embrace a very wide area of coal country.

There is more than one seam on the leases, and as far as quantities are concerned, in all human probability more than sufficient coal exists for the purposes of the cement proposition, even if the manufacture is continued for a length of time greatly in excess of what may be at present contemplated.

To the south-east of Lease 6975 a wide run of basalt occupies the country between the main-road and the lease boundary, and reappears in the northern and north-western portion of the lease, where it rises into high ground at the back of the coal-measure country, and skirts the southern edge of the Lune Plains, sending out into the latter tongues in a northerly direction. From the persistently meridional direction of this development of basaltic rock, it may be inferred that the occurrence is that of a dyke of fissure eruption. If this is so, wherever it is met with in this locality it will be found, like the diabase, to interrupt the continuity both of coal measures and limestone beds.

The strike or level course of the main seam is from 15 to 20 degrees west of north, and it dips in a south-westerly direction at an angle of 10 or 11 degrees. Its thickness at about 50 or 60 yards in is 5 feet. It has been followed down on the dip for that distance, and has been persistent in character, with not more than a band or two an inch or so thick.

The coal is massive, somewhat soft, dull in appearance, with occasional shining layers. It burns quietly, and emits much heat. At the time of this visit it was being used in the boiler for the unwatering of the mine. At and near the outcrop the seam is somewhat clayey, but the drive had been under water for a year or two, and the coal improves as it continues under cover.

A sampling was made of the face 100 feet in, which, on assay by the Government Analyst, gave the following result:—

	Per Cent.
Fixed carbon	55·5
Loss at red heat	28·9
Moisture	3·8
Ash	11·8
	100·0

A sample at 40 feet in, yielded the following:—

	Per Cent.
Fixed carbon	67·3
Loss at red heat	14·0
Moisture	2·8
Ash	15·9
	100·0

The sulphur content was 0·8.

Mr. Willcoxson's published analysis of samples from this seam appears to correspond fairly with the figures of the last assay. The result was:—

	Per Cent.	
Hygroscopic moisture	1·54	
Volatile hydrocarbon	15·56	Calorific value 12·2
Fixed carbon	64·90	
Ash	17·55	
Sulphur	·45	
	100·00	

The outstanding features of the coal are a rather high fixed carbon value for our Trias-Jura coal and a low gas content. The sulphur content is low, and the ash about normal, for the general run of seams of this age.

According to the various assays published from time to time there is a certain degree of variability in the composition of the coal at different points in the mine. Thus, one assay made by the Mines Department gives as much as 72·2 per cent. fixed carbon, and as little as 11·3 per cent.

volatile matter. The probability is that the proximity of the diabase is responsible for a somewhat irregular expulsion of the gases and a consequent increase in the proportion of fixed carbon in different parts of the seam. The result is a variation in an anthracitic direction.

The particular proportions of fixed carbon and volatile matter in coal for cement-making are no longer of such importance as was considered at one time. As long as the caloric value is sufficient for the production of the desired heat in the proper part of the kiln, and the amount of ash is not too great and contains no objectionable elements, the coal will meet the requirements of the case. It is first crushed and then dried to expel moisture. A rotary drying cylinder is frequently employed for this. When dried, it is pulverised in a fine grinder, preferably one of the centrifugal type. There seems to be some opening for the use of mechanical stokers in the clinkering kilns, by means of which a continuous high temperature may be kept up, and so enable poorer grades of coal to be utilised. A portion of the ash remains behind in the cement, and thus an excess of ash is a drawback, but if the coal is ground fine, an ash content of 15 or 16 per cent. will not interpose difficulty.

Coal for use in kilns has always to be pulverised finely, and the poorer the quality of the coal, the finer must it be reduced. Conversely, the finer it is ground, the poorer the quality that may be used. Complete drying and fine grinding are two aids of great value to the cement manufacturer.

The heating power of the Ida Bay coal is satisfactory, and the proportion of volatile matter shown by the analysis No. 1 will be found about sufficient to induce ready ignition in the kilns. This rapidity of ignition is said to be a rather important requirement in order to obtain the highest furnace temperature at the proper distance from the feeding end of the rotary kiln. This distance is stated to be between 10 and 11 feet. If the coal is slow to ignite, its maximum temperature is attained too near the other end of the kiln, and the unduly hot gases are discharged with attendant waste of heat; besides which, the slow acquisition of the necessary temperature causes clinkering difficulties. The best coals for the kilns are such as contain between 30 and 40 per cent. volatile matter, and between 50 and 60 per cent. fixed carbon.

Some of the coal in the tunnel seam has properties which would make it suitable for special uses. Analysis No. 2 shows a coal with a relatively high carbon value and low gas content. This would be a nearly smokeless coal, with good heating qualities. The analysis closely corresponds with some of the York Plains coal, which is used for metallurgical and malting purposes. The bottom coal in that colliery, according to samples taken by the Inspector of Mines, assays 67 per cent. fixed carbon, 13 per cent. volatile matter, 16 per cent. ash, 0·7 per cent. sulphur, and 2·7 per cent. moisture; which agrees very well with the composition of the sample taken from the second tunnel at Ida Bay at about 40 feet in.

About half a mile south-west of the tunnel, and perhaps a hundred feet higher up, is a parallel seam, which has been sunk on by a shaft to a depth of about 20 feet. At the time of the present visit, only a couple of feet of this seam was exposed, the remainder being under water; it is said to be a 6 feet seam. It dips south-west at an angle of 7 or 8 degrees. The mine manager (Mr. S. J. Dawson) says that he has traced the crop through the forest for a great distance. The coal is dull in appearance, with a few shining layers in it. Mr. A. J. Willcoxson's published analysis of the coal from this shaft gives the following:—

	Per Cent.	
Fixed carbon	69·260	
Volatile hydrocarbon ...	12·300	
Ash	14·737	Calorific value 9·210
Sulphur	0·603	
Hygroscopic moisture ...	3·100	
	100·000	

The mine manager proposes to sink his main shaft so as to cut both seams and work them simultaneously to the rise of the coal.

Irrespective of the cement enterprise, it would be desirable to open up the coal seams on their own merits, with a view of establishing a market for the coal in Hobart, though owing to the particular constitution of the coal and the demand of the general market for a somewhat different class of fuel, there may be difficulties not easy to overcome at first. The market to be sought is that which requires coal of a more or less anthracitic character.

The great use for the product, however, will be as fuel for burning or clinkering the cement mixture; and in having it on the property close to the kilns the manufacturers will find that they have a unique asset. No other property in the island which could be utilised for cement-making is more favourably situated in this respect. This will be the more appreciated when it is realised that as a rule the fuel charge amounts to about a third of the entire cost of producing the cement. A small tramway cost is all that will be incurred in delivering the coal from the mine to the kilns.

OUTLINES OF THE MANUFACTURE OF PORTLAND CEMENT.

Assuming adequate supplies of raw material to be at hand, the first step is to determine what power will be available for the manufacturing processes. For cement works the outside limit of power requisite is generally considered to be 1½ horse-power per barrel of cement made per day. Where the wet or slurry process is used, the horse-power required can be reduced to 1 horse-power per barrel produced. The Ida Bay proposition, in which presumably the dry process would be employed, would on this basis require 750 horse-power for its 500-barrel plant. This would have to be supplied by steam or electricity.

Dry and Wet Processes of Manufacture.

In preparing the materials for Portland cement, the manufacturer has two mixing methods at his disposal—the wet and dry. If the wet process is adopted, the raw materials are blended and then mixed into a paste by the addition of water. With this process a larger proportion of moisture has to be driven off in the kilns, and the output per kiln is less than when the dry method is used. It is employed, as a general rule, when the raw materials consist of soft chalk and marl, and plastic clays containing a great deal of moisture.

Crushing and Coarse Grinding.

In the dry process the limestone and the shale or clay are charged into gyratory or jaw crushers in the proper proportions required for the mix. This rough crushing reduces the mixture to half-inch size. The latter then passes to

crushing mills, which grind it to a size small enough for a 16-mesh screen. The ball type of mill is most generally used for this work.

Fine Grinding.

The final reduction is effected by finest grinding in a tube pebble mill or a mill of the centrifugal grinding type. The bulk of the product is then capable of passing through a 100-mesh sieve.

Burning or Clinkering.

The finely-ground mixture is fed continuously into a rotary kiln, which is essentially a large steel cylinder lined with firebrick, and from 60 to 100 feet and more in length, and from 2 to 3 yards in diameter. It has an inclination of about half-inch to the foot, and the mixture is charged into it at the upper end and slowly passes down the tube by gravity, assisted by the rotation of the kiln, which is effected by means of gearing. At its lower end powdered or dust coal is blown in, and under the influence of the heat generated, the material is burned to the stage of incipient vitrification. The silica, alumina, lime, and iron fuse together and fall from the lower end of the rotated tube in a mass termed "clinker." The temperature during this process has to be carefully watched to prevent overburning, and the production of poor cement. The average burning capacity of a 100-foot kiln is estimated to be about 500 barrels per day of 24 hours.

Treating the Clinker.

The hot clinker is then cooled by water-spraying or air-cooling, receives an addition of about 2 per cent. gypsum to retard quick setting, and is finely ground. The fine flour to which it is finally ground will, with the exception of 5 to 10 per cent. of it, pass through a 100-mesh sieve, and a large portion of it through a 200-mesh. The resulting cement is stored until it is perfectly seasoned or cured and is in a fit state for the market.

Several experts have furnished the proprietors with estimates of the costs of manufacturing varying from 31s. to 40s. per ton. The present retail selling prices are abnormal, but in ordinary times market prices are about £4 per ton. The selling price at certain American factories has been as low as 15s. per ton, so it is evident that where conditions

are favourable working costs can be kept at a very low figure. At all events, where, as at Ida Bay, the factors are all that can be desired, the foundations of a profitable and useful industry can be laid without much difficulty.

Not the least important feature of the undertaking is proximity to a deep-water shipping port, accessible to ocean boats, and within 50 miles of Hobart, by the sheltered Channel route.

Cement in the modern civilised State ranks in importance with iron and coal, and the remarkable increase in its manufacture and uses throughout the world makes the establishment of a cement-making industry imperative for a State like Tasmania, which has the raw material ready for use, and associated with working conditions exceptionally favourable for the initiation of the enterprise. The present time, when German imports are suspended, is singularly suitable for such an undertaking.

(*c*) Strathblane Coal Mine.

This property comprises three leases held by H. J. Colbourn, 5547M, 200 acres; 6708M, 240 acres; and 6759M, 200 acres, situate in the Parish of Garrett, about 4 miles south-west from Chale Bay, which is a tidal inlet at the head of Port Esperance. The Creekton Rivulet, a permanent stream, flows in a devious course from the mine and empties into Chale Bay.

The approach to the mine is *via* Dover, a township on the shores of Port Esperance, 51 miles from Hobart by road, or accessible by the Channel route, on which steamers ply regularly. The distance by water is 38 miles.

The shores of Port Esperance are fringed mostly on the north and west sides with Permo-Carboniferous marine mudstones, sandstones, and conglomerates, belonging to the lower division of the system. Where these are absent, the Mesozoic diabase rock takes their place. These strata are seen south of the Esperance River, but between there and the mine a change of country occurs, for at the mine itself the stratified rocks belong to the Trias-Jura.

At about four miles from Dover the Dover-Hastings-road is crossed by the Hobart Timber Company's tramway, along which the visitor to the mine walks for about 3 miles, when a branch tramline leads to the principal mine workings. These are on the 240 acres, and the seam has also been opened up on an adjoining 100 acres to the south, now vacant. Some work has also been done on the northern 200 acres.

The flat land between the mining sections and the main road consists for the most part of a superficial covering of clay resting on loose sand or silt. A few holes have been sunk on the plain in search of gold, of which some colours are reported to have been found, though it is difficult to trace the information to any reliable source. Colours of gold are also said to have been obtained at the water's edge at the head of Port Esperance. The explanation of the occurrences is probably that the Tertiary sediments, of which the deposits on the Strathblane and Esperance plains are survivals, contain a little gold which has been brought from a distant source within the then drainage system of this part of the country. Similar occurrences are met with in Tertiary deposits in various parts of the island. In this case, as no productive source is known in the neighbourhood, it is not likely that the alleged discoveries will prove to be of any economic value. The nearest gold-bearing rock is that of the Port Cygnet belt.

The bed rock below the alluvial ground is no doubt the surface of the beds which form the Trias-Jura coal measures, and which rise into the hills at the western edge of the Strathblane plain. Mr. Wm. Anderson owns a farm of 320 acres on the east of and adjoining the coal properties. This is situate at the foot of the ranges and below its alluvial soil and silt will probably be found an extension of the coal-bearing country.

The prominent feature of the coal property is a rather narrow, thickly-wooded hill ridge, less than half a mile in width, and 300 to 400 feet high, traversing Section 6708M in a north and south direction. Outcrops of seams have been located both on the east and west sides of this ridge, and it is stated that indications exist showing that the seams of coal extend through the section. In any case, mine openings exist on both flanks of the southern portion of the ridge.

Coal was found here six or seven years ago by the well-known coal prospector, Mr. Wm. Anderson, who has been the discoverer of most of the seams in Southern Tasmania. All the shafts and tunnels have been put in during the last five years; most of them five years ago by the Messrs. Woods and Anderson. For the last three years the property has been held by Mr. H. J. Colbourn. About 400 feet of driving and sinking have been done, exclusive of several small trial pits, and small parcels of coal have been sent away and tried on the steamers "Dover" and "Lobo," and on the Hopetoun mill locomotive. Not far

short of 100 tons are stacked outside the tunnels. No work is being done at present, pending an attempt to secure capital for the enterprise.

A branch tramway from the main tramline leads northwards up the valley on the west side of the hill ridge to the main workings. At about 600 yards along this tramway, and 55 feet east of the line, is the first opening in this direction, situate near the northern boundary of a 100-acre section, now vacant. A tunnel has been driven in a direction N. 55 degrees east on the dip of the seam for a distance stated to be between 20 and 30 feet. It is, however, at present full of water, and cannot be entered. The visible seam is 2 feet thick, and dips in a north-easterly direction at an angle of 19 degrees (1 in 3). A bend is said to occur at the end of the tunnel, the former owner turning the drive southwards in order to avoid entering the 240-acre section which adjoins this one on the north.

The coal is dense and hard, compact in grain, with only a few shining streaks through it. It has a roughly cubical fracture, and withstands weathering well, for the tunnel is understood to have been driven five years ago, and the pile of coal at the mouth has been stacked there all the time and shows no signs of deterioration.

There is some doubt as to whether this seam is identical with the one in the main tunnel 100 feet further north. It certainly looks a few feet lower than the latter, but the question can be decided very easily when work is resumed.

Samples taken from the coal stacked were submitted to examination by the Government Analyst, with the following results:—

	Per. Cent.
Fixed carbon	55·1
Gases, &c.	26·0
Ash	15·2
Moisture	3·7
	100·0

This is a typical Trias-Jura coal, with a little less volatile matter and more ash than usual.

Main Tunnel.

This tunnel is just inside the south boundary of the 240 acres, about 100 feet north of the preceding, and a chain west of the tramway. It is a broad drive (6 feet by 6 feet),

and has been driven N. 38° E. At half a chain in, it intersects the seam of coal, and then goes down on the dip, which is very steep (25 degrees to 30 degrees). At the point where the plunge is taken, the tunnel is full of water, and it cannot be seen whether there is any dislocation of the seam here or not. For the same reason the thickness of the seam in the end could not be observed. Where it disappears below the water it is $2\frac{1}{2}$ to 3 feet thick.

At 21 feet in the tunnel, a drive south-east has been put in along the seam, but the end could not be reached owing to water. Where this drive starts, the coal is over 5 feet thick; it then thins to 2 feet, afterwards thickening to from 2 feet 6 inches to 3 feet 6 inches: the average is probably upwards of 3 feet.

The coal is black, massive, hard, and shining; to all appearance of excellent quality. Samples taken from the seam were assayed by the Government Analyst, and yielded as follows:—

	Per Cent.
Fixed carbon	55·2
Gases	30·2
Ash	7·9
Moisture	5·6
Sulphur	1·1
	100·0
Calorific value	12·4 lb.

A published analysis of samples taken from this tunnel by Mr. S. J. Dawson is as follows:—

	Per Cent.
Fixed carbon	55·6
Volatile matter	27·9
Ash	12·9
Moisture	3·6
	100·0

The mean of these two analyses shows a coal which corresponds in quality with the normal Trias-Jura coal of the East Coast. Its physical properties place it in the better class of such coal, it being hard and with no tendency to split when burning.

Creek Drive.

This has been driven from the creek a little further north, for a chain in length, in a direction 30 degrees east of south, and connects with the main tunnel. The first discovery of coal was made here. At the entrance of the drive the seam is 5 feet 6 inches thick: in the drive itself this is reduced to 3 feet and 2 feet. Several feet below the entrance the seam forms a thick ledge in the bed of the creek. The difference in level is probably due to movement at that point.

The above description embraces the productive workings on the west side of the hill. The seam has thus been tapped and driven on a little at intervals along its outcrop, but the work of proving its extensions into the hill on its dip remains to be done.

The seam no doubt also exists in the hill on the west side of the narrow valley, and it will probably be found rising in that direction, as the valley is one of erosion, and the dip of the beds would not be affected by it.

The small amount of work done does not admit of a precise determination of the strike of the seam, but, as far as can be seen, it is north-west to south-east, with an underlay to the north-east.

East Side of the Hill.

Sundry workings exist in the level country on the east side of the ridge.

Four or five chains west of the tramway and a chain or two inside the south line of the 240-acre section, a tunnel has been driven for about a chain in a direction W. 10° S. on a seam of coal stated to be 3 feet thick, and dipping 19 degrees. The tunnel is now filled with water to the entrance, but the soft outcrop is visible in the bank. This outcrop is said to be 19 feet lower than that of the seam on the west side of the hill. At 30 feet above the end of the tunnel is a shaft which has been sunk to the coal, and connects with the tunnel. At about 12 feet down it is said to have passed through an upper seam of hard coal, 15 inches thick. All the coal won in this tunnel has been sent away for testing. A parcel tested on the "Dover" steamship came from this side of the hill.

On the 240 acres on this side of the ridge is a tunnel, which was driven five years ago for 20 or 30 feet on a 3-feet seam of soft coal. In connection with this a shaft had been sunk 25 feet deep a year previously—in sandstone. The tunnel is now full of water.

On the 200 acres section, about 13 chains north of the south-east corner, a shaft, at present with water in the bottom, was sunk by Mr. Anderson to a depth of 25 feet, in a soft, shaly, micaceous sandstone, with carbonaceous films and a few impressions of plants characteristic of the upper coal measures of Tasmania. These occur in bands of dark, thinly-bedded shale, breaking down into thin laminæ under the influence of the weather. There is level country from here to the base of the ridge to the west, all covered with stringy-bark, tea-tree, honeysuckle scrub, and cutting-grass.

Quantity of Coal.

The work done on this property is insufficient to admit of any reasonable calculation of quantities of coal existing on the sections.

The east flank of the ridge is strewn with boulders of basalt, but no solid outcrop of this rock is visible, and in the absence of this it is an open question whether the hill has a backbone in the form of a basaltic dyke, in which event the passage of the coal seam through the ridge would be interrupted, or whether the stones of basalt which are now scattered through the soil are the survivals of a former capping, which would not interfere with the seam. The difference in the direction of the dip of the seam on each side of the hill has been suggested as indicating an intrusion; on the other hand, if, as the writer is told, the basalt is also found on the hill west of the main workings, the indications are in favour of a lava covering, and in this case the difference in dip might be due to sagging under the weight of the overlying lava. An attempt was made to get to the summit of the hill, with a view of gaining information bearing on this question, but in the absence of any track it was impossible to penetrate the scrub in the time available.

The outcrops are at or above the level of the surface of the great plain north-east of the hill ridge, *i.e.*, if the eastern outcrop represents the seam on the west side; and if the basalt is not in dyke form, the seams will be found to be continuous. It is, however, quite possible that a downthrow fault occurs on the plain at the eastern foot of the hill, in which event the seam will be found at some distance below the surface. Some desire has been expressed to test the level ground by boring, and once operations have been fairly started and the mine is in active work, this might

very well be included in a prospecting programme; but for the present work ought to be confined to developing the seam where it has been opened on the western side of the hill. It should be followed into the hill, and an attempt made to pick it up on the western side of the valley. This programme is perhaps sufficient for the immediate future, with a company working on a moderate scale.

The only way at present of getting the coal to the port is per the Hobart Timber Company's tramway, with a royalty charge of 1s. per ton for running rights, but the mining company would have to own its own route from the mine to the water's edge.

The above scheme of work is preferable to spending money in boring on the flat, where all mining would have to be carried on from shafts and the maximum of water contended with. It is undeniable that seams may extend under the flat for miles, and that this and their depth below surface could best be determined by boring, but it does seem that the quickest and least expensive way of arriving at an output will be to open up the seam which has already been disclosed by the works on the west side of the hill.

Quality of Coal.

Physically, it is a good hard coal of the Trias-Jura division. Its hardness protects it from disintegration in the open-air, as evidenced by the coal heaps which have been preserved in good condition for the last four or five years outside the mouths of the tunnels. It burns freely and quietly on the open hearth, without any decrepitation, its physical constitution favouring a ready ignition of its volatile matter. Taking the analysis of the coal from the main tunnel as typical of the product, it should make an excellent household coal and be good for steam-raising in various industries and for use on railway locomotives under similar conditions to those in which the East Coast coals are now used in Tasmania.

In conclusion, with caution in the initial expenditure, there are good grounds for believing that the mine could be opened up easily and put into a state of efficiency. Productive work could be started on a moderate scale, while at the same time the extent of seam workable could be ascertained by prospecting as suggested above in this report.

VI.—CONCLUSION.

It must be admitted that the intermittent work which has been carried on in the southern coalfields has not resulted so far in the creation of any active collieries. There are, however, signs that this state of things is on the eve of undergoing a decided change. All three of the fields described in this report possess potentialities which are bound to be evoked and developed, and which appear now to be arousing the attention of investors.

To ensure success, it is essential that the characteristics and limitations of each undertaking be separately and carefully studied. It is bad policy to push the use of a coal, for instance, for a purpose for which perhaps it may be used passably, but for which it is not the best suited. If the best market can be got for a coal as a household coal, it would be unwise to attempt to introduce it as a gas coal. If it makes an excellent steam coal, commonsense dictates that it be placed on the market for that purpose. Advantage should be taken of any little peculiarity which may characterise a coal, indicating in which direction sales should be pressed. If the coal is tender, and a good steamer trade can be opened up, this should be cultivated in preference to household deliveries. If it is a dull heavy variety, with a low gas content, and can be absorbed for manufacturing purposes, the course is equally clear. It will only be by acting in a way which ordinary business prudence suggests, that each enterprise can stand on a sound footing, with the advantage, moreover, of not competing with one another.

It so happens that the product of each of the properties reported on can be applied with the greatest profit to distinct and separate lines of industry. The Ida Bay coal will find its most appropriate use in cement-making; the Catamaran coal is suitable for an extensive steamer bunker trade; while the Strathblane product will make an admirable domestic and ordinary coal. There is thus room for the simultaneous development of all these properties without one encroaching on the other.

Another point in connection with the development of these undertakings is the desirability of determining the extent of the seam area while the ordinary mine work is proceeding. This can be done at Catamaran and Ida Bay by adopting a boring scheme as an integral part of the working programme, and at Strathblane by ordinary pros-

pecting. In the latter instance this would consist in uncovering the hill flank on the west side of the valley, and if the seam is found to extend to that side, a much longer life will be immediately assured to the mine. The Catamaran seam has been well prospected along its crop, and it would be very satisfactory if a bore could intersect it on its dip a good way in advance of the present works. This would absolutely determine freedom from faulting in that direction, and at the same time establish the absence of igneous rock, enabling a sound forecast to be made of tonnage of coal available for mining.

The proximity of deep water to all these mines is an exceptionally favourable condition. The absence of this has been of the greatest moment in retarding the development of more than one Tasmanian coalfield, but here not only are secure harbours within easy reach, but a short, deep, and protected waterway leads straight to the capital city of the State.

No serious faulting is known as yet in any of these fields. The underground water to be coped with is nothing beyond the ordinary flow, and the working conditions generally are compatible with economic mining. An essential condition of success is that the work on each mine be laid out appropriately to the special features of each, and proper technical control maintained. Nothing further need be added to this report than that as far as geological and mining indications go, the undertakings possess the elements of success.

The cement industry which is contemplated is one which has much in its favour: the geographical and fuel conditions are unusually favourable, and there does not seem to be any reason why the manufacture of this article at Ida Bay should not prove profitable to the owners as well as a benefit to the State.

W. H. TWELVETREES,
Government Geologist.

Launceston, February 6, 1915.

APPENDIX.

Registers of Government Bores at Recherche, 1902-1903.

Catamaran No. 1 Bore.

Commenced 21st July, 1902; finished 5th September, 1902.
Total depth bored, 229 feet 10 inches.

Nature of Strata bored through.	Thickness of Strata.		Total Depth.	
	ft.	in.	ft.	in.
Clay, surface	7	0	7	0
Diabase, boulders	11	2	18	2
Sandstone, floating	1	0	19	2
Shingle and boulders	0	6	19	8
Shale, soft dark-coloured mud	2	4	22	0
Shale, hard, dark	2	2	24	2
Shale, dark and blue, soft broken	20	1	44	3
Shale, dark, and very hard	0	8	44	11
Shale, hard blue	8	7	53	6
Sandstone, hard grey	7	6	61	0
Sandstone, hard brown and blue, broken	45	0	106	0
Sandstone, hard brown, broken	29	0	135	0
Sandstone, solid	6	11	141	11
Shale, broken	9	4	151	3
Sandstone, broken	8	3	159	6
Shale, broken	1	6	161	0
Shale, broken with coal-markings	9	3	170	3
Shale, blue and dark-coloured	10	9	181	0
Shale, blue	8	0	189	0
Sandstone, broken	4	10	193	10
Shale, pink and green talcose (?), penetrated by pink and white radiating zeolites in alternate bands	4	2	198	0
Shale and sandstone, broken	10	6	208	6
Shale, broken	6	6	215	0
Clay, with scattered vesicles and amygdules of calcite	1	6	216	6
Diabase	13	4	229	10

Catamaran No. 2 Bore.

Commenced 22nd September, 1902; finished 17th December, 1902. Total depth of bore, 726 feet 6 inches.

Nature of Strata bored through.	Thickness of Strata.		Total Depth.	
	ft.	in.	ft.	in.
Clay, surface sandy...	8	0	8	0
Shale, light-coloured, micaceous...	6	0	14	0
Clay, light micaceous, containing small nodules of dark clay	32	0	46	0
Sandstone, white crystalline or saccharoidal	4	0	50	0
Sandstone, soft white micaceous...	35	6	85	6
Conglomerate, white sandstone	1	6	87	0
Sandstone, white, with mica and micaceous iron in joint planes	5	0	92	0
Sandstone, white, with mica and micaceous iron	25	0	117	0
Sandstone, white crystalline, with mica and micaceous iron	14	0	131	0
Shale, white sandy	16	0	147	0
Sandstone, white crystallinne...	13	6	160	6
Sandstone, white micaceous...	12	0	172	6
Sandstone, white, with flakes of specular iron	14	0	186	6
Sandstone, white...	38	0	224	6
Sandstone, yellowish, with mica and specular iron	23	6	248	0
Shale, grey micaceous	9	0	257	0
Sandstone, white, with specular iron	9	0	266	0
Sandstone, white...	34	0	300	0
Sandstone, oxidised...	1	0	301	0
Sandstone, white	12	10	313	10
Sandstone, white, with iron pyrites and specular iron	6	1	319	11
Shale, sandy	1	6	321	5
Shale, with very faint coal-markings	29	3	350	8
Sandstone, with micaceous iron	12	10	363	6
Shale, grey, with a little pyrites	11	0	374	6
Shale, dark grey	13	3	387	9
Shale, white sandy, with a little specular iron	5	7	393	4
Sandstone, grey clayey, with much specular iron	56	8	450	0
Sandstone, with white micaceous iron ...	25	3	475	3
Sandstone, broken	18	1	493	4
Shale, grey	36	8	530	0
Sandstone, hard, with white micaceous iron	40	0	570	0
Sandstone, white	22	0	592	0
Rock, doubtful contact, with calcite	6	0	598	0
Sandstone, light grey...	34	0	632	0
Rock, doubtful contact, with calcite...	12	0	644	0
Quartzite, with fine impregnation of pyrites	12	6	656	6
Shale, light sandy	16	3	672	9
Sandstone, blue, hard and broken	16	0	688	9
Diabase, fine-grained	12	9	701	6
Diabase, altered, almost wholly replaced with calcite veins	25	0	726	6

Moss Glen No. 1 Bore.

Commenced 2nd March, 1903; finished 22nd April, 1903.
Total depth bored, 515 feet.

Nature of Strata bored through.	Thickness of Strata.		Total Depth.	
	ft.	in.	ft.	in.
Clay and sand, surface...	3	0	3	0
Shingle	1	0	4	0
Sandstone, soft	2	0	6	0
Sandstone, felspathic, with coal-markings	84	0	90	0
Sandstone, solid	11	3	101	3
Sandstone and shale	5	4	106	7
Sandstone, dark broken felspathic, with coal-markings	7	8	114	3
Sandstone, with a little shale intermixed...	15	9	130	0
Sandstone, felspathic, with coal-markings	21	0	151	0
Shale, carbonaceous	7	0	158	0
Sandstone and shale	7	0	165	0
Sandstone, felspathic, with coal-markings	32	6	197	6
Sandstone, broken...	3	2	200	8
Shale, with coal veins	1	8	202	4
Sandstone, felspathic, with coal-markings	43	8	246	0
Shale, dark	7	0	253	0
Coal, bright	0	6	253	6
Shale, dark sandy, with small veins of coal	7	8	261	2
Shale, dark sandy	3	0	264	2
Shale, sandy	8	1	272	3
Sandstone, felspathic	47	1	319	4
Sandstone, felspathic, with coal-markings	7	8	327	0
Shale, dark, with small veins of coal	14	2	341	2
Coal, bright	0	4	341	6
Shale, with veins of coal...	1	2	342	8
Shale, dark clayey	7	0	349	8
Shale, dark sandy	13	6	363	2
Shale, dark clayey...	9	2	372	4
Shale, dark	1	2	373	6
Coal...	0	6	374	0
Shale	0	4	374	4
Coal	0	8	375	0
Shale, dark clayey...	4	9	379	9
Shale, clayey, with veins of coal	9	8	389	5
Shale, dark clayey...	7	7	397	0
Shale, dark	10	0	407	0
Sandstone, felspathic	14	0	421	0
Shale, dark micaceous	13	0	434	0
Sandstone, felspathic	13	0	447	0
Sandstone and shale	3	8	450	8
Shale, brecciated	3	10	454	6
Diabase, broken	1	6	456	0
Diabase, fine-grained	59	0	515	0

Moss Glen No. 2 Bore.

Commenced 27th May, 1903; finished 28th June, 1903.
Total depth bored, 152 feet.

Nature of Strata bored through.	Thickness of Strata.			Total Depth.	
	ft.	in.		ft.	in.
Surface soil and white clay	8	0	...	8	0
Clay, white and yellow	16	0	...	24	0
Boulders, shingle, and clay	4	0	...	28	0
Shale, soft white, clayey	4	0	...	32	0
Shale, soft brown, clayey	19	0	...	51	0
Clay, carbonaceous	4	0	...	55	0
Shale, soft, with veins of coal	1	6	...	56	6
Band	0	8	...	57	2
Coal	0	10	...	58	0
Band	0	4	...	58	4
Coal	0	6	...	58	10
Band	0	3	...	59	1
Coal	0	2	...	59	3
Band	0	4	...	59	7
Coal	0	3	...	59	10
Band	0	6	...	60	4
Coal	0	3	...	60	7
Band	0	5	...	61	0
Coal	0	9	...	61	9
Band	0	4	...	62	1
Coal	0	7	...	62	8
Band	0	2	...	62	10
Coal	0	6	...	63	4
Band	1	6	...	64	10
Coal	0	3	...	65	1
Clay, white, with veins of coal	6	8	...	71	9
Clay, white and brown, with veins of coal	6	6	...	78	3
Shale, soft micaceous	25	9	...	104	0
Coal	0	4	...	104	4
Limestone	0	5	...	104	9
Sandstone and shale, dark	2	3	...	107	0
Shale, dark, with small veins of coal	2	6	...	109	6
Shale, soft blue	1	7	...	111	1
Conglomerate	5	8	...	116	9
Shale, dark blue and brown	9	3	...	126	0
Sandstone, felspathic, with coal-markings	26	0	...	152	0

GSB20

GEOLOGICAL SKETCH MAP OF CATAMARAN COAL FIELD

LEGEND

QUATERNARY AND TERTIARY

MESOZOIC DIABASE

TRIAS-JURA COAL MEASURES

LINE OF COAL OUTCROP

GOVERNMENT BORES

SCALE

10 5 0 10 20 30 40 50 60 70 80 CHAINS

0 ¼ ½ ¾ 1 MILE

5 cm

PLATE XII

DENTRECASTEAUX RIVER

T. Ball Pur.

95.0.0 R.D.Cuthbert Pur.

R.D.Cuthbert Pur.

25.0.0 The Commercial Bank of Tas: Lim. Pur.

25.3.0 R.D.Cuthbert Pur.

457.2.19 E.S.K.Wright Pur.

23.2.4 R.Cuthbert Pur.

24.2.0 R.D.Cuthbert Pur.

48.2.0 R.D.Cuthbert Pur.

98.0.0 R.D.Cuthbert Pur.

152.3.2 H.D.O'Halloran Pur.

6230 237 R. C. Young

101.2.31

28.2.23 R.D.Cuthbert Pur.

206.2.17 J. Ryan Pur.

Lot 350 640.0.0 Moss Glen No. 2 T 152 ft. W. Brown Pur.

Moss Glen No. 1 515 ft.

99.0.35 J. Ryan Pur.

BLACK SWAN LAGOON

BENNETTS PT

20.0.0 T.S.Bennett Pur.

15.2.22 S.Bennett Pur.

5.2.16 J. Mazey Pur.

40.0.0 RESERVE

15.0.20 W.Mazey Pur.

15.1.0 H.Mazey Pur.

28.1.11 T. Watts Pur.

16.1.4 S.Scannan Pur.

16.2.18 M. Driscoll Pur.

16.0.0 R Finn Pur.

16.2.0 W.C. & J.H. Mc Dougall Pur.

96.2.0 W.C. Mc Dougall Pur.

SHAG ROCK

21.0.12 J. Ryan Pur.

10.0.0 C. Cooper Pur.

39.2.0 W.L.Domeney Pur.

15.2.0 M. Driscoll Pur.

QUIET BAY

SULLIVANS PT

Frederick Charles Howard 6658-M 1274 acres

F. C. Howard 6884-M 128 acres

320

TRAMWAY Grade

F. C. Howard

McDOUGALL & CO.

DEEP CK

6137 313

NEW MAIN SHAFT

F. C. Howard

Coal Seam

Outcrop

1035 F. C. Howard

CATAMARAN RIVER

Catamaran No. 1 229 ft.

Catamaran No. 2 726 ft.

RECHERCHE BAY

1097 F. C. Howard M. L.

TRAMWAY (10 Chains Wide)

33.1.11 W.H.Tyler Pur

RAMSCATE

99.3.5 C. Bolton

LOCKLE CK

W. H. Twelvetrees, Government Geologist
March 1915

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

GEOLOGICAL SKETCH MAP OF IDA BAY COAL FIELD

PLATE XIII

SCALE OF MILES

0 ½ 1 1½ 2

W. H. Twelvetrees, Government Geologist
March 1915

5 cm

LEGEND

QUATERNARY	*Sands and clays*
TERTIARY	*Basalt*
MESOZOIC	*Diabase*
TRIAS-JURA	*Shales and sandstones with seams of coal*
PERMO-CARBONIFEROUS	*Mudstone and Conglomerate*
SILURIAN	*Limestone*
UNDETERMINED IGNEOUS ROCK	
OPENINGS ON COAL	

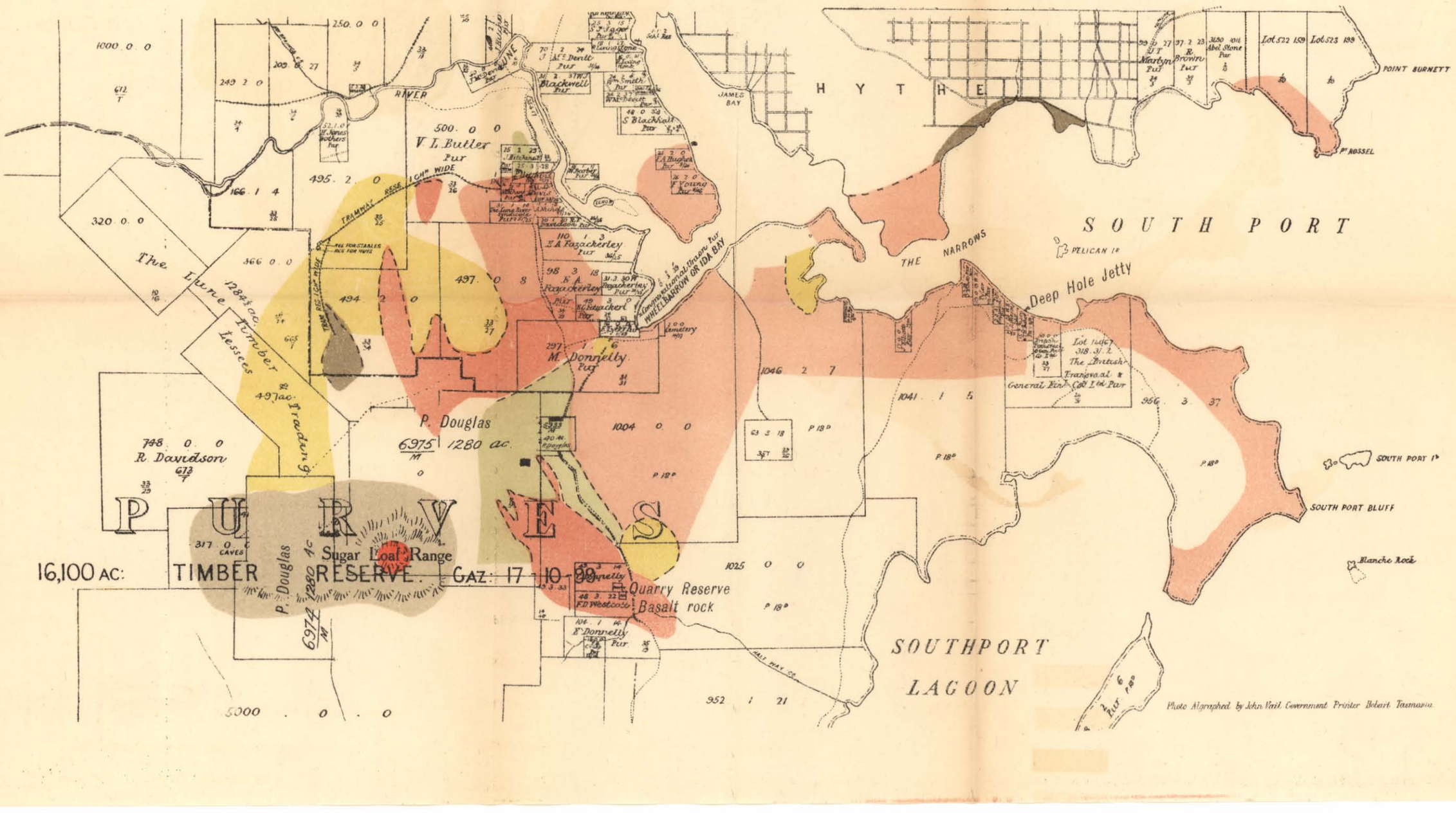


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PLATE XIV

MAP SHOWING POSITION OF STRATHBLANE COAL FIELD

SCALE OF MILES

0 ½ 1 1½ 2

W. H. Twelvetrees, Government Geologist
March 1915

5 cm

Photo Algraphed by John Vail Government Printer Hobart Tasmania.

GSB20

PLATE XV

CATAMARAN COLLIERY

F. C. Howard 320 ac.
6136-M

Shaft

Frederick Charles Howard 1274 acres

6658-M

F. C. Howard 6884-M

128 acres

Shaft

F. C. Howard 319 Ac.
6137-M

NEW MAIN SHAFT

Dip of Strata 12°

Magnetic North

Main Shaft

Old workings

New tramline

Shaft

Tramline to coal-bins Catamaran River

Tunnels

New Main Tunnel

CATAMARAN RIVER

Outcrop of coal seam

CATAMARAN RIVER

Bores through coal
Bores not through coal
Shafts to coal seam
Shafts not to coal seam

SCALE OF CHAINS

0 5 10 15 20 25

5 cm

Based on R. C. Young's Survey, 1st Oct., 1913

W. H. Twelvetrees, Government Geologist
March 1915

Photo Algraphed by John Vail Government Printer Hobart Tasmania

PLATE XVI

CATAMARAN COLLIERY

SECTIONS OF BORE-HOLES

5 cm

SCALE OF FEET
0 4 8 12 16 20

Based on R. C. Young's Sections of Bore-Holes, 2nd Jan., 1914

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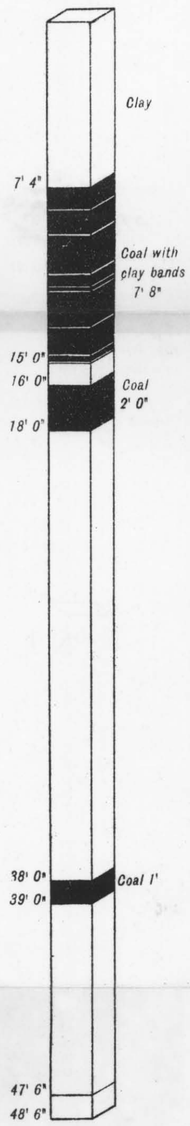

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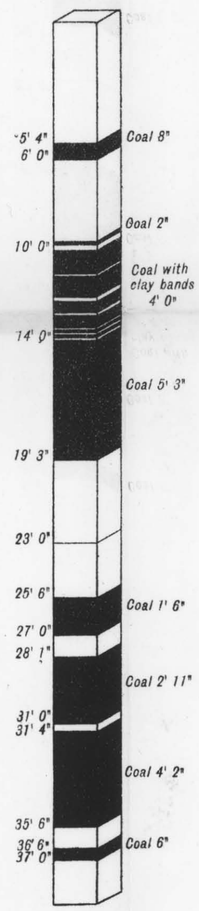

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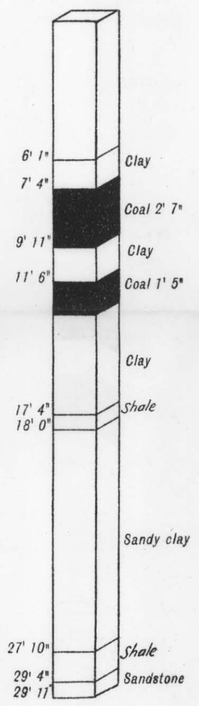

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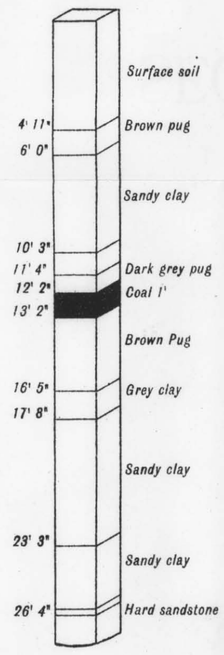

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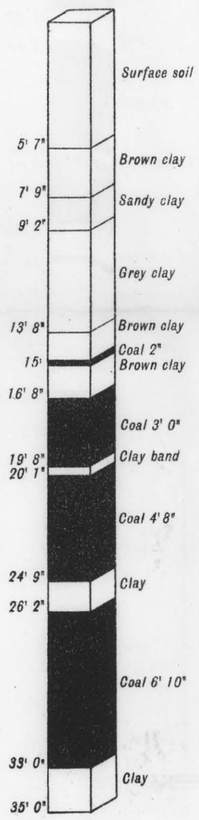

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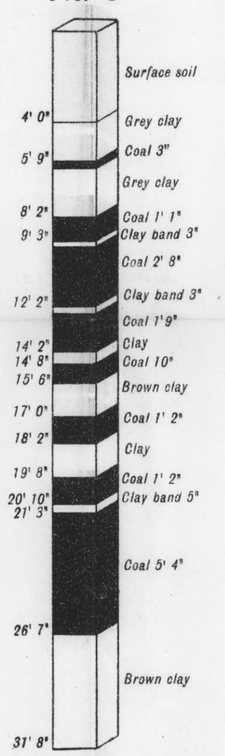

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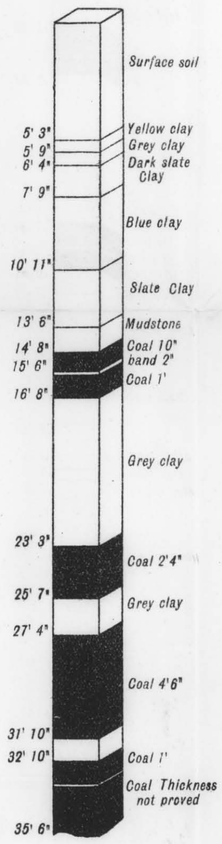

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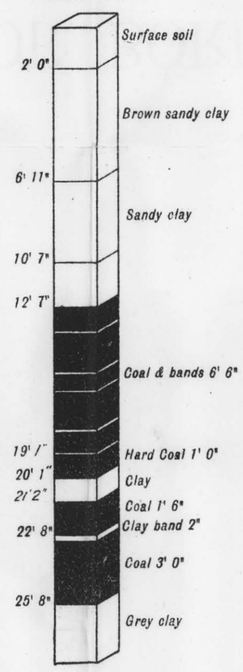

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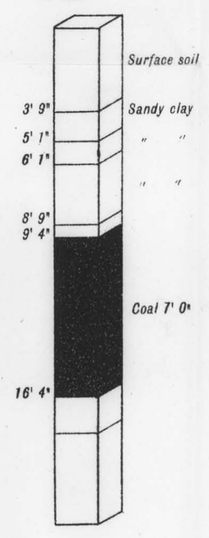

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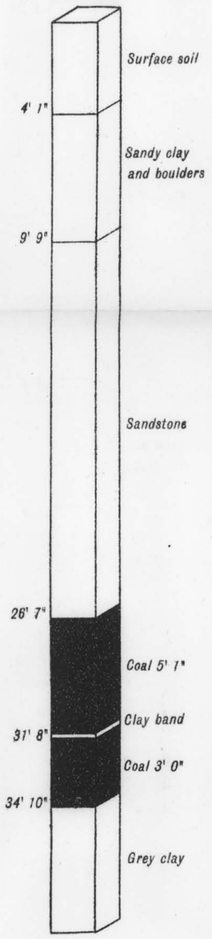

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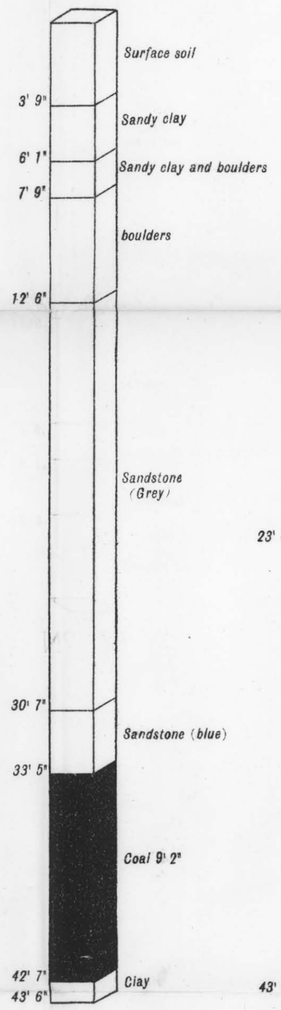

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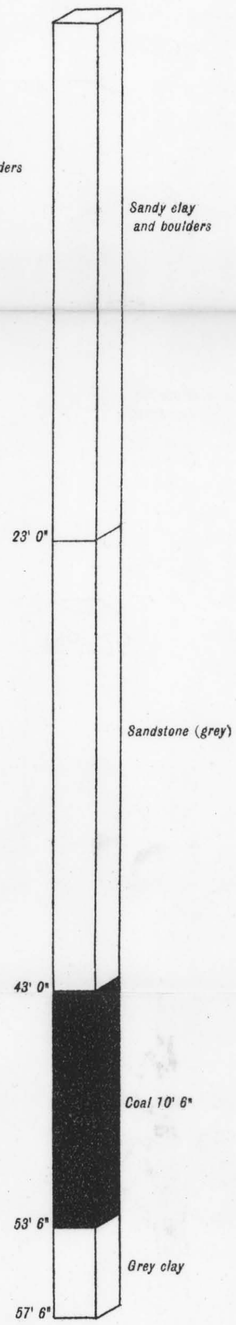

W. H. Twelvetrees, Government Geologist
March 1915

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