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Casmania

DEPARTMENT OF MINES

GEOLOGICAL SURVEY
MINERAL RESOURCES No. 8

VOLUME I.

The Oil Shale Resources of Tasmania

A. McINTOSH REID, Government Geologist

Issued under the authority of
The Honourable A. G. OGILVIE, M.H.A.
Minister for Mines for Tasmania



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Preface.

This is the first of a series of publications to be issued by the Mines Department dealing with the oil shale resources of Tasmania. This report relates to occurrences of tasmanite in the northern fields, particularly to those in the neighbourhood of Latrobe and Railton.

A description of the tasmanite deposits in the Oonah district will appear as Volume II. of this series. It is proposed to include in that publication an account of the kerosene shales of Preolenna and Mt. Pelion, and the carbonaceous shale of Karoola.

In addition it is proposed to issue a treatise on the chemistry of our oil shales. In this publication will appear the results of distillation tests performed in various types of retort, and it will treat of the conditions most favourable for successful operation. It was the original intention of the Department to present the information in this bulletin; but further tests are now being made in improved retorts, and, in order to permit of the issue of the first volume with as little delay as possible, it has been considered inadvisable to await the results of those tests.

Summary.

THE development of the oil shale industry has not advanced appreciably since the erection of the first experimental plant near Latrobe over twelve years ago. In this plant tests were made to determine in what degree the shale was amenable to treatment on a commercial scale, and it was ascertained that the operations of retorting and refining could be performed at a reasonable cost. In the initial experiments it was found that the proportion of ammonia formed in the process of distillation was very small, and that there was very little wax in the residue. The operation became one of simple retorting and condensing by the elimination of the unnecessary subsidiary plant. manite, consisting of sporangia encased in an arenaceous sediment, is more mobile than most shales, and being of average richness can be retorted rapidly on the continuousfeed system. The crude oil generated by artificial distillation from tasmanite is similar in chemical composition and physical properties to natural petroleum, and is of higher quality than some, especially as regards the amount and quality of the motor fuel fraction.

This investigation has shown that the oil shale lands are far more extensive than anyone had reason to anticipate, and that the thickness of the seam varies little from point to point. New shale lands have been found at Native Plain, Kimberley, and Quamby Brook, and there are indications of others in intervening areas. These later discoveries have enhanced the importance of the field, and prove the continuity of the seam for many miles. The Western Railway passes through the centre of the most important shale lands and close to outliers of the main body, thus providing every facility for the transportation of supplies to, and products from, a distillation plant. Moreover, the deposit is close to Devonport and within easy reach of an unlimited market. There is in effect a combination of conditions favourable to the establishment

of a very important industry.

It has been found wherever oil distillation works have been established that profitable production on a small scale of operations is impracticable. The gross value of oil shale is so low that the profit per ton, even in works of considerable magnitude, is small, consequently it is desirable to provide for the treatment of the maximum output of the mines in one large distillation plant. To effect this result the first desideratum is an amalgamation of interests in all oil shale lands in the district.

The Oil Shale Deposits of Tasmania.

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Geographic and Geologic Background.

CHAPTER I.

· Field work beings

(1)—Introduction.

A.—Preliminary Statement.

Petroleum has become one of the three indispensable commodities of modern civilisation. The demand for petroleum and its products in Australia, and its influence upon the industrial life of this country may be gauged by comparing the imports from year to year during the past decade. Last year our requirements were satisfied by 49,000,000 gallons of refined oil; this year, at the present rate of consumption, our requirements will amount to 72,000,000 gallons. These figures represent the quantity of oil imported into Australia-not any is produced here. The demand is largely for motor vehicles, which have to some extent superseded every other means of transport, and their more extended use is inevitable. planes in particular will play a very important part in the immediate development of the sparsely-populated hinterlands.

Some countries have enormous resources of natural petroleum; others, like Australia, are at present wholly dependent for supplies upon the surplus production of more favoured lands. The necessity for the provision of adequate supplies, both for war and industrial purposes, has long been realised. In recognition of this fact, and in an endeavour to encourage oil exploration, the Commonwealth Government has offered a large reward for the discovery of a commercially important reservoir, and a substantial bounty for oil distilled from shale. Several

companies have been formed during recent years for the purpose of exploring our resources of natural petroleum, but their operations have not been productive of important results. However, immediate requirements may be supplied in part from extensive deposits of oil shale, some of which occur in Tasmania.

Local shales are of three kinds—(1) the so-called kerosene shales or torbanites of Preolenna and Mt. Pelion; (2) the tasmanite shale of the northern and north-western districts; and (3) the carbonaceous shale of Karoola. This report deals with the northern bed of tasmanite and the efforts that have been made to establish the industry in that district.

B.—Field Work and Acknowledgments.

Field work began on 26th February, 1923, and continued until 9th August of the same year, except for the intervals when the writer was engaged on special examinations in other districts. At the end of February he spent four days in company with J. T. Moate in Smithton and Trowutta areas investigating the Tertiary deposits; in March 12 days were occupied in the Weldborough Tin District; in April 16 days were spent in the Brookshead Tin Area. Again, in June he visited the Quamby Brook Copper Mine and the Tin Spur Mine near Lorinna; and in July was employed on a reconnaissance survey of the Oonah area. During six months' continuous field work four months only was spent investigating these oil shale fields.

The writer was accompanied by Mr. Stanley Belton, who rendered valuable service as field assistant. He is indebted also to the mining men of the district for their courteous co-operation, particularly to Messrs. Ernest Shultz, A. McPherson, and Jas. Stewart, of the Southern Cross Oil Refineries Ltd.; E. G. Stone and J. Slade, of the Tasmanian Cement Co.; F. Richards, of the Railton-Latrobe Co.; J. Andrew Wauchope and D. M. Griffin.

His thanks are due to F. Chapman, of the National Museum, Victoria, for the determination of fossils; and to his several colleagues in the Geological Survey for their

co-operation.

C.—Previous Literature.

The earliest record of the occurrence of tasmanite at Latrobe appears in the "Papers and Proceedings of the Royal Society of Van Diemen's Land " (Vol. II., Part I., 1852) in a paper communicated on the 9th July, 1851, by J. Milligan. Further reference is made to these deposits by Milligan in the Proceedings of the Royal Society of Van Diemen's Land in May, 1852.

In May, 1855, A. R. C. Selwyn alluded to tasmanite shale in his "Report upon some of the Coal Seams of

Van Diemen's Land."

Charles Gould, Government Geologist, in 1861 submitted a report to the Mines Department, entitled "Resinous Shales (Dysodile) at Latrobe," which appeared as Tasmanian House of Assembly Paper, No. 8. In his "Report upon the Mersey Coalfield" (House of Assembly Paper, No. 135, October 29, 1861), Gould refers again to the occurrence at Latrobe.

R. M. Johnston, in his "Field Memoranda for Tasmanian Botanists," 1879, described the nature of the tas-

manite sacs.

G. Thureau, Government Geologist, in a report on the Mersey Coal Deposits, published as House of Assembly Paper, No. 52, and Legislative Council Paper, No. 61, provided additional information concerning the occurrence of this interesting rock.

A complete description of tasmanite was prepared by R. M. Johnston in 1888, and published in his "Sys-

tematic Account of the Geology of Tasmania."

In a contribution to the "Australian Mining Standard" of May 1, 1902, Hartwell Conder described the

nature of the occurrences in Mersey River Valley.

A condensed report by W. H. Twelvetrees appears in the Annual Report of the Secretary for Mines (Tasmania) for 1908. In 1911 the results of a very careful investigation by the same writer was issued as Geological Survey Bulletin No. 11 under the title of "The Tasmanite Shale Fields of the Mersey District." This work contains not only a detailed account of all the known deposits but also deals at length with the economic aspects of the industry.

(2)—HISTORY AND PRODUCTION.

The name of the discoverer of oil shale in the Latrobe district is not known. The earliest record appears in the "Papers and Proceedings of the Royal Society of Van Diemen's Land," in a paper read by J. Milligan, in the year 1851. Since its discovery this material has excited the attention of scientists, but until recent years it has proved

of passing interest only to investors, as its exploitation was

not considered a commercial possibility.

In the early nineties a local company was formed to explore the seam and determine the value of the shale as a source of oil. The history of the industry is essentially the history of the operations of this company. It may be stated without question that the work and interest of F. Richards, of Devonport, in guiding the affairs of the original and the reconstructed companies is responsible for the progress made in oil shale mining and distillation in Tasmania. After an expenditure of many thousand pounds without any profit the members of this enterprising company are now likely to receive the reward of their patient industry. The Southern Cross Oil Refineries Company is operating the mines on the leasing system from the Railton-Latrobe Oil Shale Company, and it is believed that the result will prove mutually beneficial. The erection of the new distillation plant is now nearing completion, and it is expected that production on a large scale will commence this year.

Under the direction of J. A. Wauchope the original company produced 12,000 gallons of oil in its trial opera-

tions.

13 M. Definition on 1988, and published in his "Systematic According to the Goology of Tagmania."

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CHAPTER 11.

-sectivio symbol to (1)—Geography.

A.—Situation and Access.

This district, embracing a number of oil shale fields, is situated in the Counties of Devon and Westmoreland, in the north-central part of Tasmania. All but one of these fields lie within the tract of country confined by the Rubicon and Forth Rivers, which flow in a direct course northward to Bass Strait. The exception—Quamby Brook field—is situated at the south-east corner of the district, far beyond the headwaters of Rubicon River.

The district is 30 miles long and 20 miles wide, but the shale fields in the aggregate occupy a small portion only of this area.

All the areas are well served by roads and railways, which converge upon Devonport, the chief shipping centre of the wonderfully fertile tract bordering the north coast. This port is capable of accommodating vessels of 10,000 tons gross, and provides a safe anchorage in any weather. The depth of water at the entrance to Mersey River is 26 feet at H.W.O.S.T., and the rise and fall of the tide is 10 feet. Many improvements to the port are now being effected by the Marine Board, including the extension of wharves, the dredging of a larger turning basin, and the straightening and deepening of the channel. Direct trading with Brisbane, Newcastle, Sydney, Melbourne, Adelaide, and all Tasmanian ports is maintained throughout the year.

The North-Western railway, on its way through the district, passes Deloraine, Dunorlan, Kimberley, Railton, Dulverton, Latrobe, Spreyton, and Devonport. From Railton a branch line leads to Sheffield and Staverton, and from Devonport another line passes Don, Melrose, and Paloona, on the way to Barrington. Good motor roads connect every part of the district.

Telegraph and postal facilities are provided in all the towns, and electric power on a large scale will shortly be made available by the Hydro-Electric Department.

B .- Climate and Life.

It is unusual to find mining and agriculture in successful operation in the one district, but here are cement and oil shale works surrounded by well-cultivated fields. The inhabitants enjoy all the conveniences of modern civilisation, and are generally prosperous. The principle industry is potato-culture, in conjunction with mixed farming. Coal-mining is of local importance in the area.

The climate is genial, mild, and equable, without

extremes of heat and cold in any season.

Information concerning the rainfall is incomplete, as the only climatological station is at Deloraine. However, the following particulars will prove of interest:—

RAINFALL.

(100 points = 1 inch.)

			LATROBE.		SPREYTON.
Year			Points.		Points.
1919	alba	ns yd	2628	ann s	2360
1920 .	de te	ida ad	3665	1 (loda	3186
1921	di p	nitabo	3281	not Am	2962
1922	unov.	entis:	borrename be	1/44	3008
1923	ai a	nerod	4075	bistog	4990

from Payenport another Into payers Henry Melrone, and I'oleona, on the way to Barrington. Good motor roads

Temperature (Highest and Lowest).

The shade temperatures (maximum and minimum) for Launceston are given for purpose of comparison.

DELORAINE.					LAUNCESTON.					
Year,	Max.	Date.	Min.	Date	Year.	Max.	Date.	Min.	Date.	
	Deg.		Deg.	FIRE	THE PARTY	Deg.		Deg.		
919	85.1	7 Feb.	21.7	3 & 4 Aug.	1919	87.0	31 Dec.	27.2	5 Aug.	
920	-		=		1920	94.5	24 Dec.	28.9	16 July	
921	89.6	10 Feb.	22.0	26 June	1921	96.5	24 Jan.	28.2	6 Aug.	
922	-B	r (- 	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	141	1922	94.5	11 Feb.	28.5	24 June	
923	_ 31 1	3.开车方位	_		1923	91.0	12 Feb.	29.8	27 May	

(2)—Рнузгодкарну.

A .- Existing Topography.

(a) General Features.

The area under review presents many variations in topographic relief. This is occasioned by the abrupt changes in the nature of the several formations outcropping at surface, and by the influence of earth movements during

several periods.

From the sea-coast there is a gradual rise of the land surface to Deloraine amounting to 760 feet in 30 miles; thence the country lies at a fairly even altitude to the base of the Western Tiers, which rise up in great escarpments to the level of the Central Plateau, over 3000 feet above the sea. These mountain scarps, forming the southern border of the district, illustrate the nature of the faulting and mark the degree to which the Permo-Carboniferous strata have been displaced by diabase and by earth movements since its intrusion. An idea of the effect of the invasion may be gained by comparing the altitude of the Permo-Carboniferous in the interior (4300 feet above sealevel) with that of the Mersey River valley. Very considerable oscillation took place at the end of the Tertiary following the extrusion of basalt. The stupendous faulting resulting from the intrusion of diabase and the basalt eruption of later times, representing compensating movements or earth adjustments, aided by the work of denuding agents, is responsible for the configuration of the land as it appears to-day.

The axial lines of the folded Pre-Devonian strata are directed to the north-west, and, as the younger formations occupy the synclinals, the older structures are impressed on the present features. Many of the hills and mountain ranges are occupied by Pre-Devonian rocks, and their axial direction is north-west. The rivers, likewise, follow the synclinals, and trend in that direction. To

this, however, there is one notable exception.

(b) Drainage.

The drainage of the region is in two directions—one, including the Forth, Mersey, Don, and Rubicon channels, flowing northward the other, Meander River, flowing eastward to join the South Esk near Launceston. Forth River, a deep Tertiary stream, and Mersey River rise in

the Central Highlands, and (especially the former) are deeply entrenched in the older rocks. Don and Rubicon Rivers are inconsiderable streams, and are comparatively young. All, in parallel formation, flow direct to Bass Strait. Their remarkably uniform course is due to the strike of the formations that constitute the adjacent hills and mountain ranges. Mersey River, in particular, was diverted from its original course by basalt lava. Other rivers were affected, but not to an equal degree. Rubicon River marks the eastward boundary of the lava flow in the district.

The broad valley of the Meander River traverses almost at right angles the prevailing structural axes, but that is because it has not yet come under their influence. It follows the course of the Tertiary alluvial basin to its confluence with the South Esk.

(c) Mountains.

The uplands may be grouped as follow:—Low axial ranges traversing the district in a general northerly direction; and the range of Western Tiers marking the edge of an elevated plateau. The first group is formed in part by recurring anticlines in early Palæozoic and Proterozoic formations, and in part by intrusions of diabase, modified by the later extrusion of basalt and by agents of erosion.

The most rugged and formidable of the mountain ranges is that referred to as the second group. This is a great mountain wall of diabase and Permo-Carboniferous strata extending transversely across the southern end of the district in an unbroken line over 40 miles. It rises upwards of 4000 feet above sea-level, and along its northern front a number of pinnacles have been carved by the removal of the comparatively soft strata.

$B.-Physiographic\ Development.$

(a) General Features.

Omitting the extreme southern portion which actually marks the boundary of the district, it may be described as an area of high hills and fairly broad valleys, largely conditional by the folds in the older formations. The present configuration of the land surface is largely due to stream corrosion. In the southern part of the district the streams are still far above base level, and the rate of cor-

rosion there is rapid but nearing the coast the flow is sluggish, and tidal waters extend miles inland. In many places the bed-rocks upon which the Permo-Carboniferous rest are now exposed by the denudation of the soft cover. Diabase and basalt, being strongly resistant to erosion, generally occupy the hills and mountains. Uplift and rejuvenated erosion are in some degree responsible for the exposure of the coal and oil shale seams at many points, thereby allowing of easy mining and more effective exploration works. Generally the topographic relief is favourable to mining.

(b) Earlier Topography.

The development of the topography can be traced with reasonable accuracy from the commencement of Permo-Carboniferous sedimentation. At that time regional synclinoria developed in Early Palæozoic and Proterozoic formations marked the course of the main channels of erosion, as they in some measure do to-day. In these shallow erosion valleys the Permo-Carboniferous sediments were laid down, and probably they were succeeded conformably by the wholly terrestrial beds of the Trias-Jura formation. Erosion of these formations followed the intrusion of diabase and the resultant uplift of the land surface in Cretaceous time, and was very rapid during the Lower Tertiary period. The effect of epi-Cretaceous erosion has been revealed by drilling through the Upper Tertiary formations in the Sassafras area. Mersey and Rubicon Rivers now form the geographical boundaries of this area. and the geological also, for they mark the west and east limits of the Tertiary sediments and the overlying sheets of basalt lava. Protruding here and there through these sediments and lava flows are hillocks of diabase, parts of very much larger masses around and over which the succeeding formation was laid down. The sides of this broad Early Tertiary topographic valley rise upwards of 700 feet above the sea, and the bottom lies at 1000 feet below sea-level. There is evidence to show that the intermontane area is broken by buried hills, the presence of which is manifested in the structure of the overlying sediments. Tertiary topography then is in some degree a reflection of that developed in the older formations. Similar erosion effects are indicated in other parts of the district in connection with the development of topographic relief following the intrusion of diabase. A reactionary subsiding

movement continued through the Tertiary until interrupted by the volcanic eruption of basalt at the close of that period. The chief effects of the eruption were the filling of existing valleys and diversion of streams and the formation of a strong protective covering to the soft sediments.

(c) River Gravels and Alluvium.

During the Quaternary a long period of quiescence and the earlier reduction of the river beds near the coast to base level led to the gradual corrosion of the valley sides and the formation of extensive flood plains. Later uplifts of 20 to 30 feet are marked by a succession of terraces on the sides of the valleys, the most recent confining the rivers to their present courses. Mersey River is now entrenched in its old bed of gravel and is entering the underlying Permo-Carboniferous strata.

The more important alluvial plains of Quaternary and

Recent ages are at Latrobe and Railton.

resent an accurate section, but on the innomation availes able one approximate cross-section is added in an alternal of illustrate the relations of the several formations.

The features of the country are clearly represented from which the physiographic development may be followed without difficulty.

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(1)—GENERAL GEOLOGY.

A .- Geological Map.

The accompanying map is based on the mineral and agricultural charts of the district, and presents the same degree of accuracy. Altitudes were determined by aneroid readings, and the contours were sketched in the field as the examination progressed. This map, in addition to the physical features of the region, shows the location of boreholes, the position of mine-openings, and the mining leases of the several operating companies.

The following geologic units were mapped:—Pre-Cambrian schists; Cambrian sandstones and slates; Ordovician limestones, slates, and sandstones, and Ordovician igneous rocks; Silurian conglomerates and sandstones; Permo-Carboniferous mudstones, shales, sandstones, &c.; Cretaceous diabase; Tertiary sandstones, lignitic clays, &c., and basalt; Quaternary and Recent sands and gravels.

So complex is the structure that it is very difficult to present an accurate section, but on the information available one approximate cross-section is added in an attempt to illustrate the relations of the several formations.

The features of the country are clearly represented, from which the physiographic development may be followed without difficulty.

Data relating to some of the formations, the Tertiary especially, have been amplified by the records of deep bores generously furnished by the Adelaide Oil Exploration Company and the Mersey Valley Oil Company operating in the district. Cores of the later bore-holes were submitted for examination, but those of the earlier holes were not available. The nomenclature given in the records is that adopted by the two drillers to describe the rocks explored in the boring operations. In some cases the determinations of rocks are inaccurate or indecisive, and the descriptive terms employed are not those in common usage. Moreover, the drillers apply different names to the same rocks; and no attempt is made to mark the plane of junction between the formation of one age and that of another age. Again, precise descriptions are lacking:

tocks are referred to indefinitely as of conglomerate, sandstone, mudstone, &c., and the non-committal terms rock, sand, and mud are occasionally employed. Considerable difficulty has been experienced in resolving the meaning of some of the terms used by the drillers. An attempted interpretation is appended to the records of the bores as given herein.

However, the information derived from these records has proved of great value. From them accurate sections have been made of the formations intersected by the drills in these operations.

B.—Geological Summary.

Pre-Cambrian mica and sericite quartz schists are the oldest rocks in the district. They attain a great thickness and are well exposed here. The rocks outcrop 5 miles along the course of Mersey River and rise on the east and west sides of the region into hills over 1000 feet above the sea.

Unconformably overlying these intensely metamorphosed rocks is the Cambrian formation consisting of quartz conglomerate, quartzite, slate, and fossiliferous sandstone. The last of the rehearsed members outcrops at Caroline Creek and at Railton; the others there are covered by Permo-Carboniferous sediments, but at Quamby Bluff they are to be seen in contact with the schists. In many respects they are similar to rocks of the West Coast Range series, with which they have been confused.

This formation is overlain by Ordovician limestone and slate. The contact is not exposed at any point, but there is evidence of an unconformity between them.

The next in order of succession is the so-called "porphyroid" series of pyroclastic slates, porphyries, &c., also of Ordovician age.

Resting on the upturned edges of the porphyroid is the West Coast Range series of conglomerates and sandstones of Silurian age.

All the foregoing have been folded into broad anticlines and synclines with north-west axes, and some of them exhibit the effects of shearing stresses.

The Devonian period is characterised in Tasmania by the intrusion of granite. No outcrops have been observed in

this district, although numerous boulders, the waste of that formation, occur in the basal member of the Permo-Carboniferous sediments, indicating their transport by ice.

Permo-Carboniferous sediments, 1500 feet in thickness, were laid down in regional synclinoria developed in the Early Palæozoic and Proterozoic rocks.

Vestiges only of the Trias-Jura are known. Cretaceous diabase in the forms of dykes and sills intrudes the Permo-Carboniferous in all quarters of the district, dislocating and uplifting the strata to various altitudes. Sediments of Tertiary age crop out from the mantle of basalt in many parts of the Sassafras area, and are to be seen also at Kimberley, Dunorlan, and Deloraine. At Sassafras they have been penetrated to a depth of 1000 feet below sea-level.

Basalt ash and lava are widely distributed, and intrusive forms occur in Sassafras and Nook areas.

Quaternary and Recent gravels, sands, and muds occupy the flood-plains of existing rivers, and in places fringe the sea-shore.

C.—Proterozoic Rocks.

The lowest and oldest rocks in Tasmania are represented in this district, and are considered as belonging to the lower division of the Algonkian system. They consist of a series of finely laminated mica quartz-sericite, graphite, and sericite schists; and are regarded as being metamorphosed sediments derived from unknown Archæan formations. They are highly foliated, puckered, and strongly contorted rocks, possessing well-defined crystalline texture.

The mica variety consists principally of quartz, biotite, and muscovite, and is of medium to coarse grain and brown to grey in colour. It outcrops in an anticlinal extending from Latrobe to Native Plain, and is exposed again at Kimberley, Quamby Bluff, Asbestos Range, and Forth River Valley.

The graphite and sericite varieties are usually closely associated, and in many places consist almost exclusively of those minerals. Graphitic schists outcrop at Asbestos Range, Port Sorell, on the road near Forth Bridge, in Forth Valley (on both sides of the river), and at Abbots-

ham on the west side of the Forth). Sericite schist occurs in fairly clean bands on the Wilmot-Forth road, and again near Quamby Bluff.

These rocks here have been folded into broad anticlines

and synclines, with north-west axes.

Their general strike is north-westerly, and the dip in Latrobe area is south-west. Near Cherry Hill, a mile south of Latrobe, a crystalline sandstone or quartzite, with associated black slate, appears, and apparently belongs to this group. This is not certain, however, for these beds may form the base of the Cambrian formation. Similar rocks occur in this relation at Quamby Brook, and, in addition, a quartz conglomerate, which might easily be mistaken for that of the West Coast Range series, is interbedded with them. At Quamby the conglomerate bed, 350 feet thick, stands out prominently from the associated sediments, and, in conformity with the overlying limestone, dips north-easterly. Its old outcrop is easily followed in a north-westerly direction from Quamby Bluff, and it is well exposed in Meander River, where it is associated with slates and sandstones closely resembling the Caroline Creek beds.

These conglomerates, quartzites, and slates occur in similar relation to the schists in the valleys of Gordon and Florentine Rivers, and were there confused with the West Coast Range formation.

Another occurrence of the quartzite member is at Kimberley, in the bed of the Mersey River. Here the rock dips north-easterly as at Quamby Brook, and is indicative of an overturned fold.

Products of the System.—Wherever these schists are exposed, disseminations of copper ore are found in them, as instance the occurrences at Badger Head, East of Port Sorell; at Preolenna, in the valley of Flowerdale River; at Quamby Brook; and in Savage River area, West Coast. Another product of this foramtion is rutile, which, attached to quartz, occurs in large deposits in Clayton Rivulet, between Ulverstone and Forth River, and again at Abbotsham. The rutile crystals are well formed, and are found up to 1 inch in length. Other deposits concentrated from the waste of these schists are known in tributaries of Gordon River.

The sericite member of the formation may prove of considerable value. Beds of clean, white sericite of pearly

lustre and unctuous feel occur at Templar's farm, Gawler, and in the valley of Forth River.

Talc, also, in the igneous member has been developed in fairly extensive deposits.

Two years ago, in cultivating his 78-acre farm at Quamby Brook, Thos. Hennessey unearthed a boulder of copper ore. A little exploratory work revealed a large deposit of azurite and malachite, containing gold and silver, in a body of altered gabbro. The magma of this rock intruded the Pre-Cambrian schists previous to the mountain-building movements that brought about the intense folding of these old rock formations. A similar occurrence was observed by the writer in the valley of Dasher River, 15 miles to the eastward, a point where the next succeeding anticline is exposed at surface.

The composition of the original rock is reflected in that of its derivatives epidote, quartz, amphibole asbestos, scapolite, and bastite. These secondary minerals indicate that the rock was of basic igneous character conforming to gabbro, which consists essentially of augite and the labradorite variety of plagiculase. The alteration was brought about by the action of hot carbonated waters, which percolated through the rock, completely transforming the original mineral components into the secondary ones referred to.

Bulk samples of the copper ore contained: -

Copper 0.29 per cent.

Silver 2 dwt. 15 gr. per ton.

Gold 1 dwt. 7 gr. per ton.

It is evident that the copper ore is contemporaneous with the encasing rock. The formation, with a smaller proportion of copper, has been traced considerable distances scuth-east and north-west of Hennessey's. Deposits of copper ore are of frequent occurrence in this formation, and are so found in many parts of the island.

D.—Palæozoic Rocks.

(a) Cambrian System.

The occurrence of strata of this age at Caroline Creek, a tributary of Mersey River, marks an important geological horizon in Tasmania. These strata, exposed at the second railway crossing of Caroline Creek and on the roadside towards Railton, consist of thickly-bedded sandstones of fine grainsize replete with trilobites and other fossils. The following fossils have been recognised by R. Etheridge:—

Crustacea-

Dikelocephalus tasmanicus (Eth.).
Ptychoparia stephensi (Eth.).

Gasteropoda—Ophileta. Lamellibranchia—Raphistoma.

These strata rest unconformably on the Pre-Cambrian schists, and, with them, have been subjected to the forces inducing regional folding. They show little sign of schistosity, and the fossils found in them are not distorted. At Caroline Creek and at Railton the dip of the strata is south-westerly at 50 to 65 degrees, and the strike varies from 15 to 25 degrees west of north in conformity with the west limb of the anticline.

The uppermost members of the Cambrian formation are exposed again in beds of yellow to purple grits, slates, and fossiliferous sandstone, which lie immediately below the limestone at Blenkhorn's quarry, near Railton, and overlie quartz conglomerates.

The strike here is north-westerly, and the dip south-westerly. Here the relation between the sandstone and the limestone is not perceptible, as the line of contact is covered. The thickness of the bed is fully 1000 feet.

A number of fossils were obtained from the sandstone beds near Blenkhorn's quarry and submitted to F. Chapman, of the National Museum, Melbourne, for investigation. Mr. Chapman doubts whether this sandstone is related to that exposed at Caroline Creek, but on the geological evidence they appear identical. Unfortunately the exposures of contacts are few and not well defined.

In a cutting on the Melrose Railway, about half a mile northward of the limestone quarries, these sandstones are very well exposed, and here again are in contact with the limestone. The grit member is exposed on the roadside near Paloona in association with limestone; and at the Paloona Bridge, crossing Forth River, the rock has been transformed into chert by a granitoid intrusive of the porphyroid series, consisting essentially of quartz, oligoclase and orthoclase.

On the eastern shore of Port Sorell the conglomerate and sandstone members, unconformably overlying the Pre-Cambrian schists, rise into hills nearly 200 feet above sealevel.

Information acquired by W. H. Twelvetrees in the Florentine district shows a similar geological sequence of strata. The following table is taken from his report:—

Geological System.	Occurrences.
Ordovician	Humboldt, Florentine Valley, Gor-
Cambrian	Purple slates at Humboldt Mine. Yellow dikelocephalus sandstone on Humboldt Divide and Florentine Valley.
	Conglomerate and pebbly sandstone and quartzite on Thumbs, Clear Hill, Mt. Wright, and Denison Range.
	Quartzitic schist and sericitic quartz- ite accompanied by argillaceous and sericite schist. These belong to the upper division of the system.

In the Frankford district P. B. Nye reports a similar succession of strata.

(b) Ordovician System.

Railton Limestone.—This has been called the Railton limestone for the reason that it is well exposed there, and because it has been quarried for industrial purposes in that locality for many years. It extends in two beds from Railton in a south-easterly direction to Quamby Bluff, and north-westerly to Melrose, a distance of 30 miles. It is not continuous at surface, but is exposed here and there along its course, where erosion has removed the covering of younger rocks. The aggregate width of the members at Railton is nearly 3500 feet, and their thickness, computed from observations, is estimated at 1280 feet. The limestone is generally found in the lowlands or flanking

low hills. In the flat country its presence is indicated by brick-red clayey soil, hardly distinguishable from that derived from basalt; in the higher country it stands out prominently as rocky projections with rounded outlines.

The material exposed in the quarries is wavy and even schistose, and where unweathered it is hard and compact and of a bluish-grey colour. It weathers along cleavage-planes to a lilac-coloured material, which ultimately breaks down to a brick-red clay, leaving the fresh rock in the form of cone-shaped pinnacles. Being impervious to water, alteration at depth has taken place along cleavage-planes and joints only.

Percolating waters form large cavities in the rock, and the lime-laden solutions migrating deposit calcite in the joints and cleavages. Laminations, indicating original planes of bedding, are indistinct; but the planes of cleavage, inclined at angles of 20 to 30 degrees thereto, are well developed. Probably the lilac colour of the decomposed limestone is due to the presence of iron.

This rock is confined to the west side of Mersey River, from the coast to Railton, dipping north-east at its western edge near Melrose, and south-west at an angle of 65 degrees at its eastern edge at Blenkhorn's quarry. So far as can be seen the deposit is 50 chains wide, and probably it is wider, but its full extent at surface could not be determined at Railton owing to the deep cover of Tertiary and Quaternary gravels over part of the area. Between Blenkhorn's Nos. 1 and 2 quarries, at a point 160 feet west of the railway-line and a little north of the station, a shaft and bore (No. 5) sunk by Henry Law many years ago in search of coal were in limestone all the way down to 550 feet. There is no doubt that the limestone continues to a depth far below the reach of quarrying operations.

On the 100-acre block, on which the Tasmanian Cement Company is interested, limestone is exposed at surface in a low rounded hill rising 75 feet above the level of the railway-line. An open-face 24 feet deep and 40 feet wide has been cut into this hill a distance of 60 from the south side, and another face has recently been opened on the east side. The top of the hill is occupied by a thin bed of conglomerate debris, made up largely of boulders from the West Coast Range series. Whether these boulders were laid down by Permo-Carboniferous waters, or whether they

represent detritus of the West Coast Range conglomerate, it is difficult to determine. If the latter, the limestone is definitely older than the conglomerate.

Although operations have been carried on at Blenkhorn's No. 1 quarry, on the east side of the railway-line, for many years, the production is not large. Sufficient only to meet the demands of builders and agriculturists in the neighbourhood is crushed and burnt, consequently production is small and intermittent. In these operations a large quarry has been gradually opened in the massive limestone.

Localities of the Railton Limestone.—In addition to the exposures at Blenkhorns Nos. 1 and 2 quarries, other occurrences are known at Langmaid's Ramsdale's, and Dally's land in the vicinity. Between Langmaid's and Dally's the limestone is not exposed, but its presence is indicated by the brick-red clay soil in the flat country.

Limestone outcrops again at Paloona and Melrose, where it is quarried on a large scale for export to the Broken Hill Proprietary Company's steel works at Newcastle, N.S.W. Here it outcrops boldly in low rounded hills, and in the higher ground is generally devoid of clay. The dip, contrary to the Railton exposure, is to the north-east. At Melrose the rock does not rise higher than 100 feet above sea-level, but at Paloona it reaches an altitude of 200 feet.

Limestone does not outcrop at Kimberley, but its presence is indicated there by a warm spring near the centre of the town. The rock surrounding the spring is a pebbly drift of Tertiary age, and the nearest bedrock is the Cambrian quartzite of the hill bordering the town on the west side. The water is remarkably clear, 3 to 6 feet deep; and the flow is constant. At the south end of the pool bubbles of carbonic oxide intermittently rise to the surface from the gravelly bottom. A sample of the water was found to contain—solids, 20 grains per gallon, chiefly carbonate of lime, equal to 285 parts per million; chlorine, 1.4 grains per gallon, equal to 20 parts per million. temperature remains constant at 74 degrees F., and the water is slightly salty to the taste. The deposits from the spring are predominatingly calcareous, but are not extensive.

On the western side of a low ridge of mica and quartz schist and quartz conglomerate leading northward from

the base of Quamby Bluff limestone of this age occurs. Here, it has been quarried to supply local requirements. It varies in a slight degree only from that at Railton, the greatest difference being in the higher proportion of calcite. The limestone abuts against Cambrian quartzite and conglomerate, and dips north-eastward at angles of 50 to 65 degrees.

On Robinson's property, in the valley of the Quamby Brook, and on the eastern side of the bridge just referred to, is another outcrop of limestone. This part of the deposit was quarried some years ago by James Scott, of Deloraine, but the workings are now under water and otherwise inaccessible. The contact between this deposit and a bed of conglomerate to the west of it, consisting largely of igneous material and fragments of mica schist, is obscured by detritus, and the dip of the formation cannot be determined because the original outcrop is now covered with water.

Chemical Composition.—Recently an investigation of the limestone deposit at Railton was made by W. D. Reid, Government Chemist, and the writer to ascertain whether this material, with the associated clays, was suitable or not for the manufacture of Portland cement. The results of the analyses of representative samples obtained for that purpose are given hereunder:—

Analyses.

Sample Number.	Silica.	Ferric Oxide.	Alumina.	Calcium Carbonate.	Magnesia.	Ratio:	
			1.31		Alumina + Ferric Oxide		
	Per Cent.	Per Cent.	Per Cent.	Per Cent	Per Cent.	10 11 11 11	
No. 1 (No. 1 Quarry)	7.40	1.72	4.20	85.39	1 · 45	1:25	
No. 2 (No. 1 Quarry)	8.80	2.00	4.12	82.21	2.39	1.44	
No. 3 (No. 1 Quarry)	7.00	1.50	3.10	87.91	1.16	1.52	
No. 4 (No. 2 Quarry)	3.00	0.64	1.32	94.61	1.59	1.53	5
No. 5 (No. 2 Quarry)	3.00	0.57	1.63	93.44	1.45	1.36	4
No. 6 (No. 2 Quarry)	3.68	1.79	2.17	90.41	1:81	0.93	
No. 7 (No. 2 Quarry)	3.00	0.43	1.17	94.61	1.30	1.87	
No. 8 (No. 2 Quarry)	3.68	0.86	1.90	92.64	1.45	1.33	
No. 9 (No. 2 Quarry)	3.52	1.07	1.73	93.06	1.23	1.25	
Average of samples from No. 1 Quarry	7.73	1.74	3.81	85.17	1.66	1.39	
Average of samples from No. 2 Quarry	3.30	0.89	1.65	93.13	1.47	1.30	
Sample of clay from No. 2 Quarry	65 · 48	8.87	16.63	0.93	2.25	2.57	
No. 10 (between the quarries)	25.72	2.37	4.56	60.87	1.81	3 4 5 4	

No. 1 Quarry deposit, purchased lately by the Tasmanian Cement Company, is near the western edge of the formation; and No. 2, owned by James Blenkhorn, is near the eastern edge. The analyses show a marked difference in composition between the material from these quarries, but both sets of samples reveal material of high grade.

The large deposits of associated clay represent the insoluble residue from the dissolution of the lime constituent of the rock. This clay contains silica and alumina in the desired proportions for its utilisation in the manufacture of Portland cement.

Sample No. 10 was taken from a shaft sunk on the western side of Railton-Latrobe-road, between the quarries. This represents a low-grade variety of limestone (similar in appearance to the high-grade), which occurs in comparatively thin bands. From observation it appears that the lower beds represented in the two quarries are the richer.

The Age of the Limestone.—The true position of this rock in the geological scale is still in doubt, but the additional information presented herein will prove of interest. For long this rock has been confused with the Silurian of Zeehan, Wilson River, King River, and other localities; but with that formation there is little resemblance, and on stratigraphical and palæontological grounds it is definitely older At Railton this formation unconformably overlies Cambrian rocks, and in the Florentine and Upper Gordon areas a similar association has been observed. Zeehan limestone is comparatively thin, non-schistose, and abundantly fossiliferous; Railton limestone is schistose, and possesses a distinct fauna. In the collection obtained by Blenkhorn and examined by Etheridge an unidentified brachiopod was listed. This could be referred only to the genera Orthis or Strophomena, owing to the imperfect condition of the specimen. Aside from fragments of this fossil the remains of Actinoceras only were known until the recent visit, when a specimen of Trochoceras was found. Although representatives of these genera, comparatively abundant here, have no diagnostic value, possessing a wide geological range extending from the base of the Ordovician, they have not been observed in the Silurian or in any succeeding formation in Tasmania.

Some poorly preserved fossils from the Railton limestone and from the underlying sandstone were submitted to Mr. F. Chapman, of the National Museum, Melbourne, for identification, Mr. Chapman states that the evidence, so far as can be interpreted, points to the ochreous sandstone as of Silurian age and the limestone as of Ordovician.

The reasons given are:-

- (1) In regard to the sandstone the brachiopods evidently belong to the genus Camarotoechia and of a species not far removed from the Victorian C. decemplicata, Sow. sp., except that the mesial fold is perhaps more distinct.
 - (2) The limestone contains two fossil forms, Actinoceras Cf. tatei, Eth. fil., and Trochoceras sp. (?). Such an assemblage points to an horizon like the Larapintine formation of South Australia, which is undoubtedly of Ordovician age.

These fossils are more abundant in the slate and sandstone members on the west side of the limestone. In regard to the determination of the underlying sandstones, it is difficult to reconcile this with the determination of the limestone and their relative positions. The sandstones and limestones have not been transposed by faulting, the

former being older and in its original position.

Further complications are caused by the relative positions of the porphyroid suite and the Railton limestone. No contacts between these formations have been observed. The limestone is apparently older than the West Coast Range conglomerate of Silurian age, which unconformably overlies the porphyroids, and as it is definitely younger than the Cambrian sandstone it belongs, with the porphyroids, to the Ordovician group of rocks. Moreover, in the few outcrops it lies in direct contact with the Cambrian, and is, therefore, older than the porphyroid rocks.

On stratigraphic and palæontological evidence, then, the formation is tentatively ascribed to the Ordovician.

This determination is confirmed by P. B. Nye, in his investigation of the Beaconsfield-Flowery Gully district. There an orderly sequence of Cambro-Ordovician strata include a thick intercalated bed of limestone. The underlying beds are conglomerates, sandstones, and slates; and the overlying are slates and sandstones.

Twelvetrees also, in an unpublished report, describes a similar succession as occurring in the Florentine Valley,

and refers to the limestone as of Ordovician age.

(c) Silurian System.

West Coast Range Conglomerate and Sandstone.—These rocks succeed the "porphyroid," upon which they unconformably rest, and form the base of the Silurian in Tasmania. It has been observed by Hills at Darwin, and Reid at Mt. Claude, that the conglomerate is made up in part of porphyroid boulders, clearly proving their later

They form the crown of Gog and Magog Ranges; they outcrop in the valley of Mersey River near Dynan Bridge near Beulah, in the valley of Dasher River; they occupy the bulk of Badger Range, and crop out again at Bott Gorge near Nook, Denny Gorge near Melrose, and in the valley of Forth River near Hamilton. The dip at all these points is north-easterly at angles ranging from 48 to 60 degrees, and the strike is 330 to 345 degrees.

At the Rifle Range, on the east side of the North-Western Railway, an isolated outcrop of conglomerate is exposed on the hillside. This may prove to be the basal member of the Cambrian and not of this series as once supposed. Remnants of this conglomerate are strewn over the crest of Dulverton Hill, and similar materials cover the limestone rock near Railton.

Badger Range, which rises 1400 feet above the sea, consists of Silurian quartz conglomerate flanked on the east side by tubicolar sandstone and on the west by igneous porphyroid. The rhynchonella fossils noted in the tubicolar sandstone of Moina are abundant here and also at Denny Gorge and Paloona Hill.

The rock on Badger Range is made up largely of quartz and quartzite pebbles, but at Bott Gorge nearby pebbles of schist predominate. The shape of the pebbles and their disposition clearly indicate wave action on the waste of Cambrian and Pre-Cambrian rocks.

Wherever discernible in this and neighbouring districts, the base of the formation is found to be a member of the "porphyroid group." Its relation to older formations has been rendered difficut of interpretation by faulting and folding.

(d) Permo-Carboniferous System.

From the economic viewpoint the Permo-Carboniferous is the most important formation in the district, for therein are contained the beds of oil shale and coal. These strata

were laid down in regional synclinoria developed in older rock formations, and occupy the greater part of the territory. In some sections, however, neither the coal nor the oil shale seam is present. The formation consists of basal conglomerate and sandstone, limestone, Upper and Lower Marine mudstones with intercalated coal measure sandstones, shales, and grits. The soils derived from these rocks by disintegration and decomposition are very poor, and their presence at surface is clearly indicated by stunted scrub and dwarfed trees.

The sequence of the strata in both the coal and shale areas is given in the log records of the several bores.

A convenient datum for purpose of measurement is the position of the tasmanite member in the Permo-Carboniferous formation. At Native Plain the seam lies at a depth of 900 feet; in Latrobe area it is 600 feet above the basal member of that formation. The maximum thickness of the sediments of this age is then 1500 feet. Apparently the bed of shale corresponds in position to the coal measure series between the Lower and Upper Marine members of the formation. The coal measures are correlated with the Greta of New South Wales, and are replete with similar flora. The following is a list of the remains:—

Glossopteris browniana (Brongn.).
Glossopteris ampla (Dana).
Glossopteris indica (Schimper).
Gangamopteris augustifolia (McCoy).
Gangamopteris cyclopteroides (Feistmantel).
Noeggerathiopsis hislopi (Bunbury).

The fauna in the Upper and Lower Marine is generally similar, and is fully described by Twelvetrees in Bulletin No. 11 of the Geological Survey.

E.—Tertiary System.

Deposits of this system occupy a very large portion of the land surface, especially in the eastern and southern areas. In many places they are completely covered with basalt lava, but their nature and thickness have been determined at many points by drilling. In Sassafras area the base of these terrestrial beds rests on diabase at 1000 feet below sea-level. Details of these strata are given in the bore records.

Opportunities for examining the upper members of the Tertiary formation in surface exposures are very few, and the nature of the lower beds are revealed only by the drill. The greater part of the area is occupied by sheets of basalt, 300 to 500 feet thick, which apparently occurs in two distinct bands separated by a bed of loosely compacted sandstone. On the way to Harford this partially consolidated sandstone member is well exposed in the road-cuttings. It is a roughly bedded rock consisting largely of sub-angular grains of quartz cemented by felspathic material. In bores 21 and 23, according to the record furnished by the Mersey Valley Oil Company, alternate beds of mudstone and sandstone, containing pebbles and boulders of basalt, were passed to a depth of 250 feet, thus showing that the second period of sedimentation, following the first extrusion of basalt, was of considerable duration. The development of the sandstones is very irregular, the thickness and texture varying greatly from point to point. The sands do not appear to be well sorted, and even the coarser grains are not well There is evidence to show that this bed has rounded. been deeply furrowed by the later flow of basalt. The dip of the beds, as exposed on the Harford Road, is northerly at angles varying from 3 to 5 degrees. Lignitic clay, 600 feet thick, underlies the lower sheet of basalt lava. This brown clay, containing numerous plant impressions and remains, is compact, almost devoid of sand, extremely fine in grain, and is of the consistency of cheese when wet but much harder when dry. It contains nearly 20 per cent. of organic matter, and on distillation yields a little crude oil. At a depth of 1004 feet from the surface a 1-foot band of bright lignite occurs, and is succeeded by 35 feet of lignitic clay with occasional thin bands of sandstone. At 1100 feet a bed of gas sand was entered by the drill. Following the drawing of the rods an inrush of this sand caused the suspension of operations. The sand consists of sub-angular grains of clear quartz from a quarter to one millimetre in diameter, with a smaller amount of iron-stained mudstone, slate, and sandstone of coarser grainsize.

A corresponding band of lignite was cut in No. 30 bore, almost due south of No. 29, at 1007 feet from the surface, and, as the collar of this bore is 150 feet higher than that of No. 29, the general dip of the bed is towards the north.

Similar results were obtained in bore No. 31, which was drilled by the Mersey Valley Oil Company.

The composition of the lignitic clay is—

vino bala son era si il simil	F	er Cent
Water	100	22-00
Silica	1.0	28.00
Ferrous oxide	1444	3.09
Ferric oxide		1.72
Alumina		24.62
Lime		0.70
Magnesia		0.36
Carbonaceous matter		19.00

the nat

Lignite was cut in shafts near Deloraine Road a few miles south of Latrobe, and also in bores 21 and 23 in the same locality.

F.—Quaternary System.

Gravels of Pleistocene and Recent age occupy Native Plain, a strip between Railton and Sherwood, the floodplains of Mersey River near Latrobe, a large area at Cheshunt, and small areas near Deloraine. A narrow strip of gravel-covered land occurs on the east bank of Mersey River, near Devonport, and fringing the coast-line between Wesley Vale and Port Sorell.

the made asserts to approximate and the fibra many of sold range G.—Igneous Rocks. The sold distributed from the G is the solution of t

office a blate modell (a) Ordovician.

Porphyroid Series.—The several formations comprising the porphyroid series of igneous and sedimentary rocks are well represented in the southern part of this district. The types developed range from pyroclastic and fragmental rocks to syenites, porphyries of quartz and felspar varieties, and porphyrites. As these rocks have already been described in several of the Geological Survey publications, and, therefore, will not be dealt with in detail here.

In Beulah area igneous members—both the basic and acidic varieties—occupy a considerable portion of the land surface, and form the base of Gog and Magog Ranges, which are capped with West Coast Range conglomerate.

Products of the Formation.—Associated with the pyroclastic and basic intrusive members of this suite of

rocks are large deposits of barytes, and also a little galena and sphalerite. It is a striking fact that all the known important deposits of barytes in Tasmania occur in this formation, and in every district where these rocks are exposed barytes is found in them. This mineral is of contemporary formation, as evinced by its association and mode of occurrence.

Another important feature is that gold-sometimes in association with pyrite-is invariably found in the quartz porphyry intrusive member. In these narrow porphyry dykes the gold, in a very fine state of division, appears to be fairly evenly disseminated. The proportion of gold varies from ½-dwt. to 7 dwt per ton of rock, and an average of 1 dwt. may be safely anticipated. The Star of the East mine, at Beulah, was worked many years ago, but with no good result. It consists of a number of adits and opencuts driven along the course of a dyke of quartz-porphyry, 12 to 30 feet wide. The material obtained from these excavations was treated on the spot in a small milling and concentrating plant. No gold has been found in Minnow Rivulet beyond the point where it crosses the dyke, but on the downstream side alluvial gold of fine grainsize is fairly abundant, and a considerable amount has been recovered by sluicing the gravels and sands.

This deposit is worthy of very careful investigation.

noting a fixed of (b) Upper Mesozoic.

Diabase in the forms of dykes and sills and great transgressive masses intrudes all older formations. This rock occupies a very considerable portion of the land surface, and underlies the Tertiary beds of Sassafras and other areas.

berelles avad steldes (c) Tertiary, many mandance of

Basalt pipes crop out here and there in all quarters, and sheets of lava from these vents cover large areas of Tertiary sediments. This is the normal basalt, commonly found in northern Tasmania, from which have been derived chocolate-coloured soils celebrated for their fertility. Lava flows were intermittent, and in Sassafras the sheets are 450 to 550 feet thick. One of the chief characteristics of the rock in that district is the extraordinary development of aragonite, which is found well crystallised in geodes and vesicles. Another mineral of extraordinary composition

is also found filling vesicles in the basalt. The composi-

	Per Cent.
Silica	39.44
Ferrous and ferric oxide	4.72
Lime	4.00
Magnesia	8.39
Water	11:16
Ignition loss (largely CO ₂)	9.49
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It is a grey, soft, waxy mineral, closely resembling parafin wax in appearance and in some physical properties. Apparently it is an altered zeolite, but the composition is unlike that of any of the recognised varieties.

(2)—STRUCTURAL GEOLOGY.

A.—General Features.

The development of the present structure of the many formations comprising the land surface of this district is very difficult to interpret, because different influences have been at work during several periods. Crustal warpings took place during and at the close of the Proterozoic, at the close of the Ordovician, and at the beginning of the Devonian. Dislocations accompanied the diabase intrusion at the close of the Mesozoic; stupendous faulting and minor oscillatory movements followed the basalt eruption near the end of the Tertiary periods, and continued on a smaller scale through the Quaternary.

B.—Deformation of the Pre-Cambrian or Proterozoic Rocks.

Pre-Cambrian quartz and mica schists have suffered extreme metamorphism. Bedding-planes are obliterated, and are indicated only along the lines of contact between the several members. Igneous schists and gneissic rocks interbedded with the sediments record recurring periods of igneous activity.

C.—Deformation of the Palæozoic Rocks.

Cambrian strata are remarkable for their comparative freedom from schistosity. Fossils in the sandstone member are well preserved, and the planes of bedding can be recognised without difficulty, indicating a marked angular unconformity at the base of the formation.

Ordovician strata, on the contrary, show evidences of compression and shearing, especially the limestone member, which is decidedly schistose. The bedding-planes of the limestone and associated slates are not clearly defined, the strike and the dip in some places being, apparently, in accordance with that of the Cambrian sandstone. The series of incompetent "porphyroid" rocks exhibit schistosity in a like degree. Silurian conglomerates and sandstones are only slightly affected, but they register the direction and displacement of many of the major faults.

The minute deformation of post-Proterozoic rocks was largely due to the great intrusion of granite during the Devonian period, but all were affected by the disturbance. and were compressed into north-westerly trending folds, some of which were overturned and faulted. Compressional and shearing stresses were followed by tensional stresses and further faulting. These recurring folds, the axes of which are about eight miles apart, form the chief structural feature of the district. The folding resulted in the disposition of the upper beds in synclines, and their alternation with the larger areas occupied by the lower Thus limestone is found in the synclines, and the Proterozoic schists in the anticlinal areas. Range, on the eastern side, is occupied by schists, and another anticline is marked by the belt of schist extending from one end to the other through the middle of the district. At the southern end an overturned fold accompanied by a thrust fault is well illustrated. Normal faulting in direction opposite to the thrust stresses is marked by a long line of Silurian conglomerate. Normal faulting in the compressed beds is common.

Permo-Carboniferous sediments occupy the synclinoria developed in earlier formations. Deformation resulting from the granite invasion was amplied by the irruption of diabase at the close of the Mesozoic. This disturbance resulted in intense dislocation, especially of the Permo-Carboniferous to which the intrusion was confined. The extremely intricate faulting, both on a large and a small scale, for which the diabase intrusion is responsible, is exemplified also in older rocks. Silurian conglomerates on Magog and Gog Ranges of mountains exhibit block faulting on a magnificent scale by a series of downthrows of 500 to 600 feet to the south-west. They represent the

aftermath of the intrusion, as similar block-faulting is noticeable in the Permo-Carboniferous and the diabase of the Western Tiers. In Latrobe and Nook areas the Permo-Carboniferous are dislocated and tilted in all directions, generally obliquely to the folds that involve the Palæozoic beds.

D .- Deformation of the Tertiary Rocks.

The continental tablelands broken during the late Mesozoic collapsed further during the Late Tertiary. Stepfaults facing the east are signs of the uneven subsidence of the continental shelf accompanying the eruption of basalt. The great thickness of Late Tertiary terrestrial beds in Sassafras area, extending 1000 feet below sea level, indicate a gradual subsidence of the land. These movements, however, had little effect on the structure of the Permo-Carboniferous strata.

CHAPTER IV.

(1)—Economic Geology.

A .- Nomenclature of Tasmanite.

In the first written record of this shale it is referred to as "combustible schist." Since that record was made (in 1852) it has been variously described as dysodile, yellow coal, white coal, and resinous shale, until, in 1864, the name "tasmanite" was applied to it by Professor Church in an article appearing in the "Philosophical Magazine." Owing to the distinctive character of the shale this name has proved convenient, and has been retained.

B .- Nature of Tasmanite.

Tasmanite, like cannel coal and kerosene shale and the black shale of Don Valley discovered on this expedition, is not an oil-bearing, but an oil-producing substance, that requires heat for the generation of oil. The source of the oil is an organic substance called "kerogen," with which the shale is impregnated. This material, so adapted to the generation of artificial petroleum by distillation, consists of innumerable minute disc-like spore cases set in a finegrained arenaceous sediment. The amber-coloured discs or sacs are about half a millimetre in diameter, and, where not deformed, are nearly circular in outline. They appear as flattened bodies welded together in overlapping layers, and can be separated easily by means of a sharp instrument. Under the microscope they appear contorniate or crateriform, the central part apparently having collapsed. Twelvetrees (1) presents the following description: - "In transmitted light they are transparent, with a peripheral external wall, crowded with rod-like wedge or gashshaped cavities of minute size, disposed for the most part sub-radially within each sac or spore case, and suggestive of the presence of some cellular structure, faint traces of which are occasionally revealed." Cut transversely to the plane of bedding, they appear as flattened wrinkled bodies with compacted walls distributed in overlapping layers through the containing sediment. The sacs have been preserved by a decay-resistant waxy or resinous substance

⁽¹⁾ Twelvetrees, W. H.: The Tasmanite Shale Fields of Mersey District, Geo. Surv. Bull. No. 11, page 43.

forming the outer skin, but the spore cases have decayed, and their remains are generally almost indistinguishable, except for a little black carbonaceous material marking the division between the collapsed cutaneous waxy covering. However, the nature of the spore sacs is clearly revealed in the more perfectly preserved specimens. The sporangites or wax-like spore exines (walls) compose the bulk of the oil-producing material, and represent the protective covering of a plant probably of lycopod relation. Evidently the spores had been discharged, as almost every sac appeared to be fractured as if rent asunder by internal force. These waxy or resinous products of the plant are hydrogen-rich and oxygen-poor substances. They are, strangely, almost unaffected by the ordinary solvents of waxes and resins.

In Don Valley, at the northern end of Bott Gorge, a thick seam of black shale is exposed which differs in many important particulars from tasmanite, and apparently marks the transition stage between it and the kerogenite coal of the region, for, in addition to sporangia of tasmanite, it contains black coaly material derived probably from another order of plants. In this connection it is interesting to note that a black pitch-like coaly substance occurs sporadically distributed through the tasmanite bed, and occurs also in a very small seam in the sandy mudstone above the shale. It is very brittle, and is composed largely of volatile matter. The Don Valley shale cannot be lighted as readily as the tasmanite, but the characteristic odour of the latter is given off in burning. Even with the aid of the microscope the structure of this material cannot be perceived.

The kerogen of these shales, then, consists of the sporangia or spore cases of a supposed lycopodiaceous plant termed by Professor Newton, of the British Museum, tasmanite punctatus. The structure of modern clubmosses (lycopods) furnishes a feasible explanation of the origin and nature of the fossil remains, and the spore dust from these plants is likewise very inflammable. Stewart (2) obtained a substance similar to shale oil by the distillation of a mixture of 25 per cent. lycopodium spore dust and 75 per cent. of fuller's earth.

Tasmanite is distinguished from many similar plant

remains by the high proportion of sulphur it contains in

(2) Stewart, D. R.: Mem. Geo. Surv. Scotland, 1912, Part III., pp
164-165.

combination with its carbon and hydrogen. The distillate from these shales has the strong, penetrating odour of carbon bisulphide. Evidently the sulphur in that compound represents the amount originally contained in the body of the plant from which the pyrobituminous matter was derived. Sulphur in combination with iron as pyrite and marcasite is a common accessory component of the shale.

C .- Physical Properties of Tasmanite.

Colour.—Light-yellow or amber when fresh; dark-brown on exposed surfaces; grey on weathered surfaces.

Lustre.—Resinous to pearly.

Texture.—Finely laminated, fissile; weathered shale

splits into thin flexible paper-like sheets.

Fracture.—The material is tough and sectile. It breaks unevenly and with great difficulty across the plane of bedding.

Weathering.—The shale withstands weathering remarkably, and exposures stand out prominently from the encasing mudstone. The effect of weathering on the oil yield is inappreciable.

Specific Gravity.—The specific gravity varies from 1.2

to 1.6, the richer layers having the lower value.

Hardness.—This property varies according to the degree

of richness, the average being 1.

Fusibility.—The shale ignites readily with a match, and continues to burn freely when removed from the external source of heat. In burning it produces a large volume of black sooty smoke, and gives off a strong, unpleasant odour. Flexibility is increased by submersion in boiling water.

Solubility.—Nearly, if not quite, insoluble in ether, alcohol, benzine, pyridine, and carbon bisulphide; not acted on by H Cl; slowly oxidised by HNO₃; readily carbonised by H₂ SO₄ with evolution of H₂S.

D .- Chemical Composition of Tasmanite.

Tasmanite, like all other true oil shales, is not an oil-bearing, but an oil-producing substance. Oils cannot be extracted from it by solvents nor by subjecting the material to high pressure, but oils can be formed from it by the application of heat under certain conditions.

When the shale is placed in a retort and heated the organic component "kerogen" is progressively decomposed into permanent gases and oil vapours of various kinds, the latter of which can be easily condensed into crude shale oil. The richness of the shale is in proportion to the amount of kerogen it contains. Information regarding the chemical composition of the kerogen of tasmanite is meagre. From a number of analyses(3) Church arrived at the empirical formula, C40H64O2S, and suggested that the material may be a derivative of turpentine C20H32, or the radicle he assumed them to contain may be a homologue of benzoyle— $C_7H_5O + 13 CH_2 = C_{20}H_{31}O$. It is doubtful whether the kerogen of tasmanite can be expressed as a definite chemical compound. The nitrogen and sulphur constituents occur in combination with the hydrocarbon and in fairly constant proportions. The composition and the properties of the oil distilled from tasmanite differ greatly from the oils of other shales.

Table 1 gives the proximate analysis of shale from several localities, as determined in the Government labora-

tories.

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⁽³⁾ Church, A. H.: On Tasmanite, a New Mineral of Organic Origin, Philosophical Magazine, Vol. XXVIII., pp. 465-470.

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D.—Chimband Companion of Philadelphia
Entrance like all office true of States is not an allbouring but to all controlly substitute. Oils cause be
extracted from it was solvents and be subsciting the

TABLE 1.—PROXIMATE ANALYSIS OF SHALE FROM VARIOUS LOCALITIES.

No. of Sample.	Locality.	Moisture.	Volatile Matter.	Fixed Carbon.	Sulphur.	Ash.
_	Nook	0.7	37.70	3.00	1	58.6
_	Nook	0.6	31.30	2.50		65.6
-	Railton	1.3	37.30	3.40	2.6	58.0
-	Railton	0.9	22.07	2:83	_ 2	74.2
	Railton	2.30	34.31	2.20		61.19
-	Latrobe (lower band)	2.16	20.41	5.50	0.73	71 .20
558	Latrobe	0.80	30.84	5.86	2.56	62.50
559	Railton	1.00	30.00	6.20	1.92	62.8
560	Latrobe	1.10	15.10	4.50	2.47	79.30
561	Beulah (outcrop)	1.60	18.30	5.50	1.37	74 . 60
563	Nook (below Bott Gorge)	1.90	16.28	8.50	1.26	73.32
640	Bennett Creek (Latrobe)	1.00	17.50	6.10	1.41	75 .40
641	Bennett Creek (Latrobe)	1.30	22.86	5.84	1.65	70.00
642	Bennett Creek (Latrobe)	1.00	7.20	0.90	0.42	90.90
643	Railton-Latrobe, No. 1 Adit	1.30	14.96	3.64	0.89	80 .10
645	Railton-Latrobe, No. 1 Adit	1.40	22.00	6.40	2.44	70 . 20
646	Railton-Latrobe, No. 2 Adit	1.40	20.00	5.90	1.37	72.70

Ultimate Analysis of the Crude Oil.—Nitrogen, 0.31; carbon, 79.34; hydrogen, 10.41; oxygen, 4.93; sulphur, 4.93.

The calorific power of the crude oil has been estimated at 21,625 B.T.U., and at 21,336 B.T.U.; the flash-point is from 235° to 260°; and the specific gravity is 0.931 to 0.956. Laboratory tests show varying results owing to

different conditions of operation.

The nitrogen content of tasmanite is so small that it may be disregarded. However, it may prove of some value as a fertilising agent if discharged as a constituent of ammonium sulphate into the spent shale, which contains other components of plant food. The average proportion of nitrogen is 0.32 per cent. Tasmanite contains a fair proportion of pyrite and marcasite from which the greater part of the sulphur found in the shale is derived, but some of it occurs in intimate combination with the carbon and hydrogen of the substance. Sulphur is one of the most objectionable impurities of oil, producing in it a very disagreeable odour and reducing its commercial value.

Hydrogen sulphide is produced in the retorting of all oil shales, and carbon disulphide also in tasmanite. The greater part of the sulphur in these compounds probably

was derived from the organic portion.

Tasmanite, like other oil shales, contains a small amount of potash and a little phosphoric acid. The spent shale with these and the ammonium sulphate portion has a fertilising value, and applied in that way it should prove effective in breaking up the stiff basaltic soils of the

neighbourhood.

The matrix of the kerogen consists largely of clay and sand with also pebbles and boulders of quartz, quartzite, schist, and the waste of igneous rocks. The calcite of marine shells and secondary pyrite and marcasite are present in small amounts. It is interesting to note here the ocurrence of glendonite after glauberite at Nook, and of a radiating columnar mineral consisting of calcium-carbonate, with a little magnesium carbonate in the shale at Latrobe.

Table 2.—Analysis of Ash of Tasmanite (Spent Shale).

Reg. No.	Locality.	Carbon.	Ti O ₂ .	Na ₂ O.	K ₂ O.	Si O ₂ .	Al ₂ O ₃ .	Fe ₂ O ₃ .	Ca O.	Mg. 0.	S O3.
558	Latrobe	11.00	0.40	1.57	1.31	64.80	12.88	5.72	1.00	1.74	0.85
559	Latrobe	10.80	0.40	0.53	1.93	70.00	12.02	3.58	0.06	0.87	trace
560	Railton	7.00	0.40	1.15	1.92	70.60	12.48	5.72	0.20	1.00	trace
561	Beulah	9:80	-	0.92	3.30	63 · 30	15.62	6.58	0.20	0.89	trace
563	Nook (carbonaceous		7 1		F 5	5 8				1	10 3
	shale)	15.88	0.30	0.48	3.16	54.28	19.21	6.29	0.40	0.72	trace
640	Bennett Creek	_	0.30	0.65	2.28	68.10.	13.47	5.55	1.40	1.08	trace
641	Bennett Creek	11.48		0.32	2.34	65.80	12.00	5.55	0.52	1.29	0.68
643	Railton-Latrobe	7.40		0.62	2:89	71.00	15.24	2.86	0.20	0.86	trace
644	Railton-Latrobe	5.20				76.72	14.10	3.14	0.60	0.72	trace
645	Railton-Latrobe	10.80	1429	1.43	1.59	67.80	13.12	4.00	1.16	0.96	trace
646	Railton-Latrobe	10.68	7			66.12	15.20	5:16	2.08	0.78	

The yield of oil from average samples of tasmanite is given in the subjoined table:—

Reg. No.	Locality of Exposure.	Thickness of Seam in Feet.	Yield in Gallons.	Specific Gravity.
	Great Bend:	Teleg		
	Upper band	2 8	65	-
	Middle band	0 10	28	_
	Lower band		44	_
558	Railton-Latrobe Company's			
559	northern lease Railton-Latrobe Company's	4 6	51.7	0.952
000	southern lease		40.98	0.953
560	Latrobe (bulk sample)	4 0	44.12	
561	Beulah	2 6	32.62	
563	Nook (below Bott Gorge in	6 0	19.70	
040	Don River)	0 0	19.10	
640	Bennett Creek (outcrop shale), Latrobe	3 6	24.9	
641	Bennett Creek (outcrop	5 0	24 9	
041	shale), Latrobe	3 6	29.07	1
643	Railton-Latrobe (mudstone	9 0	25 01	_
045		1 4	11.40	1
645	band)	1 4	11 40	-
040	lower bands)	1 7	27.7	
646	Railton-Latrobe (outcrop)	4 3	21.4	100
0.40	No. 2 tunnel, Railton-La-	4 0	21 4	A STATE OF THE STA
s isi .	trobe Company	4 10	58.0	
	No. 1 tunnel, Railton-La-		00 0	
	trobe Company	5 2	41 - 4	
10.4	Quamby Brook	2 9	28.98	I THE I

The analyses reveal the variation in the content of oil in shale occurring in the several areas. Some of the samples were not truly representative, having been taken from the outcrop long exposed to the action of the elements. The crude oil is of an extremely dark colour and viscid character. Its specific gravity is 0.932 to 0.953. Tests of the crude oil show that it consists of 64 per cent. lubricating oils, 25 per cent. lighting oil, and 11 per cent. benzine. The proportion of vaseline and mineral waxes is very small.

E.—Mode of Occurrence.

Tasmanite occurs in a 3 to 6 foot seam at or about the horizon of the coal bed in contiguous areas. Only one seam of tasmanite and only one seam of workable coal is known in the district. In some places, as at Nook, for instance, the coal ends abruptly where the shale begins, but as there is no evidence of mergence one into the other their geographical relation may be due to faulting. However, in that area the coal seam recurs on the other side of the narrow shale belt, indicating a close correspondence in time of formation. A thick seam of black carbonaceous shale, which exhibits characteristics of both tasmanite and coal, is exposed in the bed of Don River at the northern end of Bott Gorge. This, apparently, is a freshwater deposit formed at the western edge of the Permo-Carbonaceous basin.

There is no evidence to show that tasmanite and coal occur mutually superimposed in any part of the district; on the contrary, it is found that where coal occurs it is futile to search for tasmanite, and where tasmanite occurs for coal. This knowledge facilitates exploration considerably by the elimination of all coal areas from examination. It has been established that tasmanite fringes the shore-lines of Permo-Carboniferous seas, from which it follows that where the upper mudstones abut early Palæozoic or Proterozoic rocks (conglomerates, slates, schists, &c.) the presence of tasmanite may be anticipated. A striking feature is that there is no appreciable thinning of the seam as the shore-line is approached. Probably this is due to the steepness of the Permo-Carboniferous shore-line.

The muds and spores cases forming the bed of tasmanite were deposited in very shallow seas along the shores of islands or in estuaries. The long, narrow belt extending in a direct line from Latrobe to Quamby Bluff probably represents estuarine conditions of formation. This line follows the course of Mersey River to Kimberley, thence it passes through Dunorlan and Deloraine to Quamby Bluff. Some miles to the west of this line are the Beulah and Nook deposits, the latter being separated from the main body by the Dulverton-Spreyton coal basin. Probably the Beulah deposit has been detached by faulting and erosion.

It is noteworthy that the shale bed in every locality consists of two main layers separated by a band of mudstone, 6 inches to 2 feet thick and poor in quality, similar to that in which the bed is encased, thus indicating similar conditions of formation.

F.—Geological Horizon.

In the coal portion of the basin, land and freshwater beds are intercalated between the Lower Marine and Upper Marine mudstones; but in the tasmanite portion the Lower and Upper Marine beds form a continuous series without interruption by land or freshwater deposits. It is not clear yet whether a separation can be made between the tasmanite and the coal beds as regards stratigraphy. Their frequent occurrence in juxtaposition at Nook suggests a contemporaneous deposition, one under marine, the other under terrestrial conditions. In contiguous areas the seam of coal and the seam of tasmanite occur at or about the same elevation and in connected basins. It is evident that tasmanite was deposited in very shallow seas, and the coal was formed on low, swampy lands in the same basins walled by hills of schist, sandstone, slate, and conglomerate. Comparing the logs of bores 16 and 22, commenced immediately below the seam of coal and of tasmanite respectively, it is found that there is a certain correspondence between the members, especially in the aggregate thickness. The same remarks apply to the beds everlying the coal and the tasmanite seam. Twelvetrees, in Geological Survey Bulletin No. 11, states: "In the Marine beds above the coal seam similar fossils occur to those which are found in the beds above the tasmanite; and below the shale horizon pebbly rocks passing down into a basal conglomerate prevail, just as happens below the coal measures. The fossils in the seam of shale and in the mudstone beds immediately above and below it are identical, and all are marine or open estuarine."

Although the Permo-Carboniferous formation has been greatly disturbed by the intrusion of diabase it is noticeable that both in strike and dip the coal and tasmanite seams coincide in areas similarly affected. It seems, therefore, that the present relative positions of these seams may be taken, in general, as an indication of their original association. In confirmation a veneer of coal of the following composition is found encased in or attached to the shale:—

	Pe	er Cent
Moisture		7.20
Volatile combustible matter		
Fixed carbon		45.30
Ash		4.20
Sulphur	di	2.74

The composition is remarkably similar to that of the coal in the seam found in contiguous areas.

G.—Geographical Distribution.

Tasmanite has been found in the northern portion only of the Island, and is confined within an area fronting the coast 30 miles wide and extending from Tamar River to Stanley. These arbitrary boundaries enclose not only the several known isolated occurrences, but also all other areas that are considered likely to contain important deposits. The known deposits encompass comparatively small areas, and have been definitely delimited. They are situated in two widely separated fields associated with basins of kerogenite and humic-kerogenite coals. The more important is that dealt with in this bulletin, extending from Latrobe in a south-easterly direction to Quamby Brook in conformity with the structural trend lines of early Palæozoic and Proterozoic formations. From Latrobe the seam has been traced without serious interruption, under the broad flood-plain and valley sides of Mersey River, to a point 3 miles south-east of Kimberley. Beyond that point through Dunorlan and Deloraine the Permo-Carboniferous do not outcrop, but they reappear a mile south of Deloraine, and in the valley of Quamby Brook tasmanite is exposed at intervals over 2 miles. Along this 27-mile belt the shale has been proved to extend 13 miles, and in the section intervening Kimberley and Quamby Bluff exploration may yet reveal its occurrence. At Latrobe and Railton the seam outcrops, and in no part of those areas is it far below the surface. At Native Plain it is from 300 to 900 feet below river-level. Outliers of the main body are known at Beulah and Nook on the west and at Paramatta on the east side.

The Permo-Carboniferous shore-line can be traced from Kimberley to Beulah, but the continuity of the tasmanite has been broken by faulting. At Beulah the shale seam and the containing mudstones flank Eilurian conglomerates. The Nook area, of comparatively small extent, is situated between conglomerate hills, and is separated from the Latrobe and Railton fields by the Mersey coalfield. Its north-westward extension has not been traced, but a very thick seam of impure shale has been exposed in the bed of Don River immediately north of Botts' Gorge. In a southward direction deposit will probably be found between Brown Mountain and Badger Range and along the eastern flank thereof. Paramatta field is separated from the Latrobe by a low ridge of mica schist, and underlies the hills of basalt to the east. No outcrop of shale is known here, and the extent of the field has not been determined by boring.

Far removed from these is the Cam River tasmanite field, situated 22 miles south of Wynyard. It consists of two areas—one near the point of confluence of the eastern branch with the main stream; the other and larger one 4 miles west of it, discovered during the recent investigation.

Aside from the known deposits it is considered likely that tasmanite will be found in the vicinity of Preolenna, near Newhaven, and on the Emu Bay block of the Van Diemen's Land Company. It is proposed to investigate these areas next year.

H .- The Formation of the Shale Bed.

The nature of the discs in the Mersey shale was discovered by R. M. Johnston, and was first recorded by him in "Field Memoranda for Tasmanian Botanists," published in 1874. Johnston(4) states that "tasmanite is the product of the spores and sporangia of certain cryptogams allied to the club mosses, and that the sporangia were washed down by an ancient muddy river and deposited in the quiet bottom of an inlet of the Upper Palæozoic sea, and among the sediments thus deposited marine organisms lived and died." The following marine fossils have been found in the shale:—

Spirifera tasmaniensis (Morris).
Cardiamorpha gryphoides (De Kon).
Pachydomus hobartensis (R. M. Johnston).
Pleurotomaria morrisiana (McCoy).
Pleurotomaria woodsii (?) (R. M. Johnston).
Pteronites latus (De Kon).
Aviculopecten latrobensis (R. M. Johnston).
Aviculopecten subquinquelineatus (McCoy).
Aviculopecten fittoni (Morris).
Aviculopecten sprentii (Johnston).
Eurydesma hobartense (Johnston).
Keeneia twelvetreesi (Dun).
Orthotites (Fischer).

Tasmanite occurs in bands alternating with finely laminated arenaceous flags, structurally similar to the

⁽⁴⁾ Johnston, R. M.: Geology of Tasmania.

shale, except that they are almost wholly devoid of sporangia. Embedded in the shales are numerous well-rounded pebbles of quartzite, conglomerate, chert, and schist, often very pyritic. The pebbles vary in size from beans to boulders 2 feet in diameter, the generality being 2 to 4 inches. The large boulders are less rounded, and evidently were precipitated into the shallow sea from nearby shore hills. Where the shale enwraps the pebbles it appears more compressed and more closely laminated. The distribution of sporangia through the shales varies from point to point and from band to band.

In many places the calcite of the marine fossil has been completely replaced by pyrite which has assumed the form of the organism. Secondary pyrite has also been deposited in the materials composing the pebbles found in the shale, and nodules and veinlets of that mineral are not uncommon accessory components.

Exposed to the air and sun tasmanite presents a bleached exterior due to the decomposition of the resinous or waxy material, and where less weathered the normally ambercoloured substance appears dark-brown.

The following sections convey an idea of the materials composing the seam and their sequence:—

East of Great Bend.

Nature of Strata.	ft.	in.
Buff-coloured and whitish Upper Marine sandstone Bluish-white clay		0 0 4
Arenaceous shale containing tasmanite spore-cases sparingly distributed	1	3
Tasmanite	0	6 9 2
Arenaceous blue mudstone	-	
South-east of Great Bend.		
Tasmanite	1	0
bluish mudstone	1	1
distributed	0	5 8
White and yellow clay	0	1

South-east of Great Bend-	-contd. ft. in.	
Tasmanite Clay Tasmanite Clay Tasmanite Clay Tasmanite Tasmanite Finely arenaceous bluish mudstone		
med and fined entract odd to she as all		
ment and becomes sail doldwathing of h		
reference the mediate and beautiful and the second areas.		
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Turboild a storong stramant og a bereit		
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1 1 Observation of the search		
8 0		

The Oil Shale Industry.

CHAPTER I. — MINING AND TREATMENT OF TASMANITE.

(1)—MINING DEVELOPMENT.

The oil shale lands of this district are separated by distinct geographical and geological breaks. The original fields, separated from one another by uplands of older formations, have been subdivided by the intrusion of younger igneous rocks or by faulting, aided by Tertiary and post-Tertiary erosion. This natural subdivision of the shale lands into comparatively small areas does not present serious difficulties to economic operation, because there is a limit to which profitable mining can be performed through one set of openings. The operation of mining shale in any particular area, therefore, can be successfully performed by one company. But in some areas several parties are interested, and each is operating independently of the other. For instance, in one small area of 1500 acres near Latrobe four companies are interested and two are in operation. Moreover, sections held under lease by one company are separated by a section leased by another. The Tasmanian Cement Co. is preparing to draw supplies of tasmanite from this area to the distillation plant at Railton, and the Southern Cross Motor Fuels Limited propose to operate their Railton deposits and convey the material to their works near Latrobe. This transposition of shales from Latrobe and Railton, taking all factors into consideration, cannot be regarded as a sound economic proceeding. There is room for one large establishment only in this district, and in consequence steps should be taken to bring about an amalgamation of interest for the benefit of all concerned.

Attention will now be given to another aspect of the question.

An important preliminary to mining development is the systematic drilling of the area to be mined. By this means any irregularities in the continuity of the seam, such as

rolls and faults and variations in the degree of dip, can be determined, thereby enabling the operator to fix the positions of mine-openings to the best advantage. If the mine is to be opened by dip-adit it is preferable to drive the adit on an even grade irrespective of whether it follows the seam continuously or not, unless, of course, a fault of considerable displacement intervenes. The average grade of the true dip is ascertained between the point of attack and the predetermined objective (usually at the boundary of the area), and the course and grade of the adit are laid out in accordance therewith. (With regard to direction it is sometimes found expedient to drive on the "half" dip.) If, in the drilling operations, it is found that major faults occur, then permanent and costly surface arrangements will not be necessary. Having systematically drilled the area, and having thereby ascertained the course and degree of dip of the seam and located irregularities, the nature and the location of the proposed openings may then be decided. A mine may be opened by (1) a vertical shaft, or (2) by an underlay shaft or dip-adit, or (3) by a strikeadit or level heading, the choice depending upon the peculiar conditions of the area to be mined.

Preliminary drilling, although insufficient for the purpose, has been performed on some of the holdings of the Mersey Valley Oil Co. and the Tasmanian Cement Co. The Railton block of the Southern Cross Fuel Refineries Limited has been thoroughly explored, but its northern

blocks have not been drilled.

Adverting to the subject of non-co-operation an instance of the ill-effects is provided at the main workings of the Southern Cross Co. The dip-adit follows the boundary between the northern section of Lease 6641m and a 500-acre block charted in the name of John James, and is used to mine the shale lying on the west side only. Many other instances could be given of similar difficulties which would be easily avoidable if the work were performed under co-operative arrangement.

(2)—METHODS OF MINING.

The shale bed in this district is divided into a number of mining areas by faulting. In some parts the seam lies near the surface with only a few feet of mudstone cover, and the shale may be removed by quarrying but, as a rule, the seam dips at a steep angle, and the material is removed by underground excavation. If the seam dips transversely to the longitudinal axis of the hill a strike-adit or level-heading is driven to provide the main entry to the mine. This method is applicable in a few areas, but the conditions generally are unsuitable, and other means of entry are necessary. The incline or dip-adit method is generally employed, especially in the areas where the seam outcrops. However, mining through a vertical shaft is the only available means where the seam lies at a considerable depth. Except in a few cases it is cheaper and more convenient to operate through a shaft than an incline opening. Entry by shaft and incline is preferable, as two independent openings are required by legal regulation.

The methods employed in mining oil shale are similar to those used in coal-mining. That known as the "Pillar and Stall and Retreating" system is almost general, but the "Longwall" is sometimes preferred. In the former only 40 per cent. of the shale is removed in the first stage of operations. When the boundaries of the section or the mining limits are reached the pillars supporting the roof are removed, beginning at the end of the workings and retreating towards the entrance to the mine opening. Temporary posts and head-boards are used to support the roof while the pillars are being worked.

The mudstone, in which the seam of shale is embedded, forms a sound roof and a fairly clean floor. Except in the main gangways, where more room is required, it is not necessary to cut into the floor-stone, and nowhere into the roof-stone.

Heretofore drilling has been performed with hand ratchet augers now rock-drills by compressed air are exclusively employed. The drills are of the ordinary percussion type, held in position and operated by one man. They are very light and very efficient for this class of work; but the strain on the operator produced by the vibration of the machine is rather severe. In continuous operation the rate of boring is about 6 inches per minute, except when the drill is intercepted by hard quartzite pebbles, which are occasionally found in the shale. One of the difficulties experienced in drilling is the riddance of borings from the hole. Spiral-flange drills appear to be the most effective type for that purpose. Cutting machines proved unsatisfactory.

Although there is no distinct parting between the shale and the roof mudstone it breaks down easily, and in large

slabs. The poor mudstone band separating the upper and lower bands of shale is broken first. It is more easily removed by explosives than the shale, and its removal first is of great advantage in the subsequent operations. Breaking is greatly facilitated by cross-fractures, the occurrence of which is not infrequent. Under ordinary conditions the extremely tough shale is difficult to break across the grain, but it can be split with ease. Gelignite is the explosive in general use—one of less power and slower action would prove more satisfactory. The shale is not loosened appreciably by the settling of the roof stone, all of it having to be bored and shot out. In the operation of breaking the proportion of fine material produced is very small.

Reducing the slabs to crusher size is a slow and costly operation. The material is so soft and tough that the spalling-hammer by repeated blows on one spot can be forced through a thick slab without producing a fracture in the shale alongside. However, spalling appears to be

the most effective method of breaking shale.

(3)—THE COST OF MINING.

As not one large mine has yet been opened, it is difficult to arrive at an estimate of cost of production for purpose of comparison. The drilling machines have been used more for development work than for actual mining, but tests have been made to ascertain the cost per ton in breaking shale in the various departments. An estimate based on these tests is likely to prove misleading. The Tasmanian Cement Company found that the cost of breaking shale amounted to four shillings per ton in bords, but much more in headings. To these costs must be added the cost of all other attendant operations, such as drainage, ventilation, spalling, timbering, &c.

Eight years ago shale was mined by hand and delivered into bins at the entrance to the workings at 5s. 6d. per ton. Since that time the wages rate and the cost of

materials have been raised 60 per cent.

A fair indication of mining costs is provided by coalmining companies operating on seams of equal thickness under similar conditions. The cost per ton of coal mined and hauled at the Cornwall and Mt. Nicholas Collieries, in the Eastern District, varies from 10s. 6d. to 12s. 6d. Probably shale could be produced at a lower figure, because no loss is made with slack, which amounts to 15 per cent. of the coal product. Again, using drilling-machines, the cost of breaking is greatly reduced. Drilling and cutting machines are not used in Tasmanian collieries.

(4)—Mine-Ventilation.

Mine-ventilation presents no difficulties. The two openings to each mine are usually sufficient to provide for the thorough ventilation of the workings. If not, the ordinary simple methods applied to coal-mining are employed.

Noxious gases are almost unknown, and the air contains so little explosive dust and gas that open lamps may be used in most workings with impunity. However, very little information is available yet regarding the mining of tasmanite oil shale, therefore, ordinary precautions should be taken to prevent explosions of dust and gas until it has been definitely established that they can be disregarded with safety. Probably carbon dioxide gas, which is non-inflammable, will become the chief cause of air vitiation.

(5)—Drainage.

Drainage is not likely to prove costly, even in the deepest mines. The roof and floor mudstone is almost impervious to water, and the shale itself is not at all porous. Percolating waters reach the workings along fault-planes and fissures, and through openings to the surface, but the quantity is small compared with that in metal-mining. Electrically-driven centrifugal pumps should prove the most suitable type in these mines.

(6)—Crushing.

Its tough nature necessitates a departure from the ordinary methods in the preparation of the shale for retorting. After many trials had been made with various types of rock-breakers and rolls the most suitable for the reduction of lump shale to the requisite size were selected. It was found that a heavy jaw-breaker of the Blake type and ordinary rolls, both fitted with specially designed crushing faces, were satisfactory. The object aimed at in the trials was the reduction of the lump shale to inch size and the production of a minimum amount of dust. The rock-

breaker is fitted with diamond-shaped jaws, and the rolls are either corrugated or toothed. These machines break and crush the material, and do not produce a large pro-

portion of dust.

The efficiency of gyratory crushers for this purpose has not been demonstrated, but in the breaking of some other kinds of shale this type has proved satisfactory and more efficient than the Blake type. Heavy-toothed rolls are preferable to other types for the further reduction of the shale to the requisite size.

Destrically driven centralingal purpos should prove the

ordinary rolls, both fixted with specially designed muching

CHAPTER II.—QUANTITY OF SHALE AVAILABLE.

In all the explored areas sufficient data are available for accurate calculation of the shale reserve. There are, however, certain untested areas in addition which may be regarded as potential sources of shale, and therefore deserve attention. It is proposed to calculate the quantity of shale on the basis of "actual" reserve and "probable" reserve.

The same principles employed in caclulating the contents of coal seams are applicable to the calculation of the

shale reserve.

S. J. A.

The specific gravity of tasmanite shale varies from 2.05 to 1.2, according to the degree of richness, the ordinary material being 1.6. On this basis, and allowing nearly 30 per cent. reduction on account of working losses, the quantity available is equal to 1500 metric tons per foot of seam per acre.

The tonnage of shale in the several areas is estimated

as follows :-

Area. Area services the sectors add to a service and the sector and the sectors are sectors and the sectors and the sectors and the sectors are sectors and the sectors are sectors are sectors an	Actual Reserve	Probable Reserve.
Latrobe-Railton Other Areas Native Plain Kimberley Merseylea Quamby Brook Beulah Nook Paramatta	6,260,000 3,000,000 — 211,250 387,400 260,000 22,250	3,460,000 3,865,000 4,500,000 2,026,000 4,500,000 1,043,000 1,490,000 3,620,000 2,400,000
presown extent and value bette ern Australia.	10,140,900	26,904,000

In addition there is a large "possible" reserve of oil shale in neighbouring areas.

CHAPTER III.—THE STATUS OF THE OIL SHALE INDUSTRY IN AUSTRALIA

The establishment of the oil shale industry in Australia as an important commercial undertaking has been hindered by the high cost of mining and distillation and the unsuitability of the retorts employed in the treatment of the shales. These remarks have particular reference to the Newnes and Joadja works in New South Wales, where the Scottish system of retorting was in practice. Lately other types of retort have been tested there, and one suitable for the treatment of these very rich shales has been selected for use. The temporary failure of the original companies operating at Newnes and Joadja brought about a serious depression in the industry, from which, however, it is now gradually recovering.

The deposits in the Capertee and Wolgan Valleys, near Newnes, are the most extensive in New South Wales. In thickness the seam varies from 14 to 50 inches, and along a line 4000 feet in length the average thickness is 4 feet. An estimate of the probable reserve in these fields is 20,000,000 tons, containing 100 gallons of crude oil per ton. Of the remaining deposits, those at Bathgate, Baerami, Barigan, Airly, and Murrurundi are the most important. The information at hand is not sufficient to form a safe basis for calculation of the quantity of shale in each area, but it is considered that the reserve is not less than 40,000,000 tons, containing 3,500,000,000 gallons of crude oil.

Oil shale deposits of unknown extent and value occur in Queensland and Western Australia.

The amount of oil in the known shale deposits is sufficient only to supply the requirements of Australia at the present rate of consumption for 30 years.

The collapse of the industry and the need of financial assistance for its re-establishment influenced the Commonwealth Government in making an offer of a substantial bounty for the production of mineral oils. In 1917 the "Shale Oil Bounty Act" was passed in Parliament to

provide for the payment of the following rates on crude shale oil produced in Australia:—

c on produced in Musicana.	
	Pence
On each imperial gallon up to 3,500,000 gallons	21
On each imperial gallon exceeding 3,500,000	
gallons and not exceeding 5,000,000 gallons	2
On each imperial gallon exceeding 5,000,000	
gallons, and not exceeding 8,000,000 gallons	$1\frac{3}{4}$
On each additional imperial gallon	$1\frac{1}{2}$

The maximum amount that may be paid in any one year is £67,500.

This offer was made for a period of three years—it has since been renewed. Only one firm has yet claimed the bounty.

From the foregoing statement it will be seen that the oil shale resources of Tasmania are of relatively great importance.

own area, whence they are known to extend in a southuly direction up the valley of Microsy River to Kimberley. In this field the shale is of high quality, and the seam is if more than average thickness. In the town area, and to be cast and west and south-east the bods belong to the and measures of the Pernoc-Carboniferons, consequently bulle does not occur in those parts.

This company, capitalised at £62,000 beermontly created the Rest of a proposed 15 unit discipling plant as the northern section of special leave 6641m near Lambe. It is claimed by the patence R. Schulla, of Melbourne, that the retout is capable of freeting 20 tons of all of the per diem, and that the process is continuous in operation. In addition, another of similar type and operation, in addition, another of similar type and

The company is operating under an agreement with the Hailton Latrobe Od Shale Company, to whom is paid a royally of Sa per ton of shale mined and treeted.

PART III.

Detailed Descriptions of the Shale Fields.

CHAPTER I.—RAILTON-LATROBE FIELD.

at may be paid in only on

Latrobe has been regarded as the centre of the oil shale industry since the first discovery in 1851, and residents may still claim this distinction, for no deposit of greater extent or value has been found in Tasmania. The deposits have been traced to the southern boundary of the town area, whence they are known to extend in a southerly direction up the valley of Mersey River to Kimberley. In this field the shale is of high quality, and the seam is of more than average thickness. In the town area, and to the east and west and south-east the beds belong to the coal measures of the Permo-Carboniferous, consequently shale does not occur in those parts.

(1)—Southern Cross Motor Fuels Limited.

This company, capitalised at £62,000, has recently erected the first of a proposed 15-unit distillation plant on the northern section of special lease 6641m near Latrobe. It is claimed by the patentee, E. Schultz, of Melbourne, that the retort is capable of treating 30 tons of shale per diem, and that the process is continuous in operation. In addition, another of similar type and capacity, but of slightly modified design, is in course of erection.

The company is operating under an agreement with the Railton-Latrobe Oil Shale Company, to whom is paid a royalty of 3s. per ton of shale mined and treated.

A.—Area Situation, &c.

Special lease 6641m consists of three consolidated groups of sections held by the Railton-Latrobe Oil Shale Company of Devonport. The area of northern block is 256 acres, north-eastern block is 533 acres in extent, and southern is 699 acres—a total of 1488 acres.

These sections lie between Latrobe and Railton, the northern and north-eastern being close to one another, and separated from the southern by 2 miles of schist.

B.—The Shale Seam.

On the 256-acre block the seam outcrops on the northern bank of Mersey River, and dips a little east of north into a low hill. Nearly the whole section is occupied by Permo-Carboniferous sediments covered on the western side by basalt. It was thought that at the river edge was intrusive, but investigation revealed the underlying pre-Cambrian schists at that spot. Schist occupies the south-east corner of the property, and diabase in dyke form outcrops near the north-west corner. In the western mine workings two faults of small displacement occur, and in the south-western quarter the shale has been faulted down at least 40 feet. Another fault of considerable magnitude is indicated near the northern boundary.

About 400 of the 533 acres of the north-eastern block are occupied by the Permo-Carboniferous, and of this area only 270 acres are considered to be shale-bearing. The sediments occur on both sides of a broad belt of schist, and have been intruded at several points by diabase. On the eastern side of the ridge of schist the shale outcrops in the bed of a small tributary of Bennett Creek. Two shallow shafts 20 chains northward were not productive. The prospects are favourable, however, as the overlying fossiliferous mudstones occupy the hill to the eastward.

On the 699-acre block the northern part is almost wholly occupied by shale-bearing strata, but the rocks in the southern part belong to the Cambrian formation.

A number of bore-holes and prospect-shafts were sunk under the direction of R. W. Powell to test the deposits in this area. These were laid down on four lines, based on the plan drawn by W. H. Twelvetrees and illustrated in

Bulletin No. 11. The following details of the work were furnished by the Company:—

No. of Shaft,	No. of Bore.	Chain Peg.	Shale Cut at—	Thick- ness in feet.	Hole
con, the	A " Lin 6 7 8 9	ne. 20 30 40 50	70·5—74 21—23·5	3·5 2·5	54 77 31·3 26·5
3 5 2	-	10.5 S.W. end 15 30 45 40 40 42 45	9—12·5 15·5—19·25 42·5—47 42·5—47 71·0—75·5 ———————————————————————————————————	3·5 3·75 4·5 4·5 4·5 ——————————————————————————	15·5 12·5 19·25 36 79 99 153 47 16·5 19·75
3 2 4 1 5	C" Lin	30 25 19 15 N.E. end	3—3·5 23—27	0.5 4.0	3.5
bearing, bearing, of schist, of schist, on one of the column of the colu	D" Lin 10 11 12 13 14 15	ne. S.W. end 5 20 30 40 50	72—76·5 140—151 120—122 130—135	4·5 2·0 2·0 5·0	30 47 102 153

[&]quot;A" Line.—Bores Nos. 6 and 9 were unsuccessful, the latter bottoming on conglomerate. It appears that the bed of shale peters out between pegs 40 and 41. As the seam is thick at No. 7 it probably extends westerly some distance towards No. 6, and may pass below. The shale occurs north of this line, but not far beyond it.

[&]quot;B" Line.—This line of bores and shafts is 45 chains south of "A" line, and reveals a fine body of shale 33 chains in width. In No. 5 bore only 8 inches of core was

obtained owing to the soft condition of the shale there. No. 1 shaft sunk at the same spot intersected 3 feet of shale.

"C" Line.—As the shale lay at a shallow depth prospecting was performed by shaft only. Richards' Quarry (4 chains north-east of No. 1 shaft and a little south of the line), from which a 50-ton parcel of shale was obtained and shipped to Scotland for treatment, discloses the seam 4 feet in thickness. About 200 feet north-east of this opening the seam, as exposed in a hole, is only 1 foot in thickness, indicating the approach to the edge of the basin. This line, which is 78 chains south of "B," reveals 10 chains of shale country.

"D" Line.—As the shale lay at a much greater depth the drill was employed to determine the thickness and extent of the seam. The result of this work shows a width of at least 30 chains of shale, the last hole being within 6

chains of the eastern boundary.

C.—Development.

The distillation works and the main mine openings are on the northern section of Lease 6641-M. The workings are situate at the Big Bend of Mersey River, near the eastern boundary of the section. They consist of strike and dip adits (five in all, and of small dimensions). Nearly all the shale thus far obtained came from the strike adits. The limits of these workings having been reached, mining is now performed through dip adits only. No. 1 adit, 7 feet high and 10 feet wide, has been driven nearly 200 feet, on a bearing of 12 degrees and an average dip of 7 degrees. The seam exposed is 3 to 6 feet thick, and of high quality. In the end of the adit the upper band of shale contains oil in the proportion of 72 gallons per ton; the mudstone band in the middle section of the seam contains 28 gallons and the lower band 40 gallons per ton. This shows a marked improvement, especially in regard to the mudstone band, on the grade of material near the entrance. No. 2 adit, driven northward along the eastern boundary of the section and less than 200 feet from No. 1, is nearly level for 120 feet, thence it follows the dip of the seam to 226 feet. It is proposed to continue the driving of these adits to 500 feet before commencing the first headings. This policy is regarded with disfavour, as the removal of the shale near the surface would weaken the roof and jeopardise the safety of the workings. It is advisable to continue the

driving of adits and headings in order to keep development in advance of mining. Headings are to be driven at intervals of 120 feet, and in the first operation only 40 per cent. of the shale is to be removed.

In these workings no faults have been found, but numerous cross-fractures of the shale and roof stone indicate considerable disturbance, and faults of small displacement

occur in the western workings near-by.

In addition to these works, a small open-cut, a number of exploratory shafts and trenches, and several bore-holes have been cut or sunk in the 699-acre section, in order to determine the extent and thickness of the seam and the quality of the shale. Attention is confined to the northern section at present, but when that is opened for mining operations the rich deposit on this section will be further developed.

D.—Haulage.

The shale is conveyed from the mine in trucks of halfton capacity along a 2-feet gauge tramway by means of an endless rope haulage, operated from the main engine at the distillation works. Each truck as it reaches the end of the ramp is automatically released from the hauling rope and, running into a tumbler and upended, deposits its load into a chute leading to a jaw-crusher. tumbler, rebounding from the buffer, releases the empty truck, which is shunted to a parallel line, engaged by the rope, and returned to the mine. It is considered that the tramway is capable of handling 300 tons of shale per working day of eight hours. Some doubt exists as to whether this anticipation will be fulfilled under continuous working conditions, as the spaces available for shunting and storage at the mine and treatment works are very small. However, as development work progresses more room can be provided as the need arises.

E.-Crushing.

From the chute the shale is received by a heavy rock-breaker fitted with "diamond" or grooved faces. The broken material then passes to rolls in which the larger pieces are further reduced in size. The rolls are of the corrugated type, a departure from the common form necessited by the tough nature of the shale, which under pressure tends to flatten and not to fracture. A rotary mixer receives the crushed shale, evenly distributing the dust

through the coarser material. It is then conveyed on a belt to a 30-ton bin, and passed through sizing rolls to the retort.

F.—Retorting.

The retort, which has a capacity of 30 tons per day, is the invention of E. Schultz, of Melbourne. It is a modification of the Rolle type, and is covered by Patent No. 3045 (1921). Under this patent a system of low temperature retorting, controlled by electric indicators, is employed, and it is claimed by the patentee that the improvements embodied therein bring about a complete change in the process. One of the advantages claimed is the separation of the benzine fraction direct in one operation. As the vapours are formed they are drawn by mechanical exhausters from three compartments in the retort to three separate sets of condensers. From the first compartment the benzine vapours are drawn off; from the second, kerosene and light lubricating oils are obtained; and from the third compartment, the heavy lubricating oils and residual oil vapours.

The operators state that by this method of retorting the production of fixed or uncondensible gases is reduced to a minimum. These gases are used in heating the retort, but, in addition, a certain amount of oil fuel is required for this purpose. One attendant only is required for each

set of five retorts.

The process provides for-

(a) Low temperature distillation.(b) Gradual heating of the shale.

(c) The heating of a thin layer of shale.

(d) Agitation during retorting.

(e) Continuous operation.

(f) Utilisation of permanent gases as fuel.

(g) Greater capacity of the retort.

G.-Power.

The central power unit of this plant is a 100 h.p. Diesel engine, driven by oil fuel produced by the plant. The main drive is extended on one side to a countershaft, from which the mechanical exhausters and the conveyor-belt receive their power; on the other side is another countershaft operating the endless-ropeway, rock-breaker, and rolls. This countershaft is fitted with a clutch on the main drive pulley, and also a special clutch for the rope-

way drive, which automatically unclutches should there be an accident or breakage on the tramway. There is ample reserve power in the engine for extension of the plant to 15 retorts.

H .- Refining.

The refinery is situated at Yarraville adjacent to the Mount Lyell Chemical Works, on 2 acres of land held under lease from the Melbourne Harbour Trust. This is a special conversion plant in which motor spirit of high grade is separated from the crude oil in one operation. The capacity of the plant is 20,000 gallons of crude shale oil per week, motor spirit and fuel oils only being produced at present. From tests made a recovery of 38 per cent. motor spirit is anticipated, in addition to a recovery of 15 per cent. of benzine. The motor spirit has an initial boiling point of 35 degrees Cent. and a specific gravity of 0.70.

In the process of treatment the oil is pumped through a series of pre-heaters, vapourisers, and converters; then it is passed through scrubbers, to remove carbon and the sulphur compounds, to the condensers. It is afterwards treated in a fractionating apparatus for the removal of all deleterious matter. The advantage of this process is that uncondensible gases are retained in solution in the spirit, thus increasing the recovery, and providing—what is most sought by motorists—an easy starting spirit.

The converter furnaces are heated by oil fuel burners of local design.

I .- Estimate of Mining and Retorting Costs.

The following estimate is based on figures furnished by the company:—

Two Retorts, Each Treating 30 Tons of Shale per Day:

Cost of mining 420 tons per week at 6s.	£ 126		
Royalty at the rate of 3s. per ton paid to the Railton-Latrobe Oil Shale			
Company'	63	0	0
Hauling, crushing, and retorting	47	5	0
Fuel, water, and light	14	0	0
General attendance	8	16	8
Superintendence, &c	20	0	0
	£279	1	8

아이는 이 집에 사를 계속되어 보고 있다. 그런 이번 등이 되었는 것이라고 그는 그리네요. 그 그 그 모든 그리다.			
Ninety-three tons of crude on obtained			
from 420 tons of shale would cost, per	berrine	~	_
ton, at the works		0	0
Freight to Devonport, per ton	0	8	0
Freight to Melbourne and cost of con-			
veyance to Yarraville refinery, per ton	1	5	0
MINITED SO SINCE THE SOLUTION STATE OF STATE OF STREET			_
Total, per ton	£4	13	0
Less Federal Government shale oil			
bounty (at 3½d. per gallon), per ton	3	10	0
able amounts to-	£1		os Lo
E ald all of the Charles and t	£1	3	0
Estimate of Refining Costs:			,
Ninety-three tons of crude oil, at 23s.	£	4.0.20	
per ton	106	19	0
Wages		0	0
Fuel	5	0	0
Lighting and power	20	0	0
Incidental expenses	10	0	0
Capital charges—			
Interest on capital (£62,000), de-			
preciation and amortization	214	0	0
Preciation and amortization	214	0	
Royalty to original patentees on	49	0	Ò
$21,000$ gallons, at $\frac{1}{2}$ d	11/2	0	-
mestone quarries near Hailton; but the mines,	£448	19	0
	367 - 3	Go	ls.
Benzine obtained from crude oil—15 per			150
cent. of 21,000 gallons		Э.	100
Motor spirit, 40 per cent. of remainder		-	
(17,850 gallons)		1	140
set a the distillation of on from bestmanite		10,5	290
	£	4.12	d.
10,290 gallons, at 1s. 6d. per gallon	771	0	0
Fuel oil, allowing a loss of 10 per cent.			
in heating and in fixed gases, amounts			
to 36 tons, which, at £2 10s. per ton,			
is worth	90	0	0
Spray oils-2000 gallons per week, at			
ls. 6d. per gallon	150	0	0
Gross revenue per week	1,011	0	0
	50		0
Less overhead charges, at 5 per cent	- 00	U	U
est to sarigage wash of becounty of the fitter	£961	0	0
Less expenses and production costs per week	448	19	0
her beel adorted or believes on more	100000	770	1
Estimated net revenue per week	£512	1	0

J.—Quantity of Shale on the Properties.

The actual area of shale-bearing strata has not been accurately determined by drilling or mine-openings. However, the seam outcrops at various points, and it is reasonable to assume that it continues uninterruptedly in the intervening area. Where there is doubt of its continuity the estimate of "probable" reserve only is considered.

On the basis adopted for purpose of calculation, and assuming the average thickness to be 4 feet, the quantity of shale available amounts to—

	Actual Reserve. Tons.		Probable Reserve. Tons.
256-acre block	. 1,020,000		72,000
533-acre block	. 1,620,000		378,000
699-acre block	1,440,000	***	500,000
Total	4,080,000	pdite d nuv	950,000

(2)—TASMANIAN CEMENT COMPANY LIMITED.

The cement and distillation works of this company are close to the limestone quarries near Railton; but the mines, now being opened for the supply of tasmanite, are near Latrobe. It is proposed to use ground shale as fuel and spent shale as an admixture to limestone in the manufacture of Portland cement. The hot gases from the combustion of the fuel after passing through the cement plant are to be utilised in the distillation of oil from tasmanite in improved retorts designed by E. G. Stone, the superintendent of the works. When the plant is in full operation the permanent gas, formed in the first stage of distillation, will be conducted to the cement-making section and used as fuel; and ultimately it is proposed to employ crude distilled oil also for that purpose. The idea of the designer is to utilise the heat energy generated in one operation as a source of power for another, thereby completing a cycle of events and reducing the cost of production to a minimum.

A.—Area, Situation, &c.

By arrangement it is proposed to draw supplies of tasmanite from properties owned or leased by F. Richards, of Devonport. These are situated in Latrobe, Nook, and Beulah areas. Of the Latrobe properties one is a 65-acre

freehold, north and adjoining Lease 6641m; another is Lease 8822m, of 101 acres, situated 10 chains farther northward. In addition to these interests the company holds an option of purchase over a 100-acre block owned by one Cory, of Latrobe, situated west and adjoining Lease 8822m, and also that of H. Lord, of 248 acres, north and adjoining.

B.—Lines of Transport.

Facilities are now being provided for the cheap and rapid transport of shale from the Latrobe mines to the distillation works at Railton. These consist of a branch line of the North-Western railway to Mersey River, terminating at a point opposite the Western Mine opening, and a tramway connecting the workings to storage bins on the west bank of Mersey River. The distance by rail line from the storage bins to the Railton works is 8 miles.

Both the mine and the distillation works are easily acces-

sible by road.

C .- The Shale Seam.

This area of gentle undulation is occupied or underlain by mudstone of the Permo-Carboniferous system. In places where mudstones are covered the surface is occupied by Quaternary and Recent river gravels or by Tertiary basalt, and where intruded the outcropping rock is diabase.

The river gravels occur in two terraces, indicating a recent uplift of the land of 20 feet. On the western edge of the upper terrace the seam of tasmanite outcrops a distance of 5 chains, but, dipping north-north-east at an angle of seven degrees, it is soon lost to view in that direction. A narrow dyke of diabase cuts through the eastern end of the 65-acre block, and extends towards the centre of Lease 8822-m in a north-easterly direction, thereby limiting the scope of mining from existing openings. Pre-Cambrian schist occupies the eastern half of Lord's block and a portion of Lease 8822-M but the country to the west appears to be shale-bearing. Numerous faults of small displacement occur in this much disturbed area, not sufficient in magnitude, however, to seriously interfere with mining. One only of considerable displacement is known: that is marked by the line of intrusive diabase. The boreholes prove that the dip is fairly even and regular in other parts of the company's holdings.

Elaborate descriptions of the Nook and Beulah areas are

given elsewhere, 000 371 aniamos

D .- Development.

Prior to the advent of the Tasmanian Cement Company very little work of any kind had been performed on the Latrobe properties. Since that time, after preliminary boring, two main mine openings have been driven. One is a strike adit or level heading driven in a south-easterly direction from a point near the northern boundary of the 65-acre block. If no serious fault intervenes the continuation of this adit to the diabase dyke should provide a convenient way of attack to the greater part of the shale on that section. This work is now being successfully performed in pursuance of the policy of the company to keep development well ahead of mining, and reveals a seam 3.5 to 5 feet thick, interrupted on its course by minor displacements only.

On the Section 8822-M a test hole was drilled near the north-western corner to cut the seam at a depth of 256 feet. This preliminary work of exploration having been successfully performed, a main shaft was sunk to the seam, and headings are now being driven therefrom east and west in preparation for active operation. The greater depth of the seam at this point is due to its north-easterly

dip.

The necessary equipment in connection with the operations of mining through these openings has been provided,

and everything is now in readiness for production.

The only development work performed in Cory's block consists of a hand-drilled hole 75 feet in depth, near the old noad leading towards Deloraine. Lord's block has not been prospected at all. The shale on these properties lies at a considerable depth, and can be explored only by shafts or bores.

E.—Shale Reserve on the Latrobe Properties of the Company.

Exploratory work has shown that tasmanite occurs on half only of the 65-acre section, and that the thickness of the seam, not including the poor band in the centre, varies from 3 to 5 feet. On the basis of an average thickness of 4 feet, it is estimated that the quantity available amounts to 192,000 tons. Seventy of the 101 acres of Cory's block contains shale estimated at 4 feet in thickness, and amounting to 420,000 tons. Section 8822-m is shale-bearing over 76 acres, and contains 456,000 tons.

Lord's section is shale-bearing over 110 acres, and con-

tains, on the basis herein adopted, 660,000 tons.

As the shale has been proved by exploratory works on the 65-acre block and Lease 8822m only, the estimate of quantities on the other properties is regarded as a "probable" reserve, and this distinction is adhered to in the statement given hereunder:—

partant. Oil shale has not b truthold block, and the prosp	Actual Reserve. Tons.	Probable Reserve. Tons.
Sixty-five-acre block	192,000	Though John
Lease 8822-M	456,000	Aretrahod in
Cory's block	CONTRACTOR	420,000
Lord's block	rateografic Ine records	660,000
	648,000	1,080,000
	1	

(3)—THE MERSEY VALLEY OIL COMPANY.

This company, operating from Melbourne, was organised in 1922 for the express purpose of boring for natural oil in the Mersey district. In the pursuit of its investigations the company obtained leasing rights for a long period over many freehold properties, since proved to be shale-bearing. In this way the Mersey Valley Oil Company became directly interested in the oil shale lands of the district. The search for reservoirs of natural oil commenced in Permo-Carboniferous strata is now confined to the deep Tertiary beds of Sassafras area.

The several properties over which certain rights have been acquired will be dealt with under the operations of

the Company.

A.—Area, Situation, &c.

The shale-bearing properties in which the company is interested are in Latrobe area. They may be divided into two groups, one on the east and the other on the west side of a ridge of Pre-Cambrian schist. The western group consists of one 100-acre and one 50-acre block, owned by M. Lee; one 25-acre and one 15-acre block, owned by A. Dyson; and one 49-acre block, owned by W. Dyson.

The eastern group consists of a 24-acre and two 50-acre blocks, owned by Aubrey Churchill; a 100-acre block, owned by C. Lehman; and the freehold of a 58-acre block.

These sections are separated by other freeholds leased to the Tasmanian Cement Company.

B .- The Shale Seam.

The western group of sections is almost wholly shale-bearing, and the seam is interrupted only by a narrow dyke of diabase, which passes through Allen Dyson's 25-acre block. There is evidence, certainly, of faulting, but of a

minor degree only.

The eastern group, comprising Lehman's and Church-hill's blocks, is not as important. Oil shale has not been found on the company's freehold block, and the prospects are not favourable for its occurrence, except near the northern boundary. Probably the south-western part only of Churchill's block contains the shale seam, as the underlying Early Palæozoic rocks rise sharply to the east, as shown in the log records of bores. The seam outcropping in Bennett Creek dips to the east of north underneath a steep basalt-covered hill, and is lost to view in a distance of 5 chains.

On Lot 741 (M. Lee) no work of any kind has been performed, but there is reason to believe the shale seam extends into this property. The surface is occupied by Quaternary sediments and forms an old floodplain of Mersey River. On the western side of the river opposite this block a bore-hole, drilled by Henry Law, passed through coal-measure strata. Apparently this property marks the northern limit of the shale bed, but it is quite possible that a strip continues on the eastern side of the river towards the bridge.

C.—Development.

The only development work performed on these properties consists of a few shallow shafts and trenches, and a number of bore-holes. In many of these works the shale seam was intersected.

Near the southern boundary of Lot 6858 a bore-hole passed through 5 feet of shale at 49.5 feet from the surface; and near the northern boundary, formed by the old road to Deloraine, the seam was intersected by the drill at 104 feet.

On M. Bourke's 24-acre block the seam of shale is exposed in the bed of Bennett Creek. Two shallow pits were sunk to explore the seam, and a bore was drilled from a point beyond the outcrop to test the underlying strata. Details of this and of several other deep bores drilled by the company through Permo-Carboniferous and Tertiary sediments in this area are given in the subjoined log records.

Bore No. 21 .- Mersey Valley Oil Company, No. 1.

Location: On R. Driscoll's 35-acre farm, West Sassafras. Altitude: 465 feet above sea-level.

	,	Peet.	
Nature of Strata.	From-	To-	Thick- ness.
Clay	0	29	29
Mudstone, soft	29	31	2
Sandy clay and mudstone	31	46	15
Mudstone	46	58	12
Sandstone	58	60	2
Mudstone, iron pyrites	60	69	9
Pyrite and limonite pebbles	69	80	11
Mudstone, basalt (?) pebbles	80	96	16
Mudstone, pyrite nodules, and	nelilibles		vbosk
basalt pebbles	96	110	14
Mudstone, basalt (?) pebbles	110	180	70
Mudstone, pyrite nodules, and	12 11 1		PROPE
basalt pebbles	180	196	16
Pebbly mudstone	196	207	11
Sandy mudstone	207	217	10
Sandy mudstone, basalt (?) and			detail
sandstone pebbles	217	241	24
Sandstone, mudstone with iron-	4 4 17 4 4		BELLEVIS TO
stone pebbles	241	254	13
Sandstone conglomerate	254	260	6
Conglomerate pebbles in sandstone	260	278	18
Conglomerate	278	283	5
Ironstone	283	283.5	0 ·E
Conglomerate	283 · 5	286	2.5
Mudstone	286	287	1
Sandy mudstone, pebbles, and			in sum
fossils	287	300	13

Bore No. 23.—Mersey Valley Oil Company, No. 2
Locality: On Lot 10,184, near Deloraine-road, West Sassafras.
Altitude: 390 feet above sea-level.

	اد مس	Feet.	
Nature of Rock.	From-	То	Thick ness.
Clay	0	10	10
Sandstone, pebbles and shale	10	15	5
Rubble	15	21	6
Mudstone, containing basalt (?)			
boulders and conglomerate	21	27	6
Conglomerate	27	52	25
Sandstone with pebbles	52	57	5
Sandy mudstone, pebbles of con-	02	BERRY	
glomerate and pyrite	57	93	36
		30	30
Schist, quartz, and conglomerate,	93	101	8
broken	101	108	7
	108	121	13
Quartz sandstone, hard, broken	121	139	18
Sandstone conglomerate	139	143	100
Schist conglomerate	143		3
Sandstone, quartz-schist		159	16
Quartzite	159	172	13
Sandstone conglomerate	172	210	38
Basalt (?), soft, soapy	210	217	7
Basalt (?), hard, broken	217	228	11
Basalt (?), quartz veins	228	262	34
Quartzite, sandstone	262	266	4
Quartzite and quartz conglomerate	266	321	55
Quartz and schist conglomerate	321	354	33
Conglomerate	354	359	5
Quartzite and conglomerate	359	366	7
Conglomerate	366	378	12

Bore No. 22 .- Mersey Valley Oil Company, No. 3.

Locality: South-west corner of Michael Bourke's 24-acre farm, West Sassafras.

Altitude: 265 feet above sea-level.

Remarks: Tasmanite outcrops immediately above collar of hole.

sean		Feet.	
Nature of Rock.	From-	То—	Thick-ness.
Clay	0 0	12	12
Sandstone, decomposed	12	19	7
Mudstone, pyrite pebbles	19	118	99
Mudstone, three bands of pyrite	118	126	8
Sandstone	126	127	1
Mudstone with pebbles and marine	120	141	1
	107	170	40
fossils	127	170	43
Sandy mudstone	170	173	3
Mudstone, pyrite and quartzite	Very 1		
pebbles	173	227	54
Sandstone with conglomerate		SHESOT	
pebbles	227	238	11
Sandstone conglomerate	238	263	25
Sandstone, calcite (?) and con-		SEDEN TEXT	
glomerate pebbles	263	275	12
Sandstone conglomerate	275	309	34
Sandy mudstone with pyrite,	to Russ	it ibiv	1
quartzite, and calcite (?)			death by
pebbles	309	350	41
Mudstone	350	383	33
Sandy mudstone	383	432	49
3.6 1-0	432		MI DHILLIAN BURNEY SHOULD
C 1.1 2.11 1.111	478	478	46
	478	479	1
Conglomerate, in places soft,	Engener Info		5 m
broken pebbles	479	570	91
Mudstone	57.0	572	2
Conglomerate	572	589	17
Diorite (?) with quartz veins	589	621	32
Quartzite schist and quartz con-			
glomerate	621	689	68
Conglomerate, soft cementy patches	689	714	25
Conglomerate, sandstone, and	Bol	east of	ast Diffe
schist	714	731	17
Quartz conglomerate	731	738	7
Quartzite, schist and quartz con-	41 14 14	- Sinin	Ediglick
glomerate	738	795	57
	U.C. FO	design to	0.00

Bore No. 24.—Mersey Valley Oil Company, No. 4.

Locality: Old racecourse, Latrobe.

Altitude: About 40 feet above sea-level.

trops numerinfoly above cultur.	too shod	Feet.	
Nature of Rock.	From—	То—	Thick- ness.
Clay	0	12	12
Clay			11.00
Sandstone, decomposed	12	16	4
Mudstone	16	33	17
Sandstone and mudstone, basalt	- 00		-
(?) pebbles	33	53	20
Sandstone and pebbles	53	71	18
Mudstone with marine fossils	71	90	19
Sandstone	90	91	1
Conglomerate and sandstone	91	105	14
Mudstone and sandstone	105	115	10
Sandstone and sandy mudstone,			
marine fossils	115	209	94
Mudstone, basalt (?) bands,	110	200	0.4
pebbles, fossils	209	262	53
Conditions soft			10000
Sandstone, soft	262	322	60
Mudstone with bands	322	337 · 2	15.2
Coal	337.2	338	0.8
Mudstone	338	340	2
Sandstone	340	357	17
Mudstone, with traces of coal	357	429	72
Sandstone	429	429:5	0:5
Mudstone	429 . 5	489	59:5
Mudstone with pebbles	489	514	25
Conglomerate and hematite	514	517	3
Sandstone	517	524	7
Mudstone with pebbles	524	534	10
Conglomerate	534	535	1
Mudstone with pebbles and fossils	535	560	
Sandstone			25
Mudstone and gonder mandatana	560	566	0
Mudstone and sandy mudstone	566	580	14
Sandstone, conglomerate	580	590	10
Sandy mudstone with pebbles	590	605	15
Sandstone conglomerate	605	612	7
Sandy mudstone, sandstone bands	r still distriction		emply in
and calcite pebbles	612	625	13
Sandy mudstone with pebbles	625	632	7
Sandy mudstone and basalt (?)	0.0	delomers	5 23 m
conglomerate	632	654	22
Conglomerate and sandstone with	THE PERSON	001	
calcite and pebbles	654	661	7
Sandstone pebbles and calcitic fos-	004	001	- 1
	001	CCT	
sils	661	667	6

Bore No. 24 .- Mersey Valley Oil Company, No. 4-contd.

DET TO MINO PUISO OF WHILE BUILD		Feet.	
Nature of Rock. Involuces	From—	То—	Thick-ness.
Sandy mudstone with pebbles and calcite. Slaty stone Mudstone, sandstone with pebbles Mudstone with fossils and pebbles Sandy mudstone with pebbles. Mudstone with occasional pebbles Basalt (?) Mudstone with pebbles Mudstone with pebbles Mudstone with pebbles Mudstone with pebbles Conglomerate Mudstone Conglomerate Diorite (?) or basalt (?), broken	667 685 689 700 779 790 884 888 925 927 935 963 965 968	685 689 700 779 790 884 888 925 927 935 963 965 968	18 4 11 79 11 94 4 37 2 8 28 28 23 332

Probably the bedrock of the Permo-Carboniferous is quartzite and not diorite, as given in the record. Dioritic rocks occur as members of the "porphyroid" suite, but not at the point referred to. The determination of the rock at the base as basalt is also incorrect.

Bore No. 25.—Mersey Valley Oil Company, No. 5.

Locality: On Lot 6833, Latrobe.

Altitude: 30 feet above sea-level.

181 S44 758 eRaso	THATTHE	Feet.	
Nature of Rock.	From-	То—	Thick-ness.
Clay Mudstone Mudstone with pebbles Sandy mudstone Mudstone conglomerate Sandstone, schistose Quartzite schist	0 15 35 82 125 151 155	15 35 82 125 151 155 192	15 20 47 43 26 4 37

Bore No. 26.—Mersey Valley Oil Company, No. 6.

Location: On Bauld's 11-acre block, 6 chains south of the Moriarty-road.

Altitude: 250 feet above sea-level.

		Feet.	
Nature of Strata.	From-	To-	Thick- ness.
Clay	nas Ossa	9	9
Decomposed sandstone	9	12	3
Pebbly mudstone	12	76	1
Pebbly mudstone containing pyrite	76		64
Conder mudatone Containing pyrite		101	25
Sandy mudstone (few pebbles)	101	182	81
Pebbly sandstone	182	262	80
Sandstone conglomerate	262	276	14
Sandstone	276	289	13
Sandstone with mudstone bands	289	346	57
Sandstone and mudstone contain-	346	349	3
ing calcite	349	360	11
sils	360	442	82
Sandstone	442	477	35
Sandstone with layers of black		S NR 33/00	e aaloo
sand	477	494	17
Coal	494	494.5	0.5
Coal	494.5	496	1.5
Danustone	496	506	10
Mudstone, soft, puggy Sandy mudstone, marine fossils	506	569	63
and calcite	569	647	78
Sandstone	647	671	24
Sandstone conglomerate	671	683	12
Sandy mudstone, quartz pebbles	ns las	SHLK	
and calcite	683	730	47
Sandstone conglomerate	730	758	28
Pebbly mudstone, marine fossils Conglomerate and mudstone (peb-	758	942	184
bly)	942	989	47
Diabase	989	991	2
Diorite (?) and quartz (?)	991	1000	9

Bore No. 33 .- Mersey Valley Oil Company, No. 7.

Location: On Haine's block, half a mile east of the junction of the Latrobe-Devonport road with the Moriarty-road.

Altitude: 201 feet above sea-level.

Remarks: Broken sandstone, 217-219; lost water; hole cemented.

blocks 120,000 90,000	ems-0d]	Feet.	
Nature of Strata.	From-	To-	Thick ness.
Clay	0	19	19
Sand	19	20	1
Mudstone	20	40	20
Sand	40	42	2
Pebbly mudstone	42	78	36
Sandy mudstone	78	94	16
Pebbly mudstone	94	110	16
Mudstone, basalt (?) pebbles	110	128	18
Sandy mudstone	128	151	23
Sandstone, soft	151	183	32
Sandstone	183	254	71
Sandstone with calcite (or lime-	distribution		anne.
stone)	254	286	32

From the records of the bore-holes given herein it will be seen that coal and not shale occurs in this area, except at the site of bore No. 22. These bores definitely mark the northern and eastern limits of the shale bed. Bore No. 22 was commenced below the shale bed.

D.—Quantity of Shale Available.

Until more exploratory work has been performed the actual reserve cannot be determined. These remarks apply particularly to Lehman's block, Lot 741 owned by M. Lee, and to the company's freehold block. The faulting of the seam adds to the difficulties in this connection.

With these reservations the quantity available is estimated at-

rseq Valley Oil Company, No. 7. block, ball a mile oast of the junc-	Rosarvo	Probable Reserve. Tens.
M. Lee's 50-acre block	168,000	to most
A. Dyson's 15-acre block	90,000	ser-vits
A. Dyson's 25-acre block	120,000	Attitude: 2
W. Dyson's 49-acre block	294,000	Y
Lenman s block		300,000
Lot 741 (M. Lee)		198,000
Churchill's two 50-acre blocks	120,000	90,000
58-acre block	age of Stea	72,000
Total	792,000	660,000

(4)—Tasmanian Shale and Oil Company Limited.

A.—Area, Situation, &c.

This is an Adelaide company formed a few years ago to acquire oil shale lands in the district. The company possesses a 500-acre block, charted in the name of John James, situated east and adjoining the 256-acre section owned by the Railton-Latrobe Oil Shale Company and near the Great Bend of Mersey River.

B.—The Shale Seam,

The block is occupied by a ridge of pre-Cambrian schist flanked on both sides with mudstones and shale of Permo-Carboniferous age. Shale outcrops on the western side in a cliff overlooking Mersey River, and on the eastern side near the boundary of M. Bourke's property. The seam dips at 6 to 7 degrees to the east of north, the regularity being interrupted by minor faults. A considerable amount of shale can be cheaply excavated in open-cuts, the remainder through adit-openings.

C.—Developments.

Except a few exploratory pits and shallow trenches no mining work of any kind has been performed on the property.

D.—Shale Reserve.

Oil shale occurs on 160 of the 500 acres, and has been definitely proved in the western part of the property. On the basis laid down it is estimated that the quantity available amounted to—

Be records of two bores, one on Life's	Tons.
Actual reserve	540,000
Probable reserve	420,000

E.—General Remarks.

The shale on this property can be worked to best advantage from the adit inclines of the Southern Cross Oil Refineries Company, one adit being just outside and coursing parallel to the western boundary. There is not sufficient shale to warrant the erection of costly distillation works, consequently it is suggested that the owners amalgamate their interests with their neighbour, the Southern Cross Oil Refineries Company.

(5)—The Adelaice Oil Exploration Company.

This company, formed expressly for the purpose of exploring areas likely to contain reservoirs of natural oil, has in its boring operations revealed the presence of the oil shale seam at Native Plain and the coal seam at Tarleton and Spreyton.

A.—Area, Situation, &c.

Native Plain lies 3 miles east of Railton and is bounded on the east by Long Hill. Mersey River meanders through the plain, and is now entrenched in its old bed. It represents the flood-plain of Mersey River, and parts of it are occasionally submerged after heavy rain. The plain is about 3000 acres in extent, but a small part only has been explored.

B.—The Shale Seam.

Near Hogg's bridge yellow fossiliferous beds overlying bluish fossiliferous mudstones are exposed in the road cutting. They dip at 5 to 6 degrees to the south-east, and represent the Upper Marine beds of the formation. The shale seam was not found below them, it having been removed by erosion. About 20 chains upstream the lower beds of the system are exposed in the cliff, showing that a fault passes between Kite's block and the bridge. This is proved by the records of two bones, one on Kite's and the other at Mersey River bridge.

Some years ago, in order to test the strata under Native Plain, three holes (Nos. 10, 9, and 6) were drilled from 78 to 133 feet in depth. The first is on Lot 1311, nearly 15 chains east of the river; the second on Lot 451, near the Merseylea cage, revealed the following succession:—

minumors and to semilent 4th	
Loam anied tibe and	2
Sand	7
Alluvium	91
Mudstone	
Sandstone	63
Total	133

The sandstone contained layers of calcareous mudstone with fenestella fossils. Pebbly sandstone was penetrated at the bottom of the hole.

Long Hill marks the course of a major fault which is clearly indicated by Lower Marine beds at surface. It is flanked with conglomerates, sandstones, and calcareous mudstones, and on the eastern side mudstones and conglomerates containing pebbles and boulders of granite and schist are exposed.

The Adelaide Exploration Company, in order to determine the nature of the strata underlying the plain, drilled five holes at intervals along the course of the dip. Details are given in the subjoined records, which show that the seam continues on an even dip to the south-east up to the foot of Long Hill. The shale seam lies at a great depth below the surface, and the material appears to be much thinner and poorer than it is at Latrobe. However, the drill core is not a fair representation of the thickness of the seam. The cores from these holes were broken and the material was not compact.

Bore No. 12 .- Adelaide Oil Exploration Company, No. 1.

Location: Mineral Lease 4777m, Railton, charted in name of F. D. Kite.

Altitude: 160 feet. In relew malestin beggaT

Remarks: Started below the shale bed.

1991		Feet.	
Nature of Rock.	From-	To-	Thick-
Loam and clay	0	14	14
Pebbly clay, yellow	14	60	46
Mudstone	60	120	60
Fossiliferous mudstone	120	230	110
Pebbly mudstone	230	255	25
Sandstone	255	268	13
Alternating beds of sandstone		anetebon	vldde
and fossiliferous mudstone	268	304	36
Sandstone	304	326	22
Mudstone	326	398	72
Pebbly mudstone	398	485	87
Quartzite	485	565	80
262 SAR SAR			Priorg.

iferouse a heal of water worn publics containing water under high puesaire was intersected. An attempt to stem the flow of the collar of the flow caused other cuttata to be formed in the adjacent country took. An address of

Bore No. 13 .- Adelaide Oil Exploration Company, No. 2.

Locality: Near and on south side of Hogg's Bridge, on the west bank of Mersey River, Native Plain.

Altitude: 120 feet.

Remarks: Tapped artesian water at base of the Permc-Carboniferous strata.

Feet.		Feet.	
Nature of Rock.	From—	То—	Thick-ness.
Soil and yellow clay	0	8	8
Mudstone, fossiliferous	8 700	160	152
Tasmanite oil shale	160	162.5	2.5
Mudstone	162.5	200	37.5
Pebbly mudstone, dark colour,			THE PERSON
tending to slate	200	210	10
Pebbly mudstone with some sand Mudstone, small bands of sand-	210	220	10
stone	220	230	10
Pebbly mudstone	230	258	28
Mudstone, hole making water	258	263	5
Water-worn pebbles, heavy water-		9	HERTERY.
pressure	263	268	5
Quartzite	268	294	26

At 263 feet—that is, at the base of the Permo-Carboniferous—a bed of water-worn pebbles containing water under high pressure was intersected. An attempt to stem the flow at the collar of the bore caused other outlets to be formed in the adjacent country-rock. An analysis of this water has not been made.

Bore No. 14.—Adelaide Oil Exploration Company, No. 3.

Locality: Native Plain, Mersey Valley.

P.cet.	F	'eet.	
Nature of Strata.	From-	То—	Thick-ness.
Clay	0	c	Colonia C
Clay	6	$\frac{6}{12}$	6
	12	52	453, 153, 153, 153, 153, 153, 153, 153, 1
Shingle and sand	52	56	40
	56	80	4
Mudstone, fewer pebbles, marine	90	00	24
fossils	80	105	25
Sandy mudstone	105	155	50
Mudstone and Pebbly mudstone	100	100	90
in alternating beds	155	300	145
Sandy mudstone	300	305	5
Sandy mudstone	305	307.75	2.7
Mudstone and pebbly mudstone	000	501 10	2 16
in alternating beds	307 - 75	392	84 - 25
Conglomerate	392	400	8
Pebbly mudstone, few fossils	400	420	20
Mudstone, dark and soft	420	424	4
Mudstone and pebbly mudstone	424	453	29
Mudstone, hard, slaty	453	462	9
Pebbly mudstone, loose	462	472	10
Soft mud and sand	472	484	12
Soft mud and sand	484	494	10
Pebbly mudstone, presence of	8117		10
quartzite	494	500	6
report mudstone, quartzite prom-	- 2 311112	Server Charles	37
inent	500	508 1	8
Quartzite	508	520	12

Bore No. 15.—Adelaide Oil Exploration Company, No. 4.

Locality: Native Plains, Mersey Valley.

team to the state of the state		Feet.	
Nature of Strata.	From-	То—	Thick- ness.
Quaternary—			
Clay and shingle	0	15	15
Permo-Carboniferous—	- MIRITA		
Sandy mudstone	15	47	32
Sandstone, grey	47	50	3
Coal	50	50.1	0.1
Sandy and dark mudstone,	Setagad 1		DOED IN
alternating beds	50:1	120	69 . 9
Sand, medium to coarse grain	1 135-15-4		Abanc
(no core)	120	128	8
Mudstone, soft (no core)	128	278	150
Sandy mudstone, marine fos-	· 10		Simple
sils	278	345	67
Pebbly mudstone, lime (?)	TO THE STATE OF	DRG U	and a
sediment	345	362	17
Mudstone, marine fossils	362	540	178
Sand and clay	540	550	10
Sand and clay Mudstone, occasional marine	3500 Aug		SUTSECT IN
fossils	550	596	46
Tasmanite (oil shale)	596	598.5	2.5
Pebbly mudstone	598.5	624	25.5
Sandy sediment, fine grain	624	634	10
Pebbly mudstone	634	667	33
Conglomerate	667	672	5
Pebbly mudstone	672	707	35
Sandy mudstone	707	716	9
Cambrian—		7 7 7 7 7	Juneant.
Dark mudstone, slaty	716	795	79
Pebbly mudstone, tending to			
quartzite	795	809	14
Quartzite	809	830	21

The occurrence of a 1-inch band of Permo-Carboniferous coal at 50 feet depth is interesting in that it does not correspond in position with the coal in adjacent areas.

Bore No. 27.—Adelaide Oil Exploration Company, No. 10.

Locality: Half a mile east of Merseylea Bridge. Altitude: 130 feet.

the shale seam outerens, but in	noidele a	Feet.	nerong B
Nature of Strata.	From—	To-	Thick-ness.
and an exposure is reported on		svilO n	or stilling
Recent—		sworth	
Soil and clay	0	9	9
River shingle	9	21	12
Permo-Carboniferous—			1
Fossiliferous mudstone	21	220	199
Sandy mudstone	220	442	222
Pebbly mudstone	442	460	18
Sandstone	460	480	20
Sandstone, coarse, white	480	552	72
Mudstone	552	672	120
Pebbly mudstone	672	750	78
Fossiliferous mudstone	750	830	80
Mudstone	830	913	83
Tasmanite (very poor qual-		tone, the	abrum to
ity)	913	916	3
Cambrian—	101-20		1
Conglomerate, quartz, angu-		OR HE WALL	2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
lar	916	945	29
he enterops of coal on the oppo-	and and the	sa issolo	20

C .- Quantity of Shale Available.

The data upon which this calculation is based were obtained by drilling in a south-easterly line across the plain. There is reason to believe that the shale extends over the greater part of the area, the northern end only heing barren. According to the log of the driller the thickness of the seam in the area is only 30 inches, and the quality is not equal to that exposed immediately to the west. The accuracy of the record is doubtful, as abrupt changes do not occur in other parts of the district. However, on the information available the following estimate is based:—

800-acre block	Actual Reserve. Tons. 3,000,000	Probable Reserve. Tons. 4,500,000
agre monthly are greated p a. Shale however, outcom	3,000,000	4,500,000

(6)—Sections West of Great Bend.

Between the North-Western Railway and the Great Bend of Mersey River is a large unexplored area of Permo-Carboniferous rock, the greater part of which appears to belong to the shale measure series. In the river-bed opposite the pumping station the shale seam outcrops, but in faulted relation to that in the Railton-Latrobe Company's lease nearby. Shale is cut in a shallow shaft on the east bank of the river, 30 chains farther south; an outcrop occurs on Oliver's farm; and an exposure is reported on J. C. Matthews' property.

The formation is completely intersected by a narrow dyke of diabase coursing through these properties into some shale lands on the east side of the river. On the southern side of the dyke a long tongue of basalt runs parallel to it, terminating at the river and reappearing a few chains farther on the east side. Evidently it occurs as a lava flow, as pre-Cambrian schist forms its base at the river crossing, although on the east side the formation is that

of an intrusive pipe.

Railton Road passes through a large, uninterrupted area of mudstone, the surface of which is strewn with quartzite pebbles representing the residue from the waste of that rock. How much of this area is shale-bearing is difficult of determination. The line of junction with the coal measures is close, as witness the outcrops of coal on the opposite side of the railway-line.

A.—Section 4823m, 79 Acres.

This section includes Matthews' land and part of Addison's 66-acre block. It is largely occupied by mudstone of the shale measures, but the dyke of diabase referred to passes through the southern quarter. Yellow fossiliferous claystone overlies the darker mudstone at the summit of the hill, and is well exposed in a cutting a few feet deep. A hole 18 feet deep was sunk many years ago in the soft mudstone member without result. The seam is not far below, and it is reported that its outcrop has been found farther down the hillside. It appears probable that the seam extends through the northern part of the section into Lease 4822m and westward across the Railton Road.

B.—Lease 4822m, 53 Acres.

Sandy and heavy river shingle occupy the greater part of the surface of this section. Shale, however, outcrops

in the bed of the river, and doubtless underlies the thin bed of shingle. Shale measure mudstones rise into the hill on the south-west side.

C.—Oliver's 50-acre Block.

Except a narrow strip on the east side basalt covers the Permo-Carboniferous on this property. A long strip of tasmanite resting on a bedrock of pre-Cambrian schist outcrops near the eastern boundary. The position of the shale in relation to the schist shows that this marks the edge of the basin. Many years ago blocks of shale were unearthed in the process of ploughing the fields, and later holes were sunk to the seam and its nature and thickness revealed. At this point the seam is over 100 feet above the outcrop in the river-bed, the relative heights being due to the intervention of a fault. If, as appears likely, the basalt cover is not deep, the shale seam probably extends westward through the property and southward into Wakeham and Riley's.

(7)—Sections South of Great Bend.

A.—Lease 3994m, 100 Acres.

The north-eastern corner is occupied by pre-Cambrian schist; the remaining portion by Permo-Carboniferous strata, evidently of the shale measure series.

B.—Lease 4792m, 199 Acres.

This section surrounds the Section 3994m on three sides. The north-east corner is occupied by schist, the south-west by Cambrian sandstone, and the intervening area by Permo-Carboniferous mudstone.

C.—Lease 4791m, 270 Acres.

On the western side the Permo-Carboniferous are bounded by Cambrian conglomerate; on the north-eastern they are intruded by diabase.

D.—Leases 4626m, 116 Acres; 2545m, 100 Acres; and 8954m, 100 Acres.

In these sections the Permo-Carboniferous strata are intruded by comparatively large bodies of diabase.

All the aforementioned sections are potential areas of shale country. They lie between Cambrian sandstone and pre-Cambrian schist with shale on the north and south ends. On the evidence available it is reasonable to assume that the seam is more or less continuous through them.

Shale Reserve.—Although outcrops of shale occur, insufficient data is available for calculation of the "actual" reserve. The probable reserve is based on the assumption that the seam extends over one-third of the area of upper mudstone, and that the seam is 4 feet in thickness.

Actual Reserve. Probable Reserve.

West of	Great	Bend	See arms	resit of	1,260,000
South of	Great	Bend	the set	tekur aid	1,296,000

(8)—Properties North of Hogg's Bridge.

Lot 2144, of 129 acres; Lot 2145, of 143 acres; Lot 2146, of 31 acres; Lot 2147, of 35 acres; Hogg's 48-acre block; and Bennett's 49-acre block are occupied by shale measure mudstone, which, however, in the lower ground is covered with river sands and shingle. These properties have not been explored, yet they are potential sources of shale. Assuming that shale occurs over half the area of these fields, the probable amount available is 1,305,000 tons.

Lease 8960m, 48 Acres-F. Richards.

This section, west and adjoining Lease 4777m, encloses shale measure mudstone between two low hills of Cambrian sandstone. North and adjoining is a Crown area of 62 acres, the eastern half of which is also occupied by the Permo-Carboniferous. These lands have not been explored.

(9)—MERSEYLEA AREA.

Merseylea field occupies the low level flood-plain of Mersey River and the high basalt crowned hills to the south-west. Very little rock of the shale measure series is exposed, but there is reason for the belief that it underlies the younger formations. No. 9 bore drilled on the east side of the bridge passed through sandstone and mudstone, and entered pebbly sandstone at 133 feet without intersecting the seam which, according to the log of No. 27 bore, lies at a considerable depth at this point. No

other exploratory works have been performed in this area, although the indications point to the continuance of the seam from Native Plain through Merseylea into the Kimberley area. On the assumption that the shale extends over one-third of the area of Permo-Carboniferous rock west of Long Hill, the "probable" reserve amounts to 4,500,000 tons.

Section 4777M, 242 Acres-F. D. Kite, Lessee.

Area, Situation, &c.—This property lies on the left bank of Mersey River between Native Plain and the southern block of Lease 6641m. It is connected by road to Railton station, from which it is only 1½ mile distant. The area of the lease is 242 acres.

The Shale Seam.—Except the south-west quarter the section is occupied by Permo-Carboniferous strata, but only a small part is shale-bearing. Apparently the fault at the south-east corner trends in a north-westerly direction through the property, and breaks the continuity of the seam, as it is not intersected by bore 12. It has been cut in several test holes in another part of the section, and apparently the shale there is of average quality and thickness.

Quantity of Shale Available.—The larger part of the section is barren of shale. The proved area is about 40 acres, and the probable shale area is 70 acres. On this basis the estimate of quantity is—

	Tons.
Actual reserve	200,000
Probable reserve	350,000

(10)—KIMBERLEY AREA.

The geological systems represented in this area are pre-Cambrian, Ordovician, Permo-Carboniferous, Tertiary,

and Quaternary.

The pre-Cambrian consist of white quartzite and mica schist west and north-west of the town. In the river-bed at the bridge quartzite beds strike N. 20° W., and dip north-east. Farther south, on the right bank of Mersey River, massive conglomerates stand out prominently and form the base of a basalt-covered hill. Mica schist is exposed in a road-cutting on the west side of the bridge. These strata underlie the oldest Palæozoic sediments.

Ordovician limestone underlies the township, as evinced by the thermal calcareous spring just off the main-road.

Permo-Carboniferous sediments occupy a large portion of Kimberley area. Doubtless the shale-measure mudstone of Native Plain passes without serious interruption westward under the basalt-covered hills and southward on the east side of the township. Along the road to Moltema, following the west bank of Coiler Rivulet, the upper mudstone member outcrops and is well exposed in the cuttings for a mile in length and nearly three-quarters of a mile in width. In a south-westerly direction it is covered with basalt; south-eastward it is interrupted by diabase. This is likely to prove one of the most important beds of shale in the district.

On the west side of the hill of quartzite and conglomerate, decayed pebbly marl, containing fossils of tenestella, outcrops on Murfet's farm and again on the other side of the river near E. F. Blyth's homestead. Underneath these beds sandstones and conglomerates, similar to those developed towards the base of the formation, appear at river-level. Pebbly mudstones and sandstones, containing fossil remains of spirifera and productus, occupy the hill south of Blyth's homestead, and appear to belong to the shale-measure series.

In the river, half a mile south-west of the township, are highly tilted beds of Tertiary lignite and lignitic clay. In them are found large blocks of well-preserved wood and lumps of resin. The tilted position of these beds is due to faulting.

Quantity of Shale Available.—As already remarked, there is every reason to believe that the shale seam continues southward from Coiler Rivulet, although no outcrops are known. How far the containing strata extend underneath the basalt it is impossible to determine by surface investigation. Between Kimberley and Moltema future exploration may reveal another important field, but it would be hazardous to attempt a guess at the quantity of shale likely to be found there. As there is every indication of the existence of the seam in the 450 acres of mudstone near Coiler Rivulet, an estimate of the probable reserve there appears justifiable. On the basis of a 3-foot seam the quantity is put at—

(11)—PARAMATTA AREA.

The Paramatta blocks, lately held under licence to search for oil shale by James Stewart and G. D. Meudell, are situated on the east side of the main ridge of schist and form the southern extension of the area just described. At the northern end of the area (Fossil Bank) the road-cutting exposes the yellow fossiliferous sandy mudstones that overlie the shale seam. South of Fossil Bank, near Deep Creek, two lines of bores "E" and "F" were drilled to prospect the flat country, and useful information was obtained. The record of "F" line of bores indicates that the shale belt is narrow and that the seam thins out in a short distance on the east and west sides. The evidence is not conclusive, however, and further attention is warlanted, especially in the eastern and southern quarters. Pebbles from the waste of the mudstone are strewn over a large area, but whether they were derived from the upper or the lower beds of mudstone is not known. Pebbles of schist and granite are common in the lower mudstone, but they are not prominent at surface in any part except the extreme southern end. The failure at No. 8 bore discouraged the explorers, and little further search was made.

No. of Bore.	Chain Peg.	Shale Cut at—	Thickness of Shale in Feet.	Depth of Hole in Feet.
ooly o	" E "	Line.	rilling, and	
21 11	5 15	nladle A ver	e in Jude Ar Is not <u>al</u> lietur	70 87
Tw _enr	"F"	Line.		atdade w
16 17 18 19 20	25 12 37 47 60		1 25 2 60 1 00	155 257 109 196 184

In line "E" another hole (No. 22) passed through a barren bed of mudstone and bottomed on pre-Cambrian schist.

A bore was drilled on the 160-acre block charted in the name of W. Winspear, and is on the west side of the old read. The log reads as follows:—

take by dames Sternet and C. T. Mendell,	Feet.
Sandstone	38
Pebbly sandstone with thin layers of con-	
glomerate	17
Conglomerate	12
Mudstone and clayey sandstone	11
	78
	18

These strata appear to belong to the lower division of the system. The bore lies nearly directly between two outcrops of the pre-Cambrian schist, not half a mile apart,

and evidently the bed-rock is not far below.

From Paramatta in a south-easterly direction along the route of the old road to Deloraine there is a very large area of Permo-Carboniferous country in which neither coal nor shale has yet been found. A few shallow pits have been sunk through the mudstone detritus to ascertain the nature of the upper beds, but aside from these sections few outcrops are available for examination. On the east side of Long Hill the surface rubble contains many boulders and pebbles of granite, indicative of the materials of the basal beds-this evidence, however, is not conclusive, and is not applicable to the country lying east of Paramatta, which is covered with quartzite pebbles similar to those shed from the upper mudstone. The indications are that the shale measures extend far beyond the small area proved by drilling, and by the use of the drill only can this larger adjoining area be thoroughly explored.

Quantity of Shale Available.—A very small area only has been proved to be shale-bearing, and it is impossible to speculate on its extension. The estimate of the "probable" quantity of shale is given, therefore, with hesitation.

	Tons.
Actual reserve	22,250
Probable reserve	

(12)—RUBICON AREA.

Rubicon River passes northerly through the eastern side of the district. Between the river and Long Hill the greater part of the surface is occupied by Tertiary sedi-

ments, but diabase in high hills is prominent, especially on the south side. Permo-Carboniferous strata, apparently without the coal or the shale member, underlie the Tertiary sediments. Outcrops are few, yet there are sufficient to indicate that the prospects are not favourable for oil shale. In some places the lower members, containing pebbles and boulders of schist and granite, appear at surface, and at no point were the upper members seen.

East of Rubicon River, in Dry's New Country, and near Frankford, the conditions are likewise unfavourable.

(13)—Раккнам Акеа.

Parkham differs little from Rubicon area. The southern part is occupied by Tertiary sediments, the eastern by diabase, and the western by Permo-Carboniferous sandstones, grits, and shales. In the flat country the basal member is marked by schist debris, and succeeding members are well displayed in adjacent hills.

The prospects are not encouraging either for shale or coal, treas-files nalromidl of hear will no hea surviving

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CHAPTER II.—BEULAH - QUAMBY FIELD.

(1)—Dunorlan Area.

This area is of interest only in occupying the country intervening Kimberley and Quamby Brook. It is almost wholly occupied by basalt, but the shale measures may underlie it. On the east side are Elizabeth Town and Parkham areas occupied by the coal-measure series and the intruding diabase. Coal has not been found there, however, but carbonaceous shale of no value has been observed interstratified with sandstone members. On the west side this abuts the Beulah area, from which it is separated geographically and geologically by Mersey River. The valley marks the course of a major fault bringing in juxtaposition the lower marine beds of the Permo-Carboniferous and the upper marine beds exposed at Beulah. On the east side of the river, near Dynan Bridge, a body of Silurian quartzite appears at the base of the Permo-Carboniferous, and on the road to Dunorlan settlement the lower fenestella sandstone member is cut on the roadside.

On the south-west side of Dunorlan township a hill of Silurian conglomerate and quartzite rises sharply from the basalt-covered plateau and forms the boundary of the shale measures in that direction. Underlying the basalt lava, in many parts, are beds of Tertiary strata with lignite

and brown coal.

(2)—DELORAINE AREA.

Meander River, which passes through Deloraine, is entrenched in its old flood-plain and flows easterly through the broad Tertiary plains of the Launceston basin. Immediately to the south and east basalt occupies the hilly country, thence occur Permo-Carboniferous mudstones, Ordovician limestone, igneous porphyroids, Cambrian conglomerates, and pre-Cambrian schists. Permo-Carboniferous mudstone, apparently of the shale-measure series, abuts Ordovician limestone, and is exposed in a long narrow strip in a small tributary of Meander River. Its extent underneath the basalt cannot be determined without the aid of the drill. This area should receive attention in the consideration of the development of the Quamby Brook deposit.

(3)—QUAMBY BROOK AREA.

The seam of tasmanite was discovered on A. Bakes' and J. F. Hennessey's properties about five years ago, and for some time attracted considerable attention. This occurrence is of particular interest in showing that the seam is very extensive, and in indicating that it may be found in the country intervening Quamby Brook and Railton. Outside the immediate vicinity of Quamby Brook and its tributary Eden Rivulet the shale-bearing member of the formation has not been found.

A .- Area, Situation, &c.

The proved oil shale lands at Quamby Brook are not extensive—about 50 acres—but there is a fairly large potential area. The field is south of Deloraine, 8 miles distant by road, and lies at the base of Western Tiers. The only means of access is by road; but a branch railway has been surveyed from Deloraine and preparation has been made to construct the line, particularly to serve the timber interests. The construction of a railway would greatly enhance the value of the deposits.

B.—The Shale Seam.

The seam is well exposed on A. Bakes' and J. F. Hennessey's properties. It is overlain by greyish fossiliferous mudstone which, on exposure, weathers to a yellow sandy clay. This bed is overlain by brownish-black mudstone very fossiliferous, and over 300 feet in thickness.

On Bakes' land the seam dips north 70 degrees west with the slope of the hill at an angle of five degrees. A large quantity could be removed by open-cutting, but the hill rises steeply to the south-east and inclined adits would be necessary as a means of excavating the shale. The seam appears to be from 2 feet 6 inches to 5 feet thick, not including the encased band of mudstone. On J. F. Hennessey's property adjoining, the seam is exposed in the bed of Quamby Brook at points 5 chains apart. It dips here in a north-easterly direction, the change being due to a fault which courses parallel and close to the stream. Shale is reported in the bed of Eden Rivulet about 20 chains above its confluence with Quamby Brook. Here, and along the road leading to the sawmill, buff-coloured upper marine mudstones occupy the surface. The shale seam probably lies within 100 feet depth at any point in

this part of the field, except under the diabase hill imme-

diately to the southward.

On Bernes' property west of the road leading to Great Lake is a bed of carbonaceous shale, 6 feet thick, dipping N. 30° W. at five degrees. The shale is rather thickly bedded, laminated, greyish-black in colour, and is flecked with white sericite-looking flakes. It burns with a smoky flame, producing considerable heat in the process. This shale belongs to the coal-measure series.

Southward towards Bluff River the strata belong to the

coal-measure members of the Permo-Carboniferous.

C.-Developments.

Exploratory works consist of a number of shallow pits sunk through the seam of shale. All the pits are on Bakes' property, except one on the bank of Eden Rivulet. The thorough exploration of the shale seam to determine its extent and quality has been postponed until the production stage has been reached at Latrobe.

D.—Quantity of Shale Available.

This estimate is based on the very small area proved to be shale-bearing by means of outcrops and mine openings. It is probable that the seam extends underneath the diabase mass to the east, and that it reappears up the valley of Eden Rivulet to the sawmill. The tonnage of shale in the several properties is estimated as follows:—

	Actual Reserve.	Probable Reserve. Tons.
Bakes' property	186,250	372,500
Hennessey's property	25,000	111,750
Eden Rivulet	21(3(44)) 31-21	558,750

(4)—Beulah Area.

Beulah field of oil shale was at one time called the Minnow field, but Minnow lies 3 miles to the south, and tasmanite is not found there. The occurrence of shale here has been known for many years, and attempts have been made from time to time to introduce capital for the development of the deposits. All the known shale lands were recently acquired by F. Richards, of Devonport, who has since granted options of mining to the Tasmanian

Cement Company operating at Railton. It is not likely that the deposit will receive attention until the reserve at Latrobe has been considerably depleted.

A .- Area, Situation, &c.

Beulah field occupies the narrow divide between Mersey and Minnow Rivers, and is nearly 1 mile wide and 2 miles long. The seam is reported as occurring in the bed of Mersey River, at the end of Magog Mountain, but the report is not regarded as authentic. Beulah lies 11 miles south of Railton and 5 miles west of Dunorlan, to which it is connected by good roads. The railway-station at Kimberley is 7 miles distant to the north-east.

B .- The Shale Bed.

Shale is exposed in a small cutting on the north bank of the road leading to Dunorlan. The upper layers are weathered yellowish-brown, but a few feet lower it is greenish-grey. The thickness of the seam is not known, as it has not been completely intersected. It dips to the east of north at a fairly low angle. On the south side of the road the seam is exposed again in a small creek that crosses the road to the south-east. This is the only known exposure in the area, but the greater part of the country marked Permo-Carboniferous on the geological map is likely to prove shale-bearing.

Porphyrites of several varities—in some places schistose—occupies the surface at Beulah township and the Minnow area to the southward, and forms the base of Magog Mountain. Resting on that formation are sandstones and conglomerates of Silurian age. The Permo-Carboniferous were laid down in embayments in these formations. They were intruded by diabase, and in parts were covered

by basalt lava.

C.—Quantity of Shale Available.

If the seam extends over the whole area of Permo-Carboniferous country, which appears to be geologically on the shale horizon, the quantity is fairly large. The following is the estimated tonnage of shale available:—

	sand we	sfect :				Tons.
Actual	reserve	h.10.	 	1	 	387,400
Probab	le reser	ve	 		 	1,490,000

CHAPTER III.—NOOK FIELD.

(1)-NOOK AREA.

All the earlier known oil shale lands of this area are owned or leased by F. Richards, of Devonport, who has recently arranged for their exploitation by the Tasmanian Cement Company operating at Railton. In addition to the deposits of ordinary shale occurring in the central part of this field, a thick seam of carbonaceous shale occurs at the northern end of Bott Gorge. This shale is of particular interest, in marking the transition stage between coal and tasmanite. A seam of coal occurs on both sides of the shale outcrop in the central part, and northward several pits have been opened and a larger quantity of coal has been removed. Coal occurs also on the south-west side of Bott Gorge and in the bed of Don River.

The Permo-Carboniferous formation occupies valleys in Silurian conglomerate and sandstone. It is covered in large part by Tertiary sandstones and basaltic lava. Sandstones and clays crowded with fossil flora of Tertiary age are exposed on Wilson's farm in the banks of the Don River. Basalt vents, through which the lava flowed that submerged the valleys, are found along the western edge

of Badger Range.

At New Bed, on the opposite side of Badger Range, where the conditions appear perfectly suitable for shale, coal is found; but shale may occur close to the fringe of the range.

A.—The Shale Seam.

In the bed of a creek traversing Lot 10,237 the seam of high-quality shale is exposed. It is 4 feet in thickness, and dips at an angle of 5 degrees to the north-east. Apparently the creek marks the line of a fault which is again plainly discernible towards Bott Gorge. On the west side of the creek the seam has been cut in a number of shallow pits and trenches, and extends nearly as far as the main-road; on the east side the shale-measure mudstones continue to the edge of Badger Range, where they abut Ordovician slates of the porphyroid series.

Southward the mudstones pass below basalt lava, and probably extend along the edge of the range a mile or more. This line of country should be tested by drilling

through the basalt into the underlying Permo-Carloniferous strata. It is possible, although unlikely, that the shale occurs at the northern end of Badger Range and along its eastern flank. The seam in Don River, at the end of the Gorge, is in two bands 3 to 4 feet thick, separated by sandstone. It is faulted at this point, and its extension on either side of the river cannot be traced, because the beds are covered with basalt. This shale is not of high grade, but it may prove of commercial importance worked in conjunction with the richer shale of the central part of the field.

B .- Quantity of Shale Available.

The seam undoubtedly extends over 110 acres, and probably will be found over an additional 470 acres, not including the area of carbonaceous shale exposed in Don River. The best guide to its possible continuity is the contour of the valleys in the older formations. Inlets of the Palæozoic sea were probably long and irregular in outline. This can be determined accurately by drilling. The seam may fringe the northern end of Badger Range.

The following estimate is based on the information at hand:—

	Lons.
Actual reserve	260,000
Probable reserve	3,620,000

(2)—Melrose Area.

Tasmanite has not been found at Melrose, nor is it likely, except at the south-east corner. Coal, however, has been exposed at many points, and several pits and other mine openings have been cut into the seam. In the neighbourhood of Denny Gorge, where shale might have been expected, coal has been found. Between that point and Kelcie's Tier mudstone similar to the shale measures occurs, but has not been tested. Apparently, however, there is an unbroken belt of coal country between the Don and Mersey Rivers. South of Buster-road, on the west side of Don River, is an area which, from indications at surface, should prove to be occupied by the shale measures.

The western side of the area is occupied by older formations. Paloona Hill is crowned with Silurian conglomerate and sandstone, and is flanked on the east side

with Ordovician limestone, slate, and grit. In the centre limestone hillocks (where are the Broken Hill Proprietary Company's quarries) protrude through basalt and river alluvium; and highly-tilted slates stand out prominently in Don Valley west of Kelcie's Tier, and are fringed with coal measures.

extension on either with it the river cannot be traced, because the Bots are correred with baselt. This shale is not of high graff, but it may prove of commercial importance worked in the first our prove of commercial importance worked in the first with the richer shale of the first

2 - Danwetty of Shale Ardillible:

The seem wedge brills estands over 110 arres and probably will be during over up additional 4.10 arres not importing the area of cartengeness study exposed in 10on Birm. The tree quite to its possible continuity is the excitant of the valleys in the other farmations. Insist of the Palescoir was very trabable long and tregular in outline. This can be distributed assumately by drilling. The seam may friend the conference of the Badger Range. The following streets is based on the information at

ARA SHIRE AREA.

Townsenite how not fince found at Melcoso, nor is it finely except at diet anniherest corner (lost, however, lost been exposed at many maints, and several pris and of he have exposed prise and expensively exposed at limits former, where shade estable between the finely exported, coal has been found. Hetween that there and howies Tier mudstone similar to the characterist meaning occase for has not been tested. Apparently, however, there is an untracken belt of coal country between the homeour, and Mersey Rivers, found to deal country between the west and Mersey River, is an area which, from indications at surface, should prove to be occupied by the shade measures at the western aide of the area is exequited by olds; former those. Paleons Hill is exposed with Silversa. continues. Paleons Hill is exposed with Silversa. continues.

The Search for Petroleum.

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Sassafras Area.

A.—Introduction.

Oil-producing shales and coals have been known in the district for 60 years, but the possibility of finding natural oil there had not been seriously considered until recent time. During the period of the war the late W. H. Twelvetrees, in an official circular entitled "The Search for Petroleum in Tasmania," referred to the occurrence of oil shales and their possible association with hidden stores of natural oil. The Permo-Carboniferous beds have since been carefully explored by aid of the diamond-drill.

Early last year the Mersey Valley Oil Company and the Adelaide Oil Exploration Company, after fruitless drilling in Mersey Valley, transferred their plants to Sassafras, where operations were resumed. Four holes have since been drilled through the deep mantle of basalt lava and ash into the underlying Tertiary sediments, and valuable information has been obtained regarding the nature, thickness, and structure of the beds.

B.—Situation.

Sassafras lies between Mersey and Rubicon Rivers, and extends from the sea-coast to Diabase Hill, 10 miles to the south. These streams form the geological boundaries also, for they limit the east and west extensions of the Tertiary sediments, and the basalt pipes and lava sheets that intrude and overlie them.

C .- Geologic Relations.

From the sea basalt-covered hills rise to a height of 550 feet near the southern extremity of the area. Beyond

Wesley Vale and Northdown the lava extends far out to sea; eastward, Quaternary gravels and sands and Tertiary clays and sandstones occupy the lowlands. In places conical hillocks of basalt stand out prominently above the general level, and represent small lava vents.

Protruding here and there through the sediments and lava are bodies of Cretaceous diabase. These bodies are parts of very much larger masses around and over which the later formations were laid down. In the neighbourhood of Rubicon Bridge, sandstones, shales, and mudstones of Permo-Carboniferous age are exposed. Northward graphitic and quartz schists are found unconformably overlain by Cambrian quartzites, and, near the coast, by their Quaternary beds.

The following records of bore-holes contain information relating to the nature and order of succession of the Tertiary beds:—

Bore No. 29-Adelaide Oil Exploration Company, No. 8.

Locality: North-west corner of Iles' Farm, near Harford.

Altitude: 140 feet above sea-level.

Remarks: Bore discontinued at 1100 feet owing to inrush of sand.

ere, reguined. Four heles have		Feet.			
Nature of Rock.	From-	To-	Thick ness.		
Clay and ironstone	0	26	26		
Basalt, massive and vesicular bands	26	386 408	360 22		
Volcanic ash		415	7		
Lignitic clay containing numerous plant impressions	da less s				
and remains		1004	589		
Bituminous lignite Brown lignitic clay, thin	1004	1005	1		
bands of sandstone	1005	1100	95		
Quartz sand		100	V		
Quartz sand	ire-lineed	line i	ndii		

Bore No. 30 .- Adelaide Oil Exploration Company, No. 9.

Locality: On Burgess' Farm, near Harford. Elevation: About 300 feet above sea-level.

	Feet.			
Nature of Rock.	From	To-	Thick-ness.	
Quaternary—			- continue	
Clay and loam	0	12	12	
Clay, yellow	12	53	41	
Sandstone, soft	53	59	6	
Clay, blue	59	60	1	
Tertiary—		intern		
Basalt, containing zeolite and		plantin at	fall von	
aragonite in alternate	00		100	
massive and vesicular beds	60	552	492	
Lignitic clay, brown	552	1007	455	
Lignite	1007 1008	1008	1	
Clay and gravel		1010	2	
Clay and sandy blue clay	1010	1080	70	
Yellow sediment (no core)	1080	1110	30	
Cretaceous-	1110	1122	10	
Diabase, decomposed, blue Diabase, massive	1122	1165	12	
Diabase, massive	1122	1100	43	

Bore No. 28. - Mersey Valley Oil Company, No. 8.

Location: The Hermitage, Sassafras.

Remarks: The 10-inch well drilled for natural oil.

		4		Feet.			
-alight?? Lies o	Nature	of Strata.		From-	То—	Thic ness.	
Basalt				0	16	16	
Basalt			 	16	23	7	
Broken	basalt .			23	24	1	
Basalt			 	24	40	16	
Sand, b	rown		 	40	51	11	
Conglor	nerate .			51	54	3	
Clay, b	lue, stick	у		54	75	21	
Mudsto	ne			75	87	12	
Clay, b	lue, stick	cy		87	124	37	
Mudsto	ne			124	135	11	
Clay, s	ticky			135	170	35	
Mudsto	ne			170	185	15	
Clay, st	ticky			185	303	118	
Sandsto	ne			303	304	1	
Clay				304	320	16	
Sand, b	rown			320	330	10	
Clay			 -	330	355	25	
		dy		355	409	54	
Sandsto	one			409	410	1	
Clay				410	414	4	
				414	415	1	
Clay, g	reen, stic	ky	 	415	431	16	
Sandsto	one			431	432	1	
Diabase	e, hard,	greyish-blue		432	670	238	

Bore No. 31.—Mersey Valley Oil Company, No. 9. Location: On Guy Parsons' property, Sassafras.

Company is about to commence	Feet.			
Nature of Strata.		То-	Thick-ness.	
Clay, yellow	at di bya	28	28	
	28	34	6	
Clay and gravel	34	60	26	
Basalt, broken	60	379	319	
Mudstone and lignitic clay	379		19	
Gravel and quartzite boulders	398	408	10	
Clay and mudstone	408	419	11	
Mudstone	419	524	105	
Sandy mudstone	524	614	90	
Lignitic clay	614	620	6	
Sandy mudstone	620	854	234	
Mudstone	854	949	95	
Sandy mudstone	949	981	32	
Sandy mudstone and carbonaceous matter	981	1015	34	
bands Sandy mudstone and carbonaceous	1015	1073	58	
matter	1073	1092	19	
Clay, green, carbonaceous	1092	1152	60	
Diabase	1152	1160	8	

If the geographic features could be regarded as the surface expression of the geologic structure the interpretation would be simple. Post-Tertiary erosion, however, has left its impress on the land, and has greatly modified the original configuration. In the consideration of structure, therefore, existing features are not necessarily indicative of the true form.

Where the strata have been exposed in cutting on the road to Harford the angle of dip is north-easterly at 3 to 5 degrees. Unfortunately, no other section of these partially consolidated sediments is available for examination. Using the band of lignite near the base of the lignitic clay bed as a datum it is found, according to the records of Nos. 8 and 9 bores of the Adelaide Oil Exploration Company, that the northward dip is at the rate of 150 feet per mile.

Tertiary sedimentation proceeded without interruption on a gradually subsiding land surface until the advent of the great eruption of basalt at the close of the period; there was, therefore, no erosion interval between the arrest

of sedimentation and the extrusion of basalt.

The Mersey Valley Oil Company is about to commence drilling on Thomas' property, near the sea-coast. This site is nearly 3 miles northward of the last bore, and in a larger area of Tertiary sediments. As the general pitch is northward it is expected that the lower beds will be intersected, and possibly the junction will be found between the marine and terrestrial members.

Outside of the small area fringing the coast near this point there is no possibility of finding natural oil in commercial quantity. The Port Sorell area is barren, and so

are Burgess', Thirlstane, Harford, and Moriarty.

The first essential conditions for the accumulation of natural oil are present, but the natural conditions for the formation of oil do not exist in the areas mentioned. Possible sources lie northward, perhaps further northward than the site of the hole now being drilled.

the geographic features could be rightled as the surre expression of the geologic after ture the interpretation rould be simple. First farther erreton, however, has left a impress on the local and has greatly modified the orignal configuration. In the consideration of structure, herefore, existing features are not necessarily indicative of the true form.

Where the strate have been exposed in outling on the road to Harford the angle of dip is morth-eastedly at 3 to degrees. Unfortunately, no other stripen of these parally consolidated sediments is available for estamination. Using the band of lignine near the base of the lignine clay bed as a datum it is found, according to the founds of Nex S and S bores of the Adelaide Oil Replementing Company, that the northward dip is at the gate of 100 feet per pany, that the northward dip is at the gate of 100 feet per

PART V.

The Coal Fields.

CHAPTER I.—THE MERSEY COAL MEASURES.

Associated with the tasmanite marine series of the Fermo-Carboniferous are the freshwater and land beds containing the Mersey seam of coal. These land beds are intercalated between the Lower and Upper Marine, and are considered as belonging to the Greta horizon of New South Wales. Tasmanite probably occupies that position in the continuous Marine series corresponding to the horizon of the coal measures which intervene the Upper and Lower Marine. It is significant that only one seam of tasmanite and only one seam of coal is known.

Coal-bearing strata extend over 20,000 acres, and, probably, one-fifth of the coal contained therein can be profitably mined. Since the discovery of coal in this district in 1850 one or two mines have been in almost continuous operation. The first of these was that owned by the Mersey Coal Company, which, with varying fortune, was a regular producer for a number of years. In 1861 the Alfred and Don Collieries only were in operation, the Denison and Sherwood mines, together with those of the Mersey Company, having been abandoned. As time went on new mines were opened, and they, in turn, after a short and chequered career, were closed. The Spreyton and Illamatha mines at Tarleton are being worked intermittently to supply coal for local requirements. A new mine is being opened in the Dulverton field by the Mersey Valley Oil Company. In Redwater Creek, a tributary of the Mersey, the seam outcrops at intervals of several hundred yards, and dips to the north-east. It is exposed again in Nook area between two outcrops of tasmanite.

The seam varies from 18 to 30 inches in thickness.

A .- Quality of the Coal.

The coal finds a ready sale at Latrobe and neighbourhood, and sufficient is produced to supply local requirements. It emits great heat and burns quietly in an open hearth. For domestic use the high proportion of pyrite is a disadvantage, but in other respects it is a valuable fuel. The nature and composition of the coal are given in the tables of analyses hereunder:—

Nature-Humic kerogenite.

Composition-

- Carrierora			
Proximate analysis:	Per Cent.		Per Cent.
Moisture	13.58	1 21	6.70
Volatile matter			35.92
Fixed carbon		liund 7	42.68
Ash		outs :	9.90
Sulphur	4.39	intela	4.80
Ultimate analysis:			Per Cent.
Sulphur		HireS.	4.39
Sulphur Hydrogen	12	moth	6.83
Carbon		0.01.9	65.02
Oxygen		199	18.05
Nitrogen	• • • • • • • • • • • • • • • • • • • •	Bearn	0.87
Heat values—			
Calories		7	6,142
British thermal units	east to man	1-9/10	11,056
Evaporative power	13 690 (2)	GUILLIA	11.43
Specific gravity—1.31.	g'ows to en		
DOMESTIC TRUE STATE OF THE OWN THE PROPERTY OF THE			

B.—The Permo-Carboniferous Section.

The following records of the bores contain details of the strata and the position of the coal seam:—

Section at Don Coal Shaft.

a see they re turn, after a short	Feet.			
Nature of Strata.	From -	то-	Thick- ness.	
Clay student a starril mountain	0	30	30	
Gravel	30	33	3	
Sandstone	33	36	3	
of marine fossils	36	57	21	
Grey sandstone with streaks of carbonaceous matter	57	84.5	27 5	
Black clod	84.5	89 · 5	5	
Shales with impressions of glossop- teris, gangamopteris, and næg-	great is p		.kinen	
gerathiopsis	89 . 5	90.0	0.5	
Shales	90.0	90.3	0.8	
Coal	90.3	92.0	1.7	
Fireclay	92.0	93.0	1.0	

Bore No. 16.—Adelaide Oil Exploration Company, No. 5.

Locality: Cameron's Land, Sherwood, near Latrobe.

Altitude: Thirty feet above sea-level.

Remarks: Coal outcrops immediately above collar of hole.

	1	Feet.			
Nature of Strata.	From-	To-	Thick-ness.		
Gravel and clay	0	16	16		
	16	18	2		
Clay, brown	10	10	4		
Permo-Carboniferous—	18	26	8		
Sandstone, coarse (no core) Mudstone, fine and even-	10	40	0		
	26	114	88		
grained	114	116	2		
Sandstone, hard, even-grained	116	250	134		
Mudstone, marine fossils	250	275	25		
Pebbly mudstone	250	210	40		
Sandy mudstone, marine fos-	275	457	182		
sils	457	480			
Pebbly mudstone	70 70 100		23		
Carbonaceous sandstone	480	486	6		
Mudstone, grey	486	494	8		
	494	557	00		
Conglomerate, quartz	557	566	63		
Sandstone, grey	2000		9		
Conglomerate	566	594	28		
Sandstone, brown	594	601	7		
Conglomerate	601	610	9		
Pre-Cambrian—	17				
Schist, heliotrope, slightly	010	204			
micaceous	610	631	21		

Bore No. 17.—Adelaide Oil Exptoration Company, No. 6.

Locality: Hugh Smith's Orchard, Spreyton.

Altitude: Forty feet above sea-level.

Remarks: Tapped artesian water between 425 and 437 feet.

	-oT -mings	Feet.			
	Nature of Strata.	From-	To—	Thick-ness.	
4	ASS. ASS.	1 1 1 N		W .752	
	-Carboniferous—			100 M	
Lo	am and sand	0	35	35	
Sa	ndy clay	35	40	5	
	caceous sandstone	40	54	14	
Mı	adstone, marine fossils	54	138	84	
	ndstone, arenaceous mud-	med serve		the fibre	
	stone, and thin bands of coal	138	160	22	
	al	160	162.5	2.5	
So	ndy mudstone, scaly bands	100	102 0		
		162.5	200	37 -	
3.5	of coal	Control of the Contro	100 m - 100 cm - 100	1	
	adstone, occasional fossils	200	416	216	
	ndy sediment	416	430	14	
Cambr				MATERIAL IN	
Co	arse grit, traces of quartz-	AND THE PARTY OF		300	
Marie 1	ite	430	438	8	
	artzite	438	464	26	

micachana ...

Bore No. 18.—Adelaide Oil Exploration Company, No. 7.

Locality: Near Allison's Coal Mine, Bott's Road, Tarleton

	Feet.			
Nature of Strata.	From—	To-	Thick-ness.	
Clay	0	17	17	
Fossiliferous mudstone Pebbly mudstone Mudstone Pebbly mudstone Fossiliferous mudstone Grey sandstone Cambrian	17 224 228 241 252 290	224 228 241 252 290 296	207 4 13 11 38 6	
Quartzite (fragmentary, no core)	296 302	302 332	6 30	

Bore No. 2.

Locality: Tarleton.

Remarks: Drilled by T. Hainsworth for Mines Department in 1884.

Peet	Feet.			
Nature of Strata.	From-	То—	Thick- ness.	
Terrestrial deposits—				
Clay	0	15	15	
Sandstone	15	48.75	33 . 75	
	48.75	51.75	3	
Shale	51 . 75	56.75	5	
Coal	56.75	58.25	1.5	
Sandstone	58 . 25	94 . 75	36.5	
Conglomerate	94.75	96.75	2.0	
Dark sandstone	96.75	102.25	6.5	
Shale	102 . 25	104:25	2.0	
Sandstone	104 - 25	106.25	2.0	
Shale	106 - 25	111.25	5.0	
Marl	111 . 25	143.5	32.25	
Sandstone	143.5	145.5	2.0	
Pebbly Marl	145.5	154.0	8.5	
Pebbly marl with thin veins				
of carbonaceous matter at	12			
175 and 182 feet	154.0	186.5	32.5	
Pebbly marl with sandstone			02 0	
showing carbonaceous mat-	Tr. Carrier			
ter at 263 feet	186.5	263 . 75	77 . 25	
Marine beds—		10.00		
Pebbly sandstone with marine				
shells	263 . 75	284 . 50	20.75	
Conglomerate with marine				
shells	284.5	320.5	36.0	
Conglomerate and sandstone			- 0	
with marine shells	320.5	351 . 25	30.9	
Conglomerate	351 . 25	369.0	17.75	
Ordovician (?) limestone	369 - 0	399 - 5	30.5	

Bore No. 32.—Adelaide Oil Exploration Company, No. 11.

Locality: Watling's Property, Spreyton; 1 mile south of Victoria Bridge, west bank of Mersey River.

Altitude: Ten feet above sea-level.

the beds is northward, at angles, drees, and in one place 12 degrees.	Feet.			
Nature of Strata.	From-	То-	Thick-ness.	
	RAIRSTA			
Clay and sandy silt	0	34	34	
Shingle		48	14	
Permo-Carboniferous—	87 000			
Fossiliferous mudstone	48	255	207	
Mudstone	255	265	10	
Mudstone	265	302	37	
Fossiliferous mudstone	302	323	21	
Mud, soft	323	348	25	
Sandstone, soft, grey	348	352	4	
Sandstone	352	398	46	
Mudstone	398	500	102	
Sandy mudstone	500	600	100	
Sand (lime cemented)	600	620	20	
Ordovician—	E 200 To		10.7	
Crystalline limestone	620	720	100	
Limestone (fragments, no	or other			
core)	720	780	60	
Slate (no core)	780	950	170	
Slate, grey, schistose (no	The state of the s	11		
core)	950	985	35	

C.—Structure.

Normal faults of small throw are very numerous, and limit the mines to small areas. Major faults are common also, and are generally axial in direction. The general dip is northerly, varying from a few degrees east to an equal amount west of north, at angles of inclination from 5 to 15 degrees. Local changes in direction and degree of dip occur in proximity to intrusions of diabase. The intricate dislocation of the beds containing the seam of coal is indicated in the records of the several holes drilled at different periods of development.

CHAPTER II.—ARTESIAN WATER.

On Hugh Smith's land at Spreyton a hole was drilled for coal through Permo-Carboniferous strata to Cambrian quartzite. At a depth of 160 feet a 2-foot seam of coal was cut, and at 420 feet the artesian bed was penetrated. The succession of strata is given in the log records of bores 17 and 13. The dip of the beds is northward, at angles varying from 7 to 10 degrees, and in one place 12 degrees. Porous beds, consisting of rounded grains the size of peas and an under-stratum of angular quartz grains overlain by impervious mudstone and resting on quartzite, provide the channel for the artesian water. Although the even-grained material does not make core and arrives at the surface in detached particles, the hole does not cave at the place of intersection. Bore 18, nearly a mile to the south, did not reveal this bed; but it is reported that, in boring from the bottom of a coalpit a little to the west of Spreyon station, artesian water was tapped at 760 feet from the surface.

The water issues from the hole on Smith's property at a temperature of 69° Fahr., under pressure of 72 pounds per square inch, and flows at the rate of 360 gallons per minute.

An analysis of the water shows the following mineral content:—

Grains per Gallon.

	 22.000	To the second
Total solids	 	21.84
Sodium chloride (common salt)	 .0.	2.77
Sodium sulphate	 	0.89
Sodium carbonate	 	1.10
Calcium carbonate		
Magnesium carbonate	 	3.36
Ferric oxide and alumina		
Organic and volatile matter	 	0.86

It is reported that one Ball, manager for one of the early mining companies, cut artesian water at a depth of 128 feet in a shaft on Jowett's property at the northern end of Brown Mountain. This has become a permanent spring, in which the flow has not diminished nor varied from season to season.

The information disclosed in these bores shows that the Permo-Carboniferous strata are inclined to the northward, and that the artesian water is contained in the basal bed which rests on a platform of Early Palæozoic and Proterozoic rocks.

CHAPTER III.—GYPSUM DEPOSIT.

On Flemingham's property, 10 miles along Deloraine Road from Latrobe, a deposit of gypsum was recently discovered. The deposit occupies a broad flat valley through which meanders a tributary of Deep Creek. Gypsum in clear crystals from ½ to 2 inches in length is found irregularly distributed through bluish-grey clay, the residual product after the dissolution of the lime constituent of the original argillaceous limestone. Evidently the limestone from which it was derived belongs to the Permo-Carboniferous formation and not to the Ordovician, as the firstmentioned occurs in the hills nearby. The deposit was formed by solutions that dissolved the lime from these or possibly from underlying beds, and precipitated the calcium sulphate in the swamps as gypsum in clay.

Å number of auger-holes were drilled into the deposit to ascertain its value. The test showed that the distribution of the gypsum and the gypsite (an impure unconsolidated mixture of gypsum and clay) was very irregular

and not in sufficient quantity to prove of value.

A. McINTOSH REID,

Government Geologist.

20th August, 1924.





