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The Search for Petroleum in Tasmania

BY

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FOREWORD.

THE present-day supply of crude petroleum for the production of fuel, illuminating, and industrial oils is a question which is absorbing the attention of all civilised Governments, and no Government is more vitally interested in it than our young and growing Commonwealth. Evidence furnished by geology and experience alike points to the gradual falling-off in output, and the eventual exhaustion, of oil-fields which are at present being actively operated in so many parts of the world.

Although it has happily been demonstrated that petroliferous beds are much more widely distributed than was generally anticipated some years ago, and new fields are coming into development, the fact must not be lost sight of that the stores of oil now being so feverishly drawn upon are not inexhaustible, and that, strictly speaking, each field is passing through only a transitory phase of existence as an oil-producer. From the current literature on the subject one gathers that the world's annual consumption of petroleum has reached a total of nearly 50,000,000 tons, and that the economic life of an oil-field is probably not more than 50 years.

Outside Papua, no field yielding native oil as an economic proposition has yet been discovered within the territory of the Commonwealth of Australia, but strong hopes are cherished that somewhere the desired material may be disclosed.

Under these circumstances it will be readily seen how incumbent it is on a State department charged with the care of national mineral resources to take all possible steps to disseminate information likely to be of use in guiding the search for any indications of deposits. With this aim in view the accompanying information, gathered from all available sources, is published as a sober and helpful review of the facts bearing on potentialities in Tasmania. The Geological Survey has already reported on the Tasmanite shale of the Mersey and the oil shales at Preolenna. The present publication has reference exclusively to the search for native or rock oil.

W. H. WALLACE,
Secretary for Mines.

Hobart, 22nd October, 1917.

The Search for Petroleum in Tasmania.

Introduction.

Stray lumps of bitumen on the Tasmanian coasts attracted attention a good many years ago, and sundry attempts were made to locate their source. Mr. Chas. Gould, Government Geologist, recorded their occurrence on Prime Seal Island (Hummock Island) in the Straits in 1871; and Mr. T. B. Moore discovered some of these petroleum residues on the West Coast, north and south of Sandy Cape, in 1876. He subsequently found pieces of the same material in Macquarie Harbour (near Farm Cove), near Point Hibbs, and at the mouth of the Mainwaring River. The Point Hibbs occurrences have been described by Mr. Loftus Hills in Geological Survey Bulletin No. 18, and all the known finds in Tasmania have been mentioned by the writer in Bulletin No. 24.

In the nineties a prolonged investigation was made in Macquarie Harbour and on Hummock Island by a visiting explorer from Sydney, who had been attracted to the search by a specimen from Macquarie Harbour which had come into his possession. The search for a place of origin was, however, a fruitless one.

In 1914 some interest was created by discoveries of this substance which had been made from time to time on the South Coast (New River, Rocky Boat Harbour, &c.), and a syndicate was formed to prospect the localities. A Geological Survey examination of the district was made, but the conclusion arrived at was that the pieces had been stranded by ocean currents on the beaches on which they were found, and that they furnished no evidence of local petroleum deposits. About that time some rather extensive discoveries were made of fragments of bitumen at the mouths of creeks in Port Davey harbour. There ensued an unsuccessful search for their source in that neighbourhood. There is a small development of Tertiary lignitic beds along the shores of the harbour, but the Pre-Cambrian schists and quartzites predominate overwhelmingly, and these are in the highest degree unfavourable for oil deposits. At the

termination of the exploratory work at Port Davey a search was initiated in Permo-Carboniferous beds on Bruny Island, where alleged exudations had been reported. The drilling trial there ceased this year without completing the proposed programme owing to an insufficiency of capital.

Thus, prospecting for native oil in Tasmania has not yet been successful. As far as the asphaltum occurrences are concerned, failure has been owing to a misinterpretation of the data. It not rarely happens that prospectors and other intelligent observers, either by accident or assiduous search, bring to light some signs or indications of oil, past or present, but fail to recognise the true inwardness and bearing of the facts. The geological structure of the ground, which should govern all tests, is unhappily only discovered after an expenditure unpleasant to all concerned. Although the elucidation of the stratigraphy is often difficult, and the geologist can more frequently announce where oil will not be found than say definitely where it exists, it must be remembered that in the early days of petroleum-winning the geologists established the intimate connection between oil reservoirs and crustal folds, and laid the foundations of all intelligent and successful modern drilling.

In Tasmania unequivocal indications of any native oil accumulations are so far not apparent, but it is safe to lay down as a postulate that any well-considered scheme for prospecting must be based upon, firstly, signs and evidences at surface; and, secondly, geologically correct drilling.

Nature and Origin.

Petroleum is a complex mixed series of numerous hydrocarbons, consisting of various proportions of hydrogen and carbon, with frequently associated nitrogen and sulphur. The crude oil as it flows from wells is of a dark-brown colour, occasionally, however, light-yellow. As is well known, its specific gravity is lower than that of water, ranging generally from ·8 to ·9 (water = 1).

On the subject of the origin of petroleum there has been considerable diversity of opinion. It is unnecessary here to discuss the arguments which have been advanced on one side or the other in the controversy of inorganic versus organic origin. The consensus of opinion is in favour of its derivation from organic sources, and attributes to it a dual origin, *i.e.*, from the remains of both animals and plants. Its intimate association with lignites and aquatic plants on

the one hand and animal remains on the other makes it impossible to appeal to either as exclusive factors in its genesis.

The Relationship of Oil-fields to Structural Geology.

Structural geology plays a great rôle in the search for petroleum. It may be said without fear of contradiction that every oil-field is connected with some type or other of earth-folding. If oil lies distributed in a porous horizontal bed, it will not accumulate at any one point in sufficient quantity to make its exploitation remunerative. The arched structure, in which the beds are thrown into anticlinal and synclinal folds, is the one that is the most favourable for the rise of the oil and gas on the slopes of the anticlines.(1) The water, oil, and gas take up their positions in accordance with their different densities; the gas, which is always present with petroleum, and which exercises such propulsive force in the oil-wells, occupies the crests of the folds, the oil a little below the crests, and the water usually in the troughs. This is the ideal sequence of positions, though there are some exceptions. Monoclines and terraces with a slope in one direction only also form oil-reservoirs.

This association of well-known geological features with accumulations of oil results in a good deal of attention being paid by oil-seekers to the folds of the stratified rocks when a start is made to test a field in which indications of oil are present.

The normal sequence of events in an oil region seems to be as follows:—

Primarily the animal or vegetable matter which passed through its usual stages of decomposition under pressure of overlying beds underwent under ill-understood conditions the process of distillation. The oil accumulated in porous rock, which henceforth constituted a supply reservoir. A higher impervious stratum prevented its escape. Subsequent folding allowed the gas and oil to rise along planes of bedding or folding, where they remained until released by boring.

The existence of an oil-field is dependent on three essential factors: the original oil-forming material, a porous reservoir rock, and an impervious cover-rock (usually clay

(1) ⌒ = anticline; ⌣ = syncline.

or shale). The further connection between the supply reservoir and crustal curves has to be studied on the spot in each case. The ideal anticlinal fold is not always developed; its place is sometimes taken by monoclines or deformed anticlines and terraces and beds dipping gently in one direction. The great variety of structural features makes it difficult to generalise. In some instances the anticlinal folds are so sharp that wells have been sunk in almost vertical beds. Broad dome-shaped earth curves or gently-inclined strata are, however, the most commonly favourable. It is not out of place to remind the general reader that there are such things as deeply-buried anticlines impossible to detect without a drilling scheme, and not becoming apparent before a late period in the history of an oil-field.

Indications of Oil.

The most important hint of the existence of oil in depth is a seepage of the fluid or exudations of asphaltum at points on the surface. In many instances, however, no indications of petroleum have been seen until it was met with in the bore, and this has sometimes been appealed to as a warrant for blind stabbing with the drill on the off-chance of striking oil in country which has taken the prospector's or promoter's fancy. Competent authorities, however, remark that where this has been successful, the bores were in regions which in other parts yielded oil or showed indications of it. Dr. Wade, in his report on "The Prospects of Discovering Petroleum on North Bruny Island," quotes Prof. D. T. Day, United States Naval Inst. Proc., 1914:

> "In nearly every case where oils have been discovered in the United States or other countries, the discovery has been directed by a seepage of oil or gas."

The natural gas associated with petroleum occurrences consists largely of inflammable marsh gas CH (methane), but as gas containing methane is an ordinary vegetable decomposition product characteristic of marshy areas, and is also given off by seams of coal, its occurrence is no infallible sign of the existence of petroleum. At the same time, petroleum is usually accompanied by this gas, and gas-shows in a bore, especially under increasing pressure, are indications which cause the driller to be on the alert. In some limestone fields the gas emitted is sulphuretted hydrogen. Indeed, this gas generally accompanies petroleum gas, and sometimes masks the distinctive odour of the oil. Gas-shows

at surface in springs and pools should not be neglected in collecting information about possible oil areas. In some countries the evolution of gas from oil rocks just below the surface is responsible for the formation of conical hillocks called "mud volcanoes"; in these the impervious cover has been disrupted or has absorbed oil and gas. These, of course, are excellent indications.

The most usual places for exudations of oil are in stream beds, in ravines, and low ground generally, or at outcropping joints on the slopes of rock-folds. Frequently the surface soil will have to be removed before any actual signs of seepage can be seen. Outcrops may have a bituminous appearance, but if exhausted and much weathered they may not be recognisable at the first glance as oil rock. In such cases a faint odour and, with limestones, sometimes sulphur stains are all the indications available.

The solid bitumen passing under the names of asphaltum, albertite, grahamite, manjak, &c., is a residue of asphaltic oil, as ozokerite or mineral wax is the residue of the light paraffin oils. Veins of these substances are useful indications of original occurrences of petroleum.

Brine, rock-salt, and saline waters are frequently associated with petroleum, and the water in petroliferous strata is invariably impregnated with salt. Some authors consider this as more than a coincidence. The latest views, however, regard the occurrence of brine as unrelated to the facts of oil genesis beyond being possibly due to conditions which were favourable to the formation of both oil and salt.

Iridescent films seen on the surface of streams and pools are sometimes films of oil, but more frequently owe their bright colours to oxidation of ferrous salts, leaving an oil-like film of ferric hydrate on the surface of the water. When this is stirred with a stick it does not break up in the way characteristic of oil; and, besides, the distinctive odour of petroleum is absent. Oil seepages on the sea-floor give rise to wide films of oil on the surface of the water.

In arid countries the influence of petroleum on vegetation is marked, giving a barren appearance; but in countries with a heavy rainfall and with a climate like that of Tasmania tree and plant life would supply no useful clue to the existence of petroliferous beds.

Geological Age of Limited Application as a Guide to Prospecting.

Petroleum occurs in strata of all ages, but oil-fields of any importance are not likely to exist in areas so recent in

age as the Quaternary. A large output has been derived from Palæozoic rocks, while the most numerous fields obtain their production from strata of Tertiary age. In the Eastern Hemisphere the oil-fields are principally Tertiary. The Roumanian, Galician, Caucasian, the Burmah, and the Eastern Archipelago fields are Tertiary or Cretaceous, and none older than these exist in the East Indian and Australasian regions. One might be disposed, therefore, to argue that, given the necessary conditions, the balance of probability for Australasia lies with strata of Tertiary age. Strictly speaking, however, it cannot be affirmed that the question of age is involved in the problem. The intrinsic factors are the nature and conditions of sedimentation and structure; and the necessary conditions may exist in sediments of all ages.

Prospecting in Tasmania.

So far no undoubted surface seepages of petroleum in Tasmania are known to the Mines Department. It is true vague reports are current of occurrences in different parts of the island, but none of these have been verified and confirmed by a competent observer. Exudations have been reported on Bruny Island and near Launceston, supposed oil-films on the sea surface on the South Coast, off the mouth of the New River, and loose fragments of bitumen on the West and South Coast beaches and in the Straits, but such of these occurrences, real and alleged, as have been further examined have failed to yield satisfactory evidence of the existence of an available petroleum field. When any signs of native oil are noticed, observers would do well to communicate with the Secretary for Mines, in order that arrangements may be made for an officer of the Geological Survey to visit the spot.

Unquestionable petroleum residues are present as loose fragments of asphaltum on various beaches of the Tasmanian coasts, namely on King Island, north and south of Sandy Cape, in Macquarie Harbour, north of Point Hibbs, at the mouth of the Mainwaring River, north of Port Davey, in Port Davey, east of Cox Bight, at the mouth of the New River, in Rocky Boat Harbour, on Surprise River beach, on South Cape Bay beach, and on Hummock and Cape Barren Islands.(2) These fragments are usually

(2) A collection of these asphaltum fragments may be seen in the Victoria Museum, Launceston (Case 26). A specimen of albertite (121) is exhibited in Case 11. In Case 7 are shown other bitumens, viz.:—Uintahite (Gilsonite) [2631]: asphaltum from Trinidad [2627]: Ozocerite from Galicia [2615]: elaterite or elastic bitumen from Cornwall [2629].

found near high-water mark, between normal and storm tide levels. No pieces have been found up the streams. If they had been brought down by the creeks and rivers, they would have been more plentiful on the beaches, and it would not have been difficult to locate their sources up-stream in the same way as drift-coal is easily traced to its parent stream. They vary in weight from an ounce or two to nearly a hundredweight. They are of no particular shape, being mere fragments; they are often found in flattened, cake-like forms. The substance is sometimes plastic, and fresh-looking pieces frequently have an odour similar to that of naphtha. Fresh surfaces show the lustre of pitch. Mr. W. F. Ward, Government Analyst, reports that the average density of sea-water round Tasmania is 1·030. The specific gravity of this asphaltum has been determined in the Geological Survey laboratory by Mr. W. D. Reid, Government Assayer, as ranging from 1·0313 to 1·0459; consequently, though it might not float in stationary sea-water, it would do so in moving water. It will be remembered that albertite, a kindred or practically identical mineral, that is to say, an inspissated petroleum, occurs in New Brunswick in vein-form. In the Albert Mine it was worked in a vertical vein up to 15 feet in width to a depth of 1300 feet, and after 230,000 tons of it had been extracted, the vein finally passed into a brecciated mass of shale fragments. Bores put down in search of free oil were unsuccessful.

It is possible that the fragments of bitumen met with on the Tasmanian beaches are also derivatives from veins; and it is very probable that they emanate from some submarine source or sources situate to the west or south-west of Tasmania. Similar fragments are found on the beaches along the southern and western coasts of Australia.

Unsubstantiated reports of discoveries of bitumen in undisclosed localities inland have been received by the Department from time to time.

In Petterd's "Catalogue of Tasmanian Minerals," an inland occurrence of this or a similar mineral is thus described:—

> "Occurs about 4 miles from Chudleigh, on eastern bank of Mersey River. It is perfectly black, sectile, and burns with a dense smoke and strong odour. It occurs in drab-coloured aluminous shale."

An attempt should be made to locate the above and ascertain its mode of occurrence, and whether the mineral is

identical with that found on the beaches. The drainage basin of the Arthur River has been spoken of as a district in which asphaltum has been found, but the reports are of a nebulous character. Several years ago an abortive attempt was made to locate some bituminous mineral alleged to exist as a seam on the sea-coast somewhere in the neighbourhood of Southport, which was said to be used by fishermen for their fire-pots, and was known as "kerosene stone." But so far all the asphaltum fragments have been found on beaches facing the south and west, and none on the east coast. An alleged discovery at Cockle Creek in Recherche Bay has been traced to South Cape Bay.

The hard Silurian limestones are unlikely to be oil-containers. As a rule they are very compact, and it is only occasionally that thin bands of a cavernous texture are met with in them.

Exudations of oil or some product or residuum of oil are said to have been observed on Bruny Island. The prospectus of the Bruny Island Petroleum Company issued in 1915 made the remarkable statement that liquid bitumen has been known to exude from the ground there at two distinct points for over 50 years. Dr. Arthur Wade was instructed by the Mines Department to examine the alleged petroliferous area on Bruny, but was unable to verify the existence of these exudations, and reported adversely on the chances of finding oil.(3) The company, however, proceeded with its operations, and bored to a depth of 430 feet in Permo-Carboniferous marine beds, but unsuccessfully; and work finally ceased from lack of funds. The following particulars of the bore have been placed at the disposal of the Mines Department by Mr. Guy Andrew, the company's superintendent:—

	Ft	In.
Top sand and clay	43	0
Quartz sand	8	0
Coarse sand	11	0
Running drift with no water	39	0
Sand and water	11	0
Limestone conglomerate	27	0
Brown shale	8	0
Quartz sand	5	0
Limestone conglomerate	4	0
Very fine sand with no water	14	0
Brown clay	6	0

(3) See "Petroleum Prospects on Bruny Island," by Arthur Wade, D Sc. Parliamentary Paper No. 60, 1915.

	Ft.	In.
Limestone conglomerate	3	0
Limestone	12	0
Hard brown limestone	3	0
Grey limestone	54	0
Hard carboniferous grit	1	6
Hard blue siliceous shale	3	0
Hard limestone	3	0
Very hard grit	3	0
Very hard limestone with alternate bands of shale	171	6
Total	430	0

In different parts of Tasmania the diamond-drill has prospected the beds of the Permo-Carboniferous system while exploring for coal-seams, without encountering gas or oil, and the chances of striking oil in such beds as they are developed here do not appear to be great.

A significant adverse indication is that, although the beds lying on the flanks and at the foot of the numerous mountains dip towards the hill, their outcrops have not been noticed to show any exudations or other signs of oil.

Faults are very common in the Permo-Carboniferous areas, and in connection with this circumstance it may be mentioned that fault-displacements do not always have an injurious effect on subterranean oil supplies; frequently they provide channels through which gas and oil force their way and increase the flow of a well.

The Permo-Carboniferous beds may be regarded as potential reservoir beds—they are both marine and terrestrial, some of them are charged plentifully with marine fossils, the organic remains from shallow seas, others with the carbonaceous residue of vegetation (coal-seams, &c.); they are generally tilted at a low angle, and they consist of alternating impervious and porous strata. Petroleum being a product (in greater or less quantity) normal to nearly all countries and to strata of every age, it would not be a geological surprise to meet with signs of it in these beds; but no definite evidence of its existence has been reported.

Oil is being extracted by destructive distillation from the Tasmanite shale of the Mersey district, and it can be distilled from the cannel coal or kerosene shale of Preolenna; but this has no bearing on the existence of rock oil.

The development of the Permo-Carboniferous in Tasmania is variable, but the maximum thickness of the strata is estimated between 2000 and 3000 feet.

The Trias-Jura comprises in Tasmania the continental sandstones and shales homotaxially comparable with the European Trias and Jura, and forming part of the old Gondwana continent which occupied the site of the present Indian Ocean, from Permo-Carboniferous onwards to Cretaceous times, separating the Southern Ocean from the greater Mediterranean or Eurasian Sea. It includes the Upper Coal Measures. The lowest beds of the series rest conformably on the Permo-Carboniferous, and the various members are conformable with each other. Their united thickness is probably between 1200 and 2000 feet.

The remarks on diamond-drill boring in the Permo-Carboniferous apply also to the Mesozoic. Numerous bores have been put down to locate or test coal-seams in these strata, but no record exists of oil having been struck in any of them. The series contains the plant-remains of the coal-beds and fossil tree trunks, fish imprints, and bones of amphibians here and there in the sandstone beds, but generally the strata are poor in organic remains. There is an alternation of sandstones and shales in the system, and generally speaking the conditions are not unfavourable for accumulations of oil if the material for its formation had been present. Indications, however, are wanting. Bores have passed through the whole series of Mesozoic and Permo-Carboniferous sediments to the granite or Silurian slates without yielding any trace of oil or gas.

Some uncertainty attaches to the salt-pans of the lower Mesozoic as criteria in search of oil. These saline lagoons are on the estates of Lower Park, Ballochmyle, Ellenthorpe, and Mona Vale in the midlands, and are said to extend in a chain for 7 miles N.W.-S.E. Mr. Joseph Barwick reported to the Royal Society of Tasmania in 1889 that he knew at least ten of these lagoons in an area from 1 to 100 acres. At Ellenthorpe there is one large pan of 100 acres; but the most prolific are those at Ballochmyle and Mona Vale, from which hundreds of tons have been taken in dry seasons for domestic and farm use. It is stated that the salt lagoons were often the subject of much contention among the aboriginals, and were the scenes of fierce tribal warfare.(4)

It is well known that the American oil industry had its birth in the discovery of petroleum while drilling for brine, and the association of rock-salt, or brine and saline waters, is so general that it is difficult to persuade oneself that

(4) Proc. Roy. Soc. Tas., 1889, p. xxii.

there is no genetic relationship. The association exists in the oil-fields of the United States, Canada, Roumania, Galicia, Russia, Persia, Baluchistan, Burma, and New Zealand; and, in fact, in oil-fields generally. It is not easy to believe that this association is accidental. The commercially valuable oil-fields of Texas and Louisiana are characterised by salt domes with cores of salt and gypsum. These seem to be connected with fault systems, and have been of use in guiding the selection of sites for drilling in the inclined strata on and around them.(5) One of the Texas domes (Spindle Top oil-field) is stated to have led to drilling operations yielding over 5,000,000 tons of petroleum from an area of 200 acres. In Vera Cruz, in Mexico, the oil rock is dolomite lying below Tertiary fossiliferous marls and sandstones (diatomaceous and foraminiferal), and resting on gypsum and rock-salt.(6) In Roumania the oil-producing strata are saliferous. Rock-salt is also present in the oil areas of Galicia. There are salt lakes round the oil-fields of Baku, and the whole petroliferous Caspian area may be said to be saliferous.

A. Beeby Thompson remarks(7) that in most oil-fields the oil is raised mixed with salt-water. He says:

> "In some petroleum districts salt plains or lakes are not uncommon. Wherever there are natural depressions without easy exit, and rain-water can collect at intervals, salt is dissolved from outcropping oil-beds, producing a solution of salt which in hot dry seasons suffers evaporation, leaving a white encrusting deposit on the ground. The gentle evaporation under the influence of the sun and wind often causes the salt to separate out in beautiful rose-tinted crystals which form the loveliest clusters. Dry salt lakes or salses formed in this manner are often the source of a large trade in salt, which, when required for crude uses, such as preservation, needs no purification or preparation."

Sir Boverton Redwood says:(8)

> "The peculiar relations between salt and petroleum and natural gas were noticed at an early date. The petroleum industry of the United States originated

(5) "The Relationship of Structure and Petrology to the Occurrence of Petroleum," by A. Beeby Thompson, Trans. Inst. Min. and Metallurgy, Vol. XX., 1910-11, pp. 225-6.
(6) Trans. Inst. Min. and Metallurgy, *supra*, p. 250.
(7) "Petr leum Mining," by A. Beeby Thompson, 1910, p. 112.
(8) "Petroleum," by Sir Boverton Redwood, 1906, p. 114.

in the drilling of wells for brine and the observation that gas and oil were usually found with it; and throughout the globe the association of gas and petroleum with salt, either in solution or in the solid state, is almost universal."

Expert opinion has wavered with respect to its value as an indication, but of late the view has been growing that salt and petroleum may have accumulated independently of one another under identical conditions favourable to each. Mr. Cunningham Craig, in his little book on "Oil-finding," suggests that dry and desert conditions in many fields involved the limited supply of water, which is supposed to be one of the factors in the formation of petroleum, and that these also favoured the concentration of salt, so that the two may have been influenced by a common condition, and still be quite unconnected with each other. He points out that sometimes the salts are not sodium chloride, but sodium and calcium sulphates. Nevertheless the impression remains that the association has not yet been satisfactorily explained.

In applying this to the brine deposits of the Tasmanian midlands arid conditions probably prevailed when these sandstones were laid down, which would favour the concentration of salt and gypsum, but if what may be called the raw material were absent no oil would be formed. If no other indications can be discovered, it is unsafe to regard the salt-pans as such. The boring experience in the Gondwana rocks in other parts of Tasmania is rather against any association here. Still, if any purely speculative trials are to be made in Tasmania, boring in a structurally favourable part of this field would no doubt be considered. But all that can be said at present is that the brine is the only evidence available, and this must be accepted *quantum valet*.

Search should be made for surface signs of oil or gas, particularly in the creeks and along the edges of outcropping rock. The district is an extensive one, but it must be well-known to shepherds and others whose duties take them over the ground.

It remains to consider the Tertiary sediments which are widely distributed in Tasmania. These are, for the most part, fluviatile and lacustrine deposits, with a succession of alternating clays, sands, and carbonaceous beds. The Launceston Tertiary basin, with its ramifications, is estimated to cover an area of 600 square miles. The Derwent Tertiary basin is filled with an assemblage of similar sedi-

ments; and beds of the same age are developed in various parts of the island (North-West Coast, Macquarie Harbour, Swansea, &c.). The outcrops of Tertiary fossiliferous limestone in the vicinity of Cape Grim, Marrawah, Temma, &c., should be examined by residents for any indications. The basin of the Arthur River, too, invites exploration. The development of Tertiary beds on the South Coast has been too slight to be attractive.

The greatest depth to which they have been proved was in the Belmont bores near Longford. Two bores there reached 690 and 894 feet, leaving off in lignitic sediments. The following are the registers of these bores:—(9)

No. 1 Bore.

	Ft.	In.
Surface shaft	13	6
Clay with veins of ironstone	41	11
Drift with quartz-stones	7	4
Sandy clay	28	7
Clay with lignite	98	1
Clay and sandy drift	68	10
Concretionary drift with lignite	25	0
Sandy clay with lignite	21	0
Drift	39	9
Drift with sandy clay and wood	57	9
Red clay	55	0
Sandstone	20	2
Sandstone with seams of lignite and red clay	21	6
Hard mud-shale	31	10
Mud-shale and sandstone	10	1
Shale showing fossils	11	10
Shale and sandstone	25	10
Hard brittle slate	5	2
Shale	19	5
Shale with veins of carbonate of lime	7	9
Shale and sandstone	11	5
Shale with veins of concretionary sand and lignite	6	10
Mud-shale and sandstone	10	5
Concretionary sand and lignite	8	9
Layers of mud-shale and soft mullocky sand and wood	42	3
Total	690	0

(9) "The Geology of Tasmania," by R. M. Johnston, 1888, pp. 275-276.

No. 2 Bore.

	Ft.	In.
Surface shaft	16	6
Brown clay	23	6
Wash	3	0
Black clay	53	0
Stones and drift	34	0
Black clay and wood	44	0
White clay and wood	70	0
White sandy clay and drift	257	4
Sandy clay and drift with decayed wood	150	2
Mottled clay	56	4
Red clay	7	0
Sand clays with wood (went through 4 feet of wood at 800 feet)	61	2
Light-blue clay and wood	102	0
Mottled clay and wood	16	3
Total	894	3

A bore for coal was put down on the Carr Villa estate, near Launceston, in Tertiary beds, and reached a depth of 570 feet. It left off in the diabasic igneous rock. Prospecting-shafts have been sunk in these beds in various localities, but none of them have revealed any signs of petroleum. At the same time the few vague reports which have reached the Department suggesting the existence of oil scums or oozings have invariably had reference to Tertiary beds. Such are reports of oil on the West Tamar, near Newstead, between Relbia and Evandale, and near Longford. None of these occurrences have been examined officially, and no samples of the exuding material have been received at the Survey laboratory. It cannot be said, therefore, whether the reported substances are derivatives from a petroleum reservoir or from any natural distillation of tar from beds of lignite, or merely films of iron oxide. The last of these is the phenomenon which is most common.

Field Tests.

Mr. Cunningham Craig, according to a compilation made by Dr. Wade,[10] gives characters by which genuine oil-

[10] "The Supposed Oil-bearing Areas of South Australia," by Arthur Wade, D.Sc., Geol. Surv. S.A. Bulletin No. 4, 1915, p. 39.

scums may be distinguished from those of iron oxide, as follows:—

Films of Iron Hydroxide.	*Films of Petroleum.*
1. Iridescent reds, red-browns, and blues	Iridescent vivid greens, pinks, and purples
2. Acquire a semi-metallic lustre on drying	Never exhibit this character
3. Break when disturbed into sharp-edged and sharp cornered fragments	Never break in this manner, but give rounded, curved, or convoluted figures
4. Small crystalline flakes may be seen to sink when a partially dried-up film is agitated	Film remains on surface under such conditions

In addition, suspected oil exudations may be tested by burning in a wick or by the characteristic odour.

Woodruff's test for oil in rocks is given by D. Hager in his work on "Practical Oil Geology" (1915, p. 59):—

> "Crush the sample to a powder. Place a tablespoonful of it in a bottle and pour chloroform or carbon-tetrachloride over it till saturated and covered with the liquid. Cork and shake occasionally for a quarter of an hour. Filter. If the rock contains more than a trace of petroleum the filter-paper will show a dark ring. Allow the filtrate to evaporate slowly; examine the remaining substance. It is the petroleum which was in the rock."

General.

Prospectors should perseveringly search gullies and cliff faces for oil signs and gas shows. There is often a faint odour of petroleum in gullies where gas is escaping. The boundaries of the Tertiary strata along the foothills of the Western Tiers should be examined, and wherever contacts are exposed with outcrops of the Trias-Jura or Permo-Carboniferous sediments or with the Mesozoic diabase of the ranges. The Tertiaries of the Tamar, Longford, the Derwent, Macquarie Harbour, and of the extreme North-West of the island, should also receive the attention of the oil explorer. At Farm Cove, Macquarie Harbour, boring for coal has been carried on in the Tertiary beds to a depth of 300 feet. The lumps of fossil resin which are met with in these coal measures must not be mistaken for mineral wax.

Reviewing the whole subject, the two fields which offer the best off-chance of discovery of native oil in Tasmania are, as far as at present known:—

(1) The Launceston Tertiary basin, in which rapidly alternating beds of sand, clay, and lignite recur to a proved depth of 900 feet, and probably persist for a few hundred feet deeper. The organic muds of these beds are potentially favourable for oil genesis.

(2) The Gondwana land beds of the midlands, where salt-pans are known to exist in various localities.

A discovery of oil seepages and gas emanations in these areas would justify trial bores at structurally suitable spots. But until some indications of oil have been discovered, to initiate drilling savours somewhat of putting the cart before the horse. The rule should be, first obtain the indications, and then select the drilling site according to the information afforded by a study of the structural geology of the district.

Up to the present, however, the Department has no definite knowledge of undoubted indications, but in view of the benefits derivable from the opening of a petroleum-field in Tasmania, and in view of the reasonable assumption that there is nothing exceptional in the physical characteristics and conditions of sedimentation, which would militate against the formation of oil, it recommends renewed search for surface evidences, and invites prompt communication of any discoveries made, in order that no time may be lost in visiting and examining the sites of alleged finds.

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