NATURAL OIL IN THE ESTATE OF TASMANIA

Preliminary Statement:

Importation of oils into Australia last year reached the enormous total of 76,496,487 gallons, valued at £7,421,911. The equivalent in kind was sent out of Australia to pay for it. These figures arrest the attention and show us in an irrefutable way how dependent we are on other countries for this indispensable commodity of modern civilisation. In a country of such wide spaces as Australia, where motor traction has largely superseded every other means of transport, and where the employment of oil in the generation of power and artificial light has become - especially in the outlying parts - almost general, this one time convenience has now become a requisite. Moreover the necessity for the provision of adequate supplies in the event of war is not fully realised by the body politic in Australia.

Not one commercially important oil field has yet been discovered in this country! How much to our advantage it would be to provide for our needs rather than to be dependent upon the surplus product of more favoured countries! Although the discussion of oil finding provokes opposition in certain quarters, it is not unreasonable to expect that Australia shall yet become one of the more important producers. There is no geological ground for a different view. From analogy also - and it is admissible - it is unreasonable to believe that Australia shall produce no natural oil while every other large country is blessed with a wealth of it. Within recent years only has any sustained attempt been made to discover oil-bearing fields, and when it is realised that few mining engineers and prospectors know the first principles of oil geology, and that few are able even to recognise the surface indications, is it surprising that success has been postponed? The development of this industry means so much to the advancement of Australia that every encouragement should be given to the enterprising few who are engaged in the pioneering work of oil exploration. Much "spade" work has to be performed in all potential fields as a preliminary to the drilling of wells, in this connection it may prove of interest to learn that 58 per cent of the bores drilled in well-established fields in America last year were unsuccessful, either because of faulty location or the cutting of "dry" strata. However, the productive wells amply repaired these losses. The statement has been repeatedly made in disproof of the occurrence of oil that in none of the deep mines and in none of the many thousands of deep wells bored for artesian water has any trace been found. It would be remarkable if natural oil were found under such conditions, the precise location of suitable structures under suitable conditions being essential to success.

One of the arguments used against the possible occurrence of natural oil in our great Tertiary belts is that the rocks of that formation have not been subjected to tangential compression and that in consequence anticlinal structure cannot have been developed. There are many other ways in which the classic type of fold is developed, and there are many other types of fold suitable for the accumulation of natural oil, in fact it may accumulate in strata horizontally disposed and unaffected by orogenic movements.

The Geological Survey of each State has accumulated a great store of knowledge relative to the extent of possible oil-bearing formations. This information and the advice of the officers are available to the public.

As regards Tasmania in particular, the recent discoveries in the Mersey Valley District are very important not only because of the prospects there but because they lend encouragement to operators in other fields. Natural oil in commercial quantities has not yet been found, but seeps occur and the geological conditions are particularly favourable. Drilling based on scientific data will determine the question whether the oil occurs in commercial quantity or not.

EXTENT OF PETROLIFEROUS COUNTRY

The extent of country likely to contain petroleum has not been delimited. In fact with the exception of the recent investigation of the areas containing deposits of oil shale, no effort has been made to ascertain the possibilities of Tasmania as a source of natural oil. As the Tertiary beds for many reasons appear to provide more favourable condition for storage than the Permo-Carboniferous, the area of possible oil-bearing country is largely governed by the extent of that formation. The more important Tertiary areas are situated in the north central and along the northern shores of Tasmania. Of these, the Launceston basin extending from Westbury to the mouth of the Tamar River, and covering an area of 800 square miles, is the largest. Many years ago a hole was drilled nearly 900 feet into this formation without reaching the basal member. Sassafras area, with which this report particularly deals, occupies only 50 square miles of country, and apparently it is not connected with other Tertiary basins in the neighbourhood; but its northern extension far out to sea seems probable. Its depth at Thirlstane only five miles from the coast, is over 1000 feet below sea-level. In the Parkham and Dunorlan areas other deposits occur, in the latter locality covered with a deep mantle of basalt lava. Between Wynyard and Marrawah, the littoral is almost wholly occupied by the Tertiary, and some sections of this tract of country may prove on examination favourable to oil production and accumulation.

MERSEY VALLEY DISTRICT

General Statement:

Oil-producing shales and coals have been known in this district for sixty years, but the possibility of finding natural oil there had not been seriously considered until recent time. During the war, the late W.H. Twelvetrees in an official circular entitled "The Search for Petroleum in Tasmania" referred to the occurrence of the oil shales and their probable connection with stores of natural oil, but little was known then concerning the geology of the deep Tertiary beds in the neighbourhood, which may yet prove to contain the reservoirs of commercial importance. Among the first of the operating Companies to give attention to the District are the Adelaide Oil Exploration Company Limited, represented by Messrs. J.T.Moate and W. Stott; and the Mersey Valley Oil Company Limited, of Melbourne, represented by Captain de Hautpick and Mr. Andrew Wauchope; and Mr. G.D. Maudell of the Tasmanian Oil Company, who expects to commence drilling this year. The attention of these Companies was directed at first to the Latrobe and Railton areas occupied by strata of Permo-Carboniferous age; now drilling work is concentrated on the Tertiary beds of Sassafras.

The results obtained from the test bores are such as to encourage the idea that success will ultimately attend their efforts. These results summarised are:-

(1) The proximity of oil-producing shales which by chemical composition are particularly adapted to the generation of petroleums;

(2) The occurrence of very deep beds of Tertiary strata containing a large proportion of organic matter;

(3) The development of structure favourable to the concentration of oil;

(4) The sequence of strata favourable to the retention of oil;

(5) The actual discovery of natural oil.

OUTLINE OF THE GEOLOGY

The oldest rocks in the district consist of sericitic quartz and mica schists of Pre-Cambrian age. They attain a maximum thickness, so far as can be observed, of 10,000 feet, and outcrop along the course of Mersey River for five miles, rising again on the east and west sides of the district into hills over 1000 feet above sea-level. Unconformably overlying them are the Dikelocephalus slates and sandstones of Cambrian age well exposed near Railton and at Caroline Creek. It is estimated that the thickness of this formation is nearly 4000 feet. It is succeeded, with a slight unconformity, by Ordovician limestone and calcareous slates nearly 3000 feet in thickness. The limestone is of remarkable purity, schistose and compact, and contains fossils typical of the Ordovician. For long this

formation was confused with the limestone of Silurian age occurring at Heazlewood, Zeehan, Lower Gordon River and Queenstown. Following it, comes the so-called "porphyroid" series, also of Ordovician age. This is composed of pyroclastic, partly schistose slates, quartz porphyry and diorite porphyrite. All the foregoing have been folded and form broad anticlines and synclines with north-west axes. At Latrobe and Railton the dip ofthe fold is to the south-west at varying angles.

Succeeding them with a marked unconformity are the West Coast Range conglomerates and tubicolar sandstones containing casts of rhynchonella capax and borealis and other fossils typical of the Silurian. This formation continues unbroken from Quamby Bluff to the mouth of Forth River and marks the plane of a fault of very great displacement. At Railton and Nook the dip is to the north-east at angles of 50 to 65 degrees. The Devonian period is characterised in Tasmanian by the intrusion of granite, but no outcrops of this rock have been observed in the district, although numerous boulders, the waste of that formation, occur in the Permo-Carboniferous sediments indicating transport by ice.

Permo-Carboniferous sediments were laid down in regional synclinoria developed in the Early Palaeozoic and Proterozoic rocks. In the Mersey district they attain a maximum thickness of 1500 feet. The basal members consist of conglome rates, grits, limestones and sandstones frequently containing boulders of granite and gneissose igneous rocks. The Lower Marine are generally succeeded by the Upper Marine beds without any great change in the fossil fauna, but in the coal portion of the basin land and fresh water beds are intercalated between them. In the Tasmanite portion of the basin, however, the Lower and Upper Marine beds form a continuous series without any 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 suggests their contemporaneous deposition, one under marine, the other under terrestrial conditions.

Vestiges only of the Trias-Jura occur.

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 up from the mantle of basalt all over the Sassafras area and occur again at Kimberley, Dunorlan and Deloraine. They have not been completely intersected at Sassafras, but have been penetrated to a depth of 1000 feet below sea-level. Sands at surface give place to lignitic clay over 600 feet thick containing numerous plant impressions and remains. This brown clay is compact, almost devoid of sand, extremely fine in grain, and ofthe consistency of cheese when wet but much harder when dry.

Basalt ash and lava are widely distributed and are particularly prominent in the Sassafras and Dunorlan areas. Many small cones appear in the Sassfras area, suggesting intrusion in the form of pipes.

Quaternary and recent sediments occupy the flood plains of existing rivers and in places fringe the shore.

INDICATIONS OF OIL

The first known seepage of oil in this district was discovered nine months ago on the west bank of Ray Creek in the Nook area. The oil reaches the surface along a north-westerly fault plane cutting strata of Permo-Carboniferous age. On one side of the fault, a 4-feet seam of Tasmanite (oil shale) in pebbly mudstone is exposed; on the other side of it a seam of coal is found, not exactly at the same horizon, but nevertheless of synchronous formation. A thick scum of oil covers the water in a hole 10 feet deep sunk on the shale side of the fault, and after heavy rain bubbles of natural gas and globules of oil are given off at frequent intervals. Even in dry weather agitation of the water or disturbance of the bedrock is sufficient to set free the light oil, which, rising rapidly to the surface and spreading in a thin film over the water, soon volatilises. The scum represents the residual product of volatilisation. Another seep has been noted further down stream near the approach to the main road to Sheffield. The amount of oil yielded by these seeps is too small to obtain samples for detailed testing purposes in the laboratory, but its nature has been determined.

Another authentic seep was found by P. Roche on his property in the Sassafras area. This seep, active only during the periods of extremely heavy rainfall, appeared near the summit of a hill, 400 feet above sea-level. Whereas the others were found in the coal and shale measures of Permo-Carboniferous age, this occurred in Tertiary sands covered with basaltic soil.

About a mile northward of this, an escape of natural gas and oil is reported, and small seeps are said to occur near Thirlstane, but none of these reports has been verified. These seeps represent the lighter, more easily volatilisable fractions of crude oil.

ORIGIN OF THE OIL

Whereas oil seeps from Tertiary strata at Sassafras, it escapes along a fault plane between outercrops of Kerogenite or Cannel Coal and Tasmanite (oil shale) in the Permo-Carboniferous at Nook, an area devoid of Tertiary sediments. Apparently the oils from these seeps, widely separated geographically and geologically, are almost identical in chemical composition and physical properties, and it may be stated that the petroleums generated by artificial distillation from Tasmnite shales, have much in common with them.

It appears then justifiable to assume that the ultimate source of the natural petroleum is to be sought in the Permo-Carboniferous rather than in the Tertiary, which probably merely formed a suitable repository for oil that had migrated from its parent formation. However, although there is no direct evidence yet in favour of the idea, it is possible that the lignitic clay which directly overlies gas-bearing sand in the Sassafras area, may have been a contributor to natural oil. The beds of lignitic clay are over 600 feet thick, and the material contains organic matter in the proportion of 20 per cent, showing that by its composition, it is adapted to the generation of oil. More likely their office has been to provide an impervious cover to the porous sands containing the oil.

Tasmanite, like the Cannel coal and kerosene shale, and the black shales of Don River, is not an oil-bearing but an oil-producing substance that requires the application of heat for the generation of oil. This material, so adapted to the generation of petroleums, is composed of innumerable minute disc-like spore cases set in a fine-grained arenaceous sediment. The spore cases probably belonged to an ancient relative of the modern lycopods, their size and form, according to E.T. Newton, suggesting that they were more nearly allied to lycopodiaceous macrospores than to anything else. They are found to be provided with a thick yellow coating of some waxy or resinous substance. Associated with them and distributed through the black shales as exposed in Don River near Nook, are great numbers of hard wax-like spore exines called sporangites. The so-called cannel coals of this region, are probably composed largely of the sporangites and not so much of the spores. Both the sporangites and the spore fossils are important sources of petroleums obtained by artificial distillation, and are competent to provide enormous supplies of oil by natural processes.

David White considers similar sporangites in the Devonian shales of North America to be the decay-resistant walls (exines) of some type of macrospores, possibly of Lycopod affinity.

SASSAFRAS AREA

General Description:

Sassafras area 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 oil-bearing Tertiary sediments and the basalt pipes and lava sheets that intrude and overlie them. From the sea the basalt-covered hills rise to a height of 550 feet near the southern extremity of the area, and although gently moulded, they present an irregular topography. However, a general parallelism of the axes, which are from one to two miles apart, is noticeable, and they trend in a meridional direction toward the sea. It should be noted that although basalt lava and ejectaments occupy the greater part of the land surface, Tertiary sediments outcrop on some of the highest domes and ridges, and basalt in many places is found in existing valleys. Beyond Northdown and Wesley Vale basaltic lava extends far out to sea; eastwards of those settlements, Tertiary sands and clays, which have never been covered with basalt, occupy the low-lying area near the coast. Tertiary sedimentation had proceeded without interruption on a gradually subsiding land surface until the advent of the great eruption at the close of the period - there was therefore no erosion interval between the arrest of sedimentation and the extrusion of basalt. From the foregoing it will be observed that the present structure of the sediments was largely developed prior to the intrusion of basalt and the outpouring of the lava - it follows that the present geographic features are an expression of the geologic structure. The importance of this deduction in the deciphering of the structural geology will be conceded when it is realised that few sections of the Tertiary sediments can be seen and the log of one bore only is available for examinations.

Protruding here and there through the Tertiary sediments and lava are hillocks of Cretaceous diabase and in one place Silurian conglomerate appears. These hillocks are parts of very much larger masses around and over which the later formations were laid down, and, as will be hereinafter shown, the presence of other buried hills is manifested by the structure of the overlying strata. The oil-bearing rocks occupy a broad topographic valley in folded Proterozoic and Early Palaeozoic formations the sides of which rise into hills upwards of 1000 feet above sea-level.

TYPES OF FOLDS REPRESENTED IN THE AREA

The rock folds in the area under review are of limited extent but of several types. If the geographic features may be considered an expression of the geologic structure, then the folding is most intricate and intense, for although there is a general alignment and parallelism of the axes of the more important folds, some of the minor ones lie nearly at right angles to them and add

considerably to the complexity of the structure. The more common type of structure is that of an elliptical dome, but apparent anticlinal and normal quaquaversal forms appear to have been developed also. No. 8 Bore of Adelaide Oil Exploration Company was sunk 1000 feet below sea-level on the east flank of the small end of one of these pear-shaped folds, and No. 9 Bore is being sunk from the summit of the dome on the same fold. The information which will be obtained from No. 9 Bore should prove sufficient to decipher the structure of this fold and to enable the operators to choose the most favourable site for the next bore and possibly for a well.

Few of the folds continue unbroken at surface more than two miles, and some of them encompass less than two square miles of country. They succeed each other very rapidly and give the impression of a number of minor folds developed on others of much greater magnitude. Where the strata have been exposed in deep road cuttings and in quarries, the angle of dip appears from 3 to 5 degrees or from 260 to 440 feet per mile. Unfortunately, very few sections of these partially consolidated sediments are available for examination - sufficient only as aids in these speculations, which are based on the surficial features of the country.

CAUSE OF FOLDING

Early in the investigation of this area, it became apparent that these peculiar forms did not result from the tangential compression. In the first place there is no evidence of the forces inducing lateral thrust having been operative during or since Tertiary time; again there are no extensive rock projections in the area competent to act as buttresses, except perhaps the buried hills of diabase and older rocks against which the Tertiary sediments rest. In neighbouring districts where the conditions are not similar, these sediments lie in a horizontal plane, yet they were subjected to the same forces. Possibly the intrusion of basalt towards the close of the Period had a slight effect, but, although the vents were fairly numerous, they were very small and could not have contributed appreciably to the development of the structure. Some other explanation is necessary then to account for the irregularity of arrangement and form which is characteristic of these folds.

It has lately come to be recognised that the buried topography of old formations is reflected in the structure of young overlying sediments, especially in plastic and incompetent, partially consolidated sediments such as the lignitic clays and sands of Tertiary age occurring in the Sassafras area. Reference has already been made to the presence of diabase hillocks surrounded by horizontally-bedded sediments standing out like small islands in a sea of sand. Besides these there are many others completely enveloped which are indicated only by their reflection in the structure of the overlying rocks. The present topography then is in some degree a reflection of that developed in the Pre-Tertiary rocks and serves as a guide to the geologist in the location of the most

favourable sites for boring. Blackwelder, Monnett and Powers (1) showed that such folds as have been described can reasonably be explained on the basis of differential settling or compaction of the sediments under conditions similar to those obtaining here. They point out that all sediments lose a considerable proportion of their original volume as the water content is reduced, and the grains are re-arranged by the weight of the overlying rock. The amount of shrinkage depends upon the nature of the materials, the order of their occurrence, the weight of the overlying rock, and the relief of the buried topography. Sands do not shrink as much as clays because of the relative coarseness of the component particles.

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(1) Economic Geology, Vol. XVll

Calcareous muds, likewise, are reduced by pressure into a much smaller compass. Uneven shrinkage or or differential settling of such dissimilar sediments over buried hills provide suitable conditions for the formation of superimposed folds, and make possible the accumulation of oil in these folds are favourable. In Sassafras these conditions are fulfilled. The log of No. 8 Bore shows 450 feet of lava, 20 feet of volcanic ash, 617 feet of lignitic clay containing numerous impressions of plants, and sand the thickness of which has not been determined. At a depth of 1100 feet the bed of sand, containing natural gas under enormous compression, was penetrated by the drill. The sand ascended with great speed to a point 300 feet from the surface, and, it is reported, a strong odour of gas accompanied the outbreak. This bore was sunk on the east flank of a fold, and, if it had been continued, might have entered the reservoir of the oil-bearing bed - the structure is too complicated to speculate on this point on the little data available. One of the bores sunk by the Mersey Valley Company after passing through basalt lava, and lignitic clay, entered diabase at 500 feet without meeting the sand bed. It is evident that this hole was sunk over the crest of a buried hill or ridge, and that the sand bed lies at nearly 1000 feet below sea-level flanking the hill, However, sand lenses may be found at shallower depths in the lignitic clay and in places may contain gas or oil, but only under extraordinary conditions. Some of the sand beds fail to cover the higher buried hills and the gas horizon is below their crests. Therefore, in some cases, the flanks and not the summits of the more pronounced structures offer the most favourable location for test holes.

The exact superposition of these structures over diabase hills and Palaeozoic and Proterozoic topography cannot be determined, because in addition to the few outcrops of these rocks the log of one bore only is available, and a deep mantle of basalt lava covers the greater part of the area.

NOOK AREA

Nook area is in the western part of Mersey District and is of small extent. The northern part, where the oil seep occurs, is occupied by Permo-Carboniferous strata lying between hills composed of Silurian conglomerate and Cretaceous diabase. Pipes and fissures of basalt with also lava flows are prominent on the eastern and southern parts. Whether the intrusion of this rock has, by destructive distillation, been instrumental or not in the generation of natural oil at Nook and Sassafras is still a debatable question, but the evidence at Nook suggests the influence of this medium in the process.

On the road between Tarleton and Nook deep cuttings in the Permo-Carboniferous reveal sharp irregular anticlinal folding of the strata especially opposite the north end of Brown Mountain, which is capped by a sill of diabase. In Nook proper, the folding is not so evident, but the

strata are highly tilted. As already mentioned a cannel coal seams outcrops on both sides of a seam of Tasmanite and is almost in faulted junction therewith. The mudstone in which the shale occurs is competent to form a suitable cover and the underlying grit, sandstone, and limestone members are equally well qualified to act as a medium for the migration and accumulation of oil. However, the area is very small, and the prospects are therefore not very encouraging, especially in view of the fact that the fault provides an easy way of escape for any oil that might have accumulated.

CONCLUDING REMARKS

This article is designed to lead encouragement to the Companies engaged in oil exploration in areas where the conditions are favourable. It has become a trite remark that it is easier to tell where oil will not be found than to tell where it will. Even where seeps are known and the conditions are entirely favourable, it does not necessarily follow that the concentrations will prove of commercial importance. It is really a hazardous undertaking, and necessitates a very heavy outlay, but the rewards, when they come, are very great, and the risks are, in some cases, justifiable. Perhaps the work of some of the companies has not been well advised; however, mistakes are inevitable in any undertaking and some of the difficulties could not be foreseen.

In the course of his investigations, the writer had the pleasure of working with officers directing the affairs of the several companies operating in Tasmania and he has learnt to appreciate their unflagging enthusiasm and the energy displayed by them in their efforts to locate reservoirs of oil.

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Mines Department,
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