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PETROLEUM PROSPECTS ON BRUNY ISLAND:

REPORT BY ARTHUR WADE, D.Sc. (LOND.), A.R.S.Sc., ASSOC. INST.
M.M., F.G.S.

Presented to both Houses of Parliament by His Excellency's Command.

REPORT ON THE PROSPECTS OF DISCOVERING PETROLEUM ON NORTH BRUNY ISLAND, TASMANIA.

I.—INTRODUCTORY.

OWING to the fact that certain areas on North Bruny Island have been taken up under the Mining Acts of Tasmania for the purpose of prospecting for petroleum, I made an examination of North Bruny at the request of the Minister of Mines.

II.—PHYSIOGRAPHIC FEATURES.

Bruny Island lies off the eastern coast of Tasmania, only a few miles to the south-east of Hobart. It is separated from the mainland by a deep narrow channel (D'Entrecasteaux Channel), which is little more than a mile in width in most places. The northern part of the island, which concerns this report, is almost severed into three portions by two inlets, Barnes Bay and Great Bay. The island is very hilly, ridges and low conical peaks being irregularly distributed, though north and south directions are noticeable. A thin forest of blue gum is the chief cover, save where the agricultural occupants have made their clearings.

III.—GEOLOGY.

Geologically the island consists chiefly of the black basic igneous rock called diabase, with which is associated, especially on the northerly and southerly sections, sedimentary rock belonging to the Permo-Carboniferous system, as developed in Tasmania. The central section consists, so far as examined, almost entirely of diabase, only two small isolated patches of Permo-Carboniferous sandstones being noted on the coast of Barnes Bay, west of Sykes Cove. The impossibility of finding petroleum supplies in igneous rocks removes the central portion of the island from consideration, and no further remarks concerning it are necessary.

The southern area is the more important of the two remaining sections, and will be next considered.

Excellent coastal sections of the Permo-Carboniferous series extend from Ford Bay to the south of Fancy Bay, where they disappear under the remarkable narrow sandy isthmus which connects North Bruny with South Bruny.

The beds exposed at the jetty on the western shore of Ford Bay consists of buff-coloured sandy limestone, crowded with fossils, which are chiefly preserved as casts, most of the calcium carbonate having been removed by solution. The fossils consist chiefly of *Bryozoa*, such as *Fenestella* and *Brachiopoda*, such as *Productus* and *Spirifera*. The fauna is typically Permo-Carboniferous in type. The beds dip to the south-west at the jetty, changing to west as we proceed westward. Around the point, numerous pebbles of quartz and boulders of igneous rock are somewhat sparsely distributed. Near the point a huge block of grey granite about 9 feet by 8 feet is embedded in the fossiliferous beds. At first sight it appeared to be a vein of granite piercing the beds, but further examination led me to consider it an exceptionally large boulder.

Further to the west the beds become more compact and sandy, and fossils are practically absent from the whole of the succeeding beds. North of the unnamed bay between Ford Bay and Fancy Bay, a white chalk conglomerate is exposed, but the buff-coloured sandy beds follow it again and form the remainder of the sequence.

The thickness of beds exposed is, approximately:—

Buff-coloured sandstone, somewhat calcareous, fossils rare	Feet. 200
White chalky conglomerate	50
Buff-coloured sandy beds, fossils rare...	500
Sandy limestone, fossiliferous	150
Total	900

These beds probably form most of the country between Great Bay and Adventure Bay, and exposures of the sandstone are common on passing from the one to the other. The beds probably swing round, so as to dip to the south-west between the two bays, and are, I believe, affected by a fault, running north and south just west of the lagoon, near the south-eastern extremity of North Bruny. At this point the hilly country east and south-east of Ford Bay suddenly gives place to a marshy plain occupied by two fresh-water lagoons separated from the sea by sandhills which are a continuation of the sandy isthmus joining the two islands. The hills curve round to the north of the lagoons and jut into the seas as three sharp promontories, about 1 mile to the west of Cape Frederick Henry. The country between Cape Frederick Henry and Fancy Bay is that which has been chiefly taken up for the purpose of prospecting for oil. The coastal section between the promontories mentioned and Cape Frederick Henry is important. The most westerly promontory consists of the fossiliferous Permo-Carboniferous strata, which dip to the south-west at about 15°.

The beds are apparently closely related to those at Ford Bay, judging by their characters and the similar nature of the fossils, but they represent a somewhat lower horizon. Almost 240 feet of strata are here exposed, consisting of seam of grey shale, buff-coloured sandy limestones, and sandstones in beds varying between about 1 foot and 4 feet in thickness. The sandy limestones and shales are very fossiliferous, the types being similar to those at Ford Bay. Some of the sandy beds show a sort of incipient pisolitic structure, but the most remarkable feature shown by the strata was the intense induration, especially of the shales. This led me to suspect the close proximity of igneous rocks. The sea washes around the base of the two westerly points, so that an attempt to scramble round the face of the cliff from the west was unsuccessful. Climbing over the top and down the steep slope to the eastward, the promontories were examined from the opposite side, and here the secret of the induration was exposed. The westerly face of the cliff is formed by the sedimentary series described, but the eastern face is composed of diabase, against which the strata rest as a sort of shell. A little of the sandy limestone resting on the diabase on the eastern side had been converted into a flinty marble, and the whole of the sandy strata much resembled flint or chert. The third promontory is composed entirely of diabase, which continues eastward and forms the mass of the Cape Frederick Henry Peninsula. A sandy bay separates the latter from the former outcrop. On the ocean side of Cape Frederick Henry indurated Permo-Carboniferous strata containing fossils come in again to the east of the diabase.

The whole structure appears to me to be that of a large sill or laccolite, which has been intruded from the west into the Permo-Carboniferous strata on north and south fractures. This observation is confirmed to some extent by an examination of the diabase itself.

Where the basic igneous rock first crops out from under the sedimentary strata west of Cape Frederick Henry, it is a black compact finely-crystalline rock. Passing to the east a sharp line of junction is seen on the cliff face showing the contact between the compact rock and a more coarsely crystalline variety. This line of junction dips away to the south-west, just as do the sedimentary strata above, thus showing that the intrusion has been almost along the bedding-planes of the strata, and that the pressure was from the west or south-west.

Passing further east the diabase becomes more coarsely crystalline, until in Cape Frederick Henry it assumes the character of a diorite. The degree of crystallisation is dependent on the rapidity of cooling. The surface of the intruded sheet cooled quickly in contact with the sedimentary strata above, while the molten material towards the centre of the flow cooled more slowly, and with the consequent formation of large crystals. Hence, Cape Frederick Henry represents the interior of the intrusive sheet, which was both overlain and, probably, underlain by the Permo-Carboniferous rocks, which are now associated with it. The structures are typically those connected with that form of igneous intrusion which is known as "laccolite."

The northern section of North Bruny Island is very similar in many ways to the southern. The western coast consists, again, mainly of Permo-Carboniferous strata. From Kelly's Point to a little south of Rat Bay, buff-coloured and yellow sandstones, sometimes calcareous, often of a friable nature, easily weathered, and frequently false bedded, dip over in south-westerly directions. Over 1000 feet are here exposed, unless the beds are repeated by faulting in places. To the south the beds are terminated by a diabase mass forming the peninsula at Woodcutters' Point. East of Shelter Cove the sandstone strata form a peninsula, the beds, now dipping to the north-east, showing that the diabase intrusions have considerably disturbed the sedimentary formations. The peninsula to the east of this is again diabase, but the eastern side of Simmonds Bay is occupied chiefly by the yellow sandy beds, which are here somewhat metamorphosed, owing to the proximity of the igneous rocks. East of Simmonds Bay the diabase occupies most of the country forming the hills, and running out to sea at One-Tree Point. As at Cape Frederick Henry, the rock here is coarsely crystalline, and is more of the nature of a diorite.

Summarising, it is clear that North Bruny Island consists chiefly of diabase rocks which have been intruded into, and which have considerably affected, a series of strata of Permo-Carboniferous age.

Two horizontal sections are appended, showing the structure of the country. AA is taken across the southern end of the south part of the island; BB across the southern end of the northern segment. The map shows the disposition of the rocks so far as examined by myself. The diabase covers a greater area than is shown, and it is certain that other patches of sedimentary rocks be upon it. Sufficient is shown on the map for the purpose of this report, and the quantities omitted do not affect the main issue.

In a comparatively small area like North Bruny Island, the rocks showing around the coast will represent the average structure of the country throughout. The sea, acting like a saw, has laid bare the rock-formations along one line, and we may take it as

certain that if the cut had been made some little distance on either side of this, little difference in the average nature of the rocks exposed would be noted. Thus, we may conclude that the Diabase rocks so evident around the coasts of North Bruny Island would still form the greater part of any exposure we should make were we to cut an artificial section elsewhere through the island.

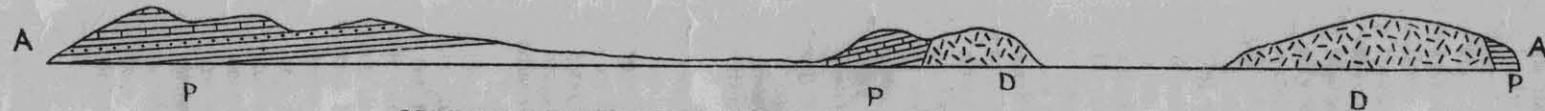
IV.—PROSPECTS OF FINDING PETROLEUM.

The belief that petroleum will be found on North Bruny Island seems to be based upon reports that seepages of oil have been seen there. These seepages are peculiar in that they are apparently only observable in the summer time, and that they cease to flow in cold weather. No samples seem to have been collected and preserved to show the nature of these phenomena, nor do they seem to leave any evidence of their existence behind them when they are not active. So far as I can learn, nobody competent to ascertain whether the oozing material was really bituminous in its nature has ever seen them, and I must remark here that no phenomenon in nature seems to have more valueless imitations wherewith the untrained observer is deceived than a petroleum seepage. Every man who has applied himself to the study of petroleum has at some time or other in his career subjected himself to many discomforts, toiled over many miles of country, and wasted much valuable time in order to examine reported seepages, which at the end turned out to be merely films or deposits of hydrated oxide of iron or black muds filled with the foetid residues of organic decay, which are common associates of springs and marshes. So that in the first place the mere report of seepages by persons whose training has not made them competent to judge, or who have never before been actually acquainted with such phenomena, carries no weight, unless accompanied by actual samples. Nobody would think of expending time or handing over money for the purpose of prospecting for gold or other minerals on a report unaccompanied by samples.

In the second place, the circumstances accompanying the report are not very favourable. Many crude oils still remain liquid enough to flow from the rocks at 20° below freezing point (Fahr.), a temperature which is probably never reached in the lowlands and coastal areas of Tasmania. Heavy bitumens and certain heavy crudes might congeal in the winter time, but even then they would continue to show distinct traces of their presence, and would easily be found. Oil seepages usually stain the rocks for some distances around them, saturate any loose or sandy beds about, and are always accompanied by an odour which is unmistakeable at any time, winter or summer.

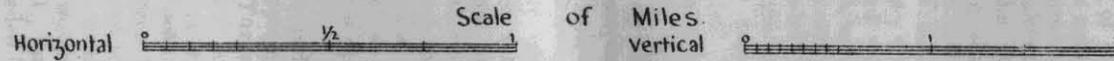
It is far most likely that the seepages observed on Bruny Island consist of films or deposits of ferric hydroxide or hydrated oxide of iron in connection with springs of water, which are by no means rare, especially on the coast. The diabase is a rock rich in iron, and any water which came into contact with it would certainly acquire sufficient iron to give rise to such deposits. Such springs would naturally flow more in the winter time, and would tend to become intermittent or quiescent in the summer. As long as the flow was regular the iron would be carried away, and would not be observed. In the summer it would accumulate, as is most usual in the stagnant pools and marshy places near to the springs. The gradual accumulation of the iron would present the oily appearance, which is so often taken for an oily scum or a seepage of petroleum. I have already shown how such an occurrence can be distinguished from a true petroleum seepage in my

SECTION II



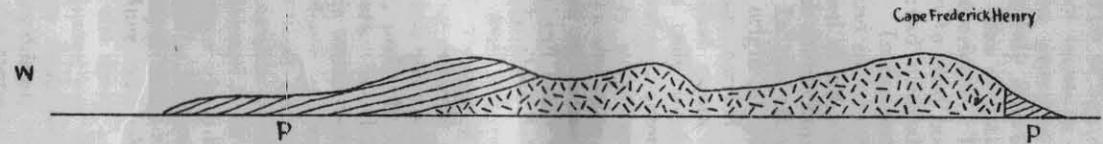
SECTION ACROSS SOUTH END OF SOUTHERN PENINSULA
NORTH BRUNY ISLAND.

SECTION III



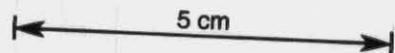
SECTION ACROSS SOUTH END OF NORTHERN PENINSULA
NORTH BRUNY ISLAND.

SECTION I



GENERALISED SECTION SHOWING STRUCTURE OF THE SOUTH END
OF NORTH BRUNY ISLAND

- P Permo Carboniferous Strata.
- D Diabase (which is more coarsely Crystalline towards the East.)



report on the "Supposed Oil-bearing Areas of South Australia."*

It may be objected that the question of the existence of petroleum seepages does not matter. Indeed, the public has been informed that such is the case, and that oilfields are common throughout which no seepages or surface indications are to be found. Such a statement requires to be amplified and explained. In itself, it is likely to be misleading. Taking the leading oilfields of the world, seepages occur in California, Pennsylvania, Canada, Mexico, the great Russian oilfields, along the Carpathians, in the East Indies, in Burma, in Persia, and in Egypt; and it is these seepages which have led to the development of these oilfields.† Now, oil is a liquid which escapes through joints which are watertight. Moreover, if the supply is large enough to be payable, it is usually under greater pressure than a body of enclosed water would be. If, therefore, the rocks containing it are broken, faulted, or otherwise disturbed, the oil will leak out along such lines of weakness, and will be seen somewhere or other at the surface. Where the rocks outcrop the oil-bearing character is usually easily observed. Seepages will not occur where the surface rocks are whole and undisturbed. It does not follow that in all such cases oil must exist. It is safe to say that in most such cases oil does not exist. But, assuming that the same rocks at some not far distant locality have already been proved to contain oil, then it is certainly worth while to put down bores for the purpose of testing the area of undisturbed rocks. This has been done frequently in America, and is what the Americans call "Wild Catting," a very different application of this term than is usual in other branches of mining, and these are the cases referred to in the statement we are dealing with. The facts, therefore, are that seepages are of the utmost importance, but in certain well-defined cases we are justified in boring without them. To extend this to all areas where seepages are unknown would be absurd, and is merely waste of time and money. It would mean that every area of sedimentary rocks would be a possible oilfield, and that this is not so, is proved in innumerable cases throughout the world, and especially in Australia, where strata have been bored through for water and minerals to very great depths without a trace of oil being discovered.

But even seepages are not an infallible indication that oil in payable quantities exists.‡ Seepages occur in England, in France, in Spain, and in Turkey, and yet though boring has been done in each of these countries, no oilfield has been discovered in any one of them by this means. Large seepages occur along the Egyptian coast near which over a dozen borings have been put down, all of which have failed to strike any appreciable body of oil. The whole question is not so simple as the wild enthusiast would have people believe. Seepages are important, but they are not infallible, something else is needed. The structure of the strata must be suitable, and the oil-bearing beds must be safeguarded beneath the surface, so as to prevent them from being waterlogged. Several fields that produced once are now useless,

* Geol. Surv., S. Aust., Bull. No. 4, 1915, p. 39.

† "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."—Prof. David T. Day, U.S. Naval Inst., Proc., Vol. 40, Jan.-Feb., 1914.

‡ "It must not be thought, however, that every petroleum seepage or outcrop of an oil sand is indicative of the presence of oil in abundant quantities. Many seepages are found, but few develop into oilfields, because the oil may never have been present in the strata except in minute quantities, or, if there at one time, it may have escaped because of any one of a number of geological changes and the resulting alterations in underground conditions and structure."—Pain and Stroud, "Oil Production Methods," San Francisco, 1913, pp. 48-49.

owing to the fact that water has penetrated into the oil-bearing strata and destroyed their value. It should now be plain that the whole question of the presence of oil in underground strata is one that requires the most careful investigation by men whose knowledge of the necessary conditions has been acquired by careful training and wide experience. Even the experienced well-drillers of California are now applying to the Government of that State for such men to help them to locate sites for borings in order that money shall not be wasted in foolish ventures.

The idea has been widely spread that the occurrence of coal in strata is an indication that petroleum is likely to be found. This is, again, very erroneous. The fact is that oil is not found in any quantities in close connection with the principal coalfields of the world. The idea is entirely due to the reading of petroleum literature by men of little scientific knowledge and no oilfield experience. It seems to be as dangerous for some men to read books on petroleum as it is for others to read medical works on "the ill the flesh is heir to." In the one case he acquires the idea that he can find oil anywhere, and in the other that he is possessed of all the ills referred to. Let us try to state, in as simple language as possible, how the idea arises. In the attempt to solve the vexed problem of the origin of petroleum, notable investigations have been carried out in Eastern India. It was found that strata of a certain age varied considerably, as they were traced across a considerable tract of country, according to the conditions under which they were deposited. Some of the strata were laid down on an old shore-line, and in consequence consisted of coarse gritty materials containing pebble beds and other features common to coastal conditions. In these beds plant remains were rarely preserved, and consisted of stems and impressions now entirely formed of gritty materials, the woody matter having entirely disappeared. At other places the materials were evidently deposited in rather deeper water, probably in coastal lagoons or in estuaries of rivers. In this case a greater quantity of plant debris accumulated, and was preserved by the greater depth of water and by the greater amount of fine mud and sand which was deposited in such favourable areas. In this case coals seams have been formed from the carbonaceous matter during the vast ages which have elapsed since the period of deposition. Elsewhere, where the water was probably deeper still, and the materials deposited were again finer, and when the character of the vegetation from the decay and destruction of which the deposits originated was of a different character, may be a change from tropical land plants to marine plants and organisms, which thrive in the warm shallow seas of the tropics; the carbonaceous material seems to have been preserved as petroleum. It must be observed that the oil is not found in the beds containing coal, but in the extension of these beds, where conditions and materials were very different, and happened to be favourable to the formation of petroleum. Now, such conditions do not occur in conjunction with all, nor even with most, coalfields. They may occur by themselves in areas where no coal has been found at all. Coal is found near to the Great Pennsylvanian oilfield in America, but it occurs in beds whose age differs by millions of years from that of the oil-bearing strata, with which it has no connection whatever. Coal may exist without connoting the presence of oil, and oil without coal; and neither is an indication of the presence of the other in any area of sedimentary rocks.

Oil is chiefly found at present in strata of Tertiary age, and I find that there is an impression abroad that beds of this age exist on North Bruny Island.

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There are no strata of Tertiary age on the island. The sedimentary rocks belong entirely to the Permo-Carboniferous system, which has not been prolific in oil supplies. This does not mean that oil is necessarily absent from rocks of this age, but that the chances that it is present are not so good.

The fact that these strata on Bruny Island are frequently crowded with marine fossils has also been spoken of as a hopeful sign. With regard to this, I need but quote McLaughlin & Waring, in a review of the petroleum industry of California:* "Fossil remains of land or water animals and plants occur in nearly all sedimentary rocks, but are not an indication of the presence of oil."

V.—CONCLUSIONS.

Leaving these general considerations, let us examine the more particular problems presented by North Bruny; and really there is little to say if the foregoing facts are borne in mind. R. M. Johnston examined the island more closely and scientifically than has ever been done by any other person, and he stated nearly 30 years ago "the fundamental rock of Bruny Island, here and there rising into bold crests, as at Fluted Cape and Mt.

Bruny, is essentially a diabasic greenstone"; and my own observations confirm this. Neither myself nor any other person qualified to judge has seen any evidence of petroleum seepages on Bruny Island; they appear to be mythical and elusive.

The sedimentary rocks everywhere rest on the diabase foundation, which has disturbed them, and completely changed their characters in places. Apart from the lack of seepages, there is no more evidence to justify the boring for petroleum on the part of the island with which we are concerned than there is in any part of Hobart itself or over the rest of Tasmania. Even a genuine oil seepage from which samples can be taken and tested in a tolerably thick series of sedimentary rocks showing suitable structure is a speculation, but a legitimate speculation; but to bore for petroleum on the evidence which is available on Bruny, and with igneous rocks forming the greater part of the surface and the whole of the foundation of the island at no great depth, is a waste of public money at a time when money is required for urgent national purposes and for legitimate enterprise.

* California State Mining Bureau, Bull 69, 1914, p. 21.

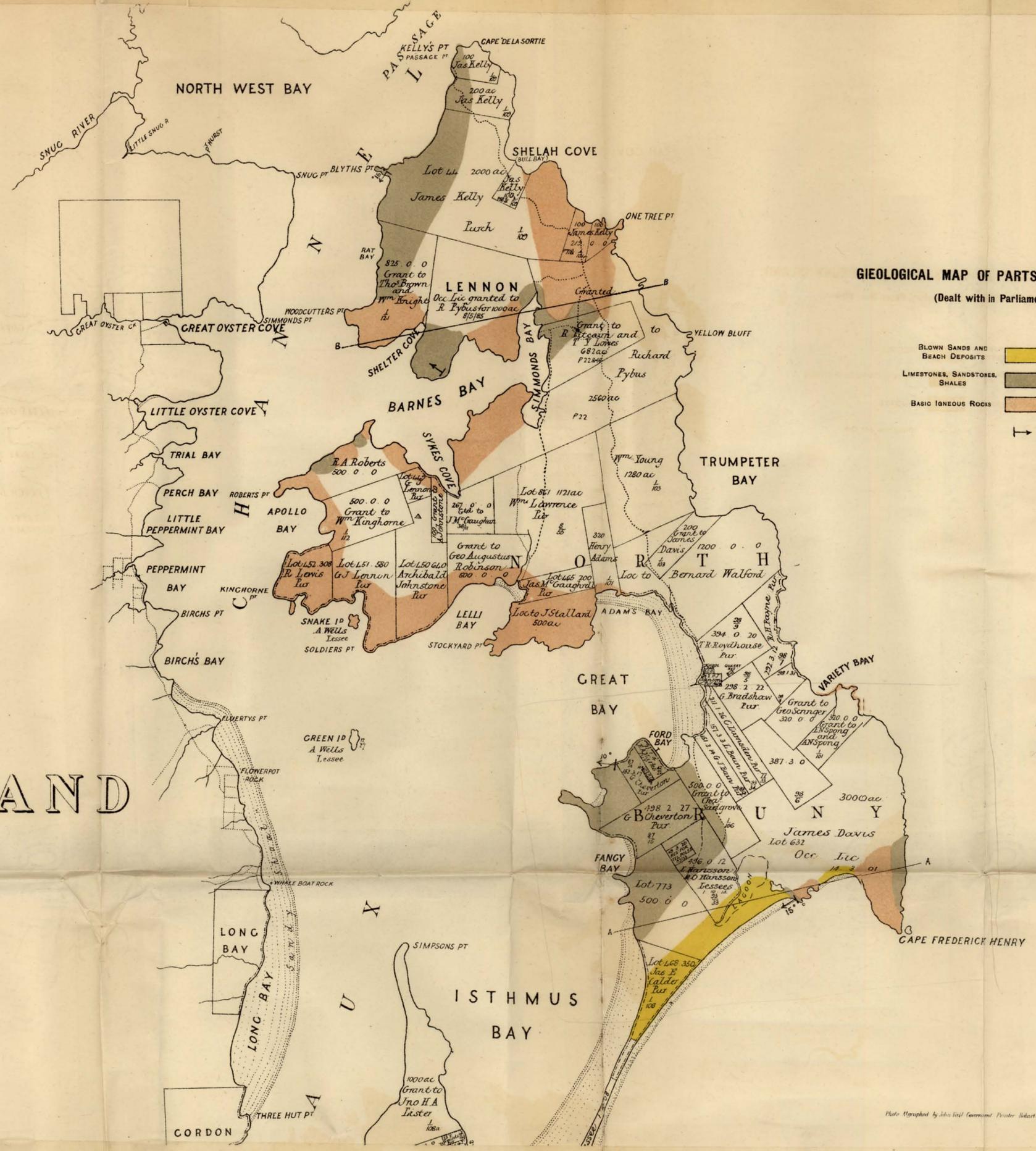
* "Notes on the Geology of Bruny Island," Papers and Proc. of the Royal Society of Tasmania for 1886, p. 19.

ARTHUR WADE, D.Sc., &c.

GEOLOGICAL MAP OF PARTS OF NORTH BRUNY ISLAND.

(Dealt with in Parliamentary Paper No. 60.)

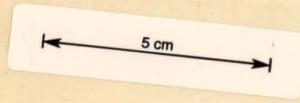
- BLOWN SANDS AND BEACH DEPOSITS RECENT
- LIMESTONES, SANDSTONES, SHALES PERMO-CARBONIFEROUS
- BASIC IGNEOUS ROCKS DIABASE
- DIRECTION OF DIP



BRUNY ISLAND

SCALE 1 INCH TO A MILE

Compiled and Drawn at the Dep^t of Surveys Hobart



North of sheet.
Along east coast and of sheet.

Photo Micrograph by John Vasil Government Printer Robert Tasmanian