

GEOLOGICAL REPORTS MADE IN 1921

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P R E F A C E

This folder contains three reports made
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As will be seen the reports were made in
1921 but they are still of interest.

PROGRESS REPORT ON THE POSSIBILITY OF THE
OCCURRENCE OF LIQUID PETROLEUM IN THE FALKLAND
ISLANDS

I have the honour to submit herewith a progress report on the results of my investigations concerning the possibility of the occurrence of liquid petroleum in the Falkland Islands.

In the prosecution of this enquiry attention is being specially directed to the following points:-

1. Evidence at the surface suggestive of the existence of liquid petroleum below.
2. The geological age and character of the possible oil-bearing rocks.
3. The tectonic features and general disposition of the strata.

In connection with (1) above, I am seeking especially:-
(a) Surface oil-seepages, (b) Bituminous material filling cracks and fissures. I regret to state that, so far, both these lines of enquiry have produced no substantial result. I have examined many alleged "oil-seepages", and have found in every case that the seeming appearance of oil was due to the presence of iron-oxide in peaty water. One case only perhaps, of an alleged oil-seepage is worthy of record. An old inhabitant told me that many years ago he came upon an unmistakable "paraffin spring" at Bold Cove (the creek running in a N.N.E. direction between Bold Point, West Falkland, and the entrance to Port Howard). He was very positive upon the point and assured me that he could not be mistaken as he supposed the liquid to be water and attempted to drink it. He informed me that he had tried on many subsequent occasions to rediscover the spring but had failed to find it. Afterwards he was moved to another part of the Falklands and had had no opportunity of late years of revisiting the spot. I also examined the same neighbourhood but could find no signs of any oil-seepage. My only reason for incorporating this statement in the present report is that in this area I discovered an outlier of the Lafonian tillite - an occurrence which is probably, but not certainly, associated with faulting. The junction-plane of two geological formations, especially in the neighbourhood of faults, is a likely area to examine for oil-seepages, hence I think it possible that there may be something in the tale.

I have, so far, seen no signs whatever of bituminous material filling cracks and fissures. Apart from the bituminous shale of Port Sussex, (which is a distinctly bedded material) I have seen no bituminous substances whatsoever from the Lafonian Beds. Bedded black shales, some apparently slightly bituminous, occur in the Devono-Carboniferous rocks (upper part).

With regard to consideration (2) above, we are dealing, in the Falklands, with a sequence of rocks, the whole of which are of Palaeozoic age and which have, consequently, passed through many vicissitudes since the very remote period of their deposition. It should be borne in mind, therefore, that, even assuming these rocks to have been at one time oil-bearing there must have been much more opportunity for the escape of the oil than would have been the case in younger strata. The Devono-Carboniferous rocks can be correlated, at/...

at least in part, with the Bokkeveld and Witteberg Beds of South Africa, and these beds have, unfortunately, never been known to yield oil.

Nevertheless, if oil occurs in the Falkland Islands, it is in the Devono-Carboniferous rocks and not the Gondwana Beds that I should expect to find it. It is generally accepted now that oil-bearing strata are (very frequently) rocks of marine origin which were deposited in water of no very great depth but of sufficient depth to exclude air. Whilst the uppermost Devono-Carboniferous rocks are very probably of fresh water character, judging from their plant remains, yet at no great depth below them occur shallow-water marine beds with abundant shell-fish remains.

The Gondwana Beds of the Falklands, on the other hand, are, very clearly, strata accumulated under terrestrial conditions, as may be seen from the facts that their lowest beds are glacial accumulations whilst the succeeding beds contain the *Glossopteris* flora. Strata of this character are now generally regarded as a more hopeful source of coal rather than oil. In this connection it is of interest to note that the Lower Gondwana Beds of the Southern Karroo were recently examined for liquid petroleum by the officers of the Geological Survey of that area, and their report was adverse.

In view of the great age of the Devono-Carboniferous sediments I consider (in the absence of definite surface indications) that there are no special grounds for any hope of finding liquid petroleum in areas where these rocks are now exposed at the surface and unprotected by any cap-rock to serve as a sealage. I do not look, therefore, with any special hope to West Falkland, since its surface is composed almost entirely of Devono-Carboniferous strata. The most hopeful area is Lafonia (the southern part of East Falkland) where the Devono-Carboniferous rocks are overlain by the Gondwana or Lafonian Beds.

In regard to consideration (3) above, the structure of the Falkland Islands is that of a syncline, the Gondwana or Lafonian Beds resting in a great hollow or sag in the Devono-Carboniferous rocks. This structure is the result of earth-movements which took place some time after the deposition of the Lafonian rocks. Two sets of folding-movements combined to bring about this result. One set of movements operated about axes oriented slightly north of west and south of east, although wavering somewhat in their courses. The effects of this set of folding-movements are very clearly seen in the northern, Devono-Carboniferous area of East Falkland, and are still to be traced to some extent in the northern part of West Falkland. The other set of folding-movements operated about axes of N.N.E.-S.S.W. orientation and the area chiefly affected by them is that lying near to the east coast of West Falkland. Both sets of movements died out towards the south, so that Lafonia and the southern part of West Falkland are comparatively undisturbed.

Both sets of movements gave rise to the production of parallel ridges and troughs. The folding affected the border of the main area of Lafonian rocks but does not appear to have extended very far into the region occupied by them. I have seen, both in East and West Falkland, isolated outliers of the Lafonian tillite preserved in the troughs or valleys between neighbouring fold-ridges of the Devono-Carboniferous quartzite. As a result, the junction everywhere between the Devono-Carboniferous and the Lafonian is marked by a very high dip which rapidly flattens out as the main area of deposition of the Lafonian rocks is approached.

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Only the northerly and westerly terminations of the synclinal area are known. I have no knowledge of the position of the termination of the basin of Lafonian rocks on the south and east. Over the greater part of Lafonia the rocks dip very gently indeed and are practically horizontal over wide stretches of country. I have, so far, seen no signs in the south and east of the complementary upturn of the rocks which indicates proximity to the remaining portion of the boundary of the syncline.

In the absence of surface-indications of its presence, the occurrence of oil in a set of strata can only be determined by exploratory boring. If it were proposed, at any time, to bore for oil in Lafonia the following considerations should be borne in mind. A depth of something between 3,000 and 4,000 feet is usually not exceeded in boring operations. If the Devono-Carboniferous rocks beneath Lafonia were being explored for oil it would be necessary to bore fairly near the exposed junction of these rocks with the Lafonian. The Lafonian tillite and succeeding Lafonian Sandstone alone make up a thickness exceeding 3,000 feet. In those portions of Lafonia remote from the Lafonian boundary the total thickness of strata above the concealed Devono-Carboniferous rocks must be well over 3,000 feet, consequently a boring of the usual depth would not succeed in reaching the latter rocks. Furthermore the probable horizontality of these strata here renders this area not the best for oil-seeking operations. Some site on the outcrop of the Lafonian tillite would probably be the best for any such exploration.

In that case only the tillite itself would have to be passed through before reaching the underlying Devono-Carboniferous rocks, and that not at its full thickness. Moreover the dip of the strata in the neighbourhood of the exposed junction of the two formations is sharper, and this is an important factor favouring the separation of gas and oil in the strata from water.

To sum up in conclusion:-

1. The rocks in other parts of the world corresponding to the Devono-Carboniferous of the Falkland Islands have never been known (so far as I am aware) to yield oil.
2. The rocks in other parts of the world corresponding to the Lafonian Beds of the Falkland Islands have been examined for oil and have been reported adversely upon.
3. I have, so far, seen no surface-indications of the existence of oil in the Falkland Islands.

In view of these considerations, whilst I feel that there are certain theoretical grounds on which oil might be expected to occur beneath Lafonia, I am not, at present, prepared to state that exploratory boring-operations in that area would be likely to meet with success.

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Stanley.
31st May, 1921.

REPORT ON THE OCCURRENCE OF CERTAIN MINERALS,
OTHER THAN COAL AND OIL, IN THE FALKLAND
ISLANDS

I have the honour to submit herewith a report on the occurrence of certain minerals in the Falkland Islands.

1. GLASS SAND.

Much good white quartz sand occurs on certain beaches in the Islands. It is produced, usually, by the weathering of the white Devonian-Carboniferous quartzite and sandstone. It varies in coarseness from place to place, but is usually fine-grained and appears to be very well graded (i.e. the sand-grains are very uniform in size). It is not sharp sand, the sand-grains being well rounded. The appearance of much of this sand suggests to me that it would probably serve well for the manufacture of glass, but it is not possible to say definitely until chemical and mechanical analyses of samples have been made. I have myself made a special study of the methods of making mechanical analyses of sands (Geological Magazine, 1920 - "On the Investigation of the Mechanical Constitution of Loose Arenaceous Sediments by the method of Elutriation") and am collecting samples of Falkland Islands sands which I propose to examine on my return to England.

Of numerous localities the following are noteworthy as being likely to produce good glass sand:- Yorke Bay near Port Stanley, Elephant Bay (Pebble Island), Carcass Island, New Island, Carcass Point (east of Fox Bay, West Falkland), Port Stephens.

2. KAOLIN.

Thin seams of impure Kaolin, of poor quality, occur in some places, though not abundantly, the usual mode of occurrence being on low ground at the foot of a quartzite ridge. The Devonian-Carboniferous quartzites and sandstones are somewhat felspathic and the decomposition of the feldspars has produced the kaolinitic material. The clay is very gritty from its inclusion of quartz-grains and it is doubtful whether the material is of any commercial value. A sample will be forwarded to the Imperial Institute for examination.

3. IRON ORE.

Bog iron-ore occurs in the Falklands. It is seen either as earthy forms of limonite, found mostly in the swamps and bogs of the "camp" or as siderite (chalybite). The latter usually occurs on somewhat drier ground. A sample of siderite from the Falklands has already been analysed at the Imperial Institute and reported favourably upon. The iron-ore of the Falklands is, however, very sporadic in its occurrence, and is found only in small, local patches, not more than a foot or so in diameter, and a few inches in thickness. It would take a long time to collect any quantity of it, and the question of its transport over the "camp" would be a difficult one.

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At various times samples of Iron-pyrites have been sent for analysis to the Imperial Institute from the Falklands. This mineral is, however, surprisingly rare, so that specimens of it are regarded as great curiosities. It would appear that, in the past, mineral specimens from the Falklands have been sent to the Imperial Institute for examination, not because the minerals occur in abundance and may possibly be of value commercially, but because they have been regarded as rare specimens likely to interest scientific authorities at home.

4. GRAPHITE.

I have already discussed the graphitic shale of the Falklands in my report dealing with the possibility of the occurrence of coal. The graphitic material which I have seen is quite worthless, and I have no knowledge of the existence of graphitic segregations.

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31st May, 1921.

THE POSSIBILITY OF THE OCCURRENCE OF COAL IN THE FALKLAND ISLANDS

I have the honour to submit therewith a report on the results of my investigations into the possibility of the occurrence of coal in the Falkland Islands, in so far as such investigations have proceeded at present.

I regret to state that the result of my enquiries is disappointing, and that the outlook, in reference to the possible occurrence of coal from the Colony, is not hopeful.

It will be seen, from my progress report on the general geology of the Falkland Islands, that there are two geological formations within the islands which could possibly be coal-bearing (1) The Devono-Carboniferous rocks (2) The Lower Gondwana or Lafonian rocks.

The outcrop of the Devono-Carboniferous rocks occupies the whole of West Falkland, save for certain coastal fringes of other strata; and the whole of East Falkland, north of a line extending from Port Fitzroy to Port Sussex, is similarly occupied.

As I have indicated in my general report, these Devono-Carboniferous rocks consist of a lower barren formation of sandstones and quartzitic rocks, succeeded by strata which can be correlated with...

with the Bokkeveld and Witteberg Beds of South Africa. Unfortunately the Bokkeveld and Witteberg Beds have never yet yielded coal, so far as I am aware.

As is only to be expected in strata known to contain plant-remains, seams and other occurrences of carbonaceous material are to be found, in the upper part of the Devono-Carboniferous formation. There occur what the inhabitants call "coal-seams". I have myself noted examples, and have had others pointed out to me by various guides. The thickest example which has come under my notice was less than 2 feet thick. These seams are simply bands of shale, sufficiently carbonaceous to be black in colour, which, happening to occur in a zone of pressure where the rocks have been folded and crushed, have had imparted to them, in consequence of slickensiding, a shining coal-like appearance. A good example occurs on the south side of Chartres River opposite the settlement. Here, a diabase dyke cutting through the Devono-Carboniferous rocks, has disturbed and metamorphosed them for some distance. Near the intrusion occurs the coal-like shale-band. The material will not burn, although it appears to be faintly bituminous. In my opinion it is quite worthless, but even if it were a good coal, or a highly bituminous shale, it would make no difference since the seam is less than 2 feet in thickness and can be traced for a few yards only.

Another so-called "coal-seam" occurs in the Devono-Carboniferous rocks of West Point Island. I have seen the material and regard it as of no importance. Mr A.E. Felton, the occupant of West Point Island, the discoverer of this seam, admitted to me that he could not succeed in making the material burn, even in his forge-fire.

In some instances where the pressure has been particularly intense, as for example, in the neighbourhood of faults, carbonaceous shales have become somewhat graphitic. Of several specimens which I have examined, from exposures noticed either by myself or shown to me by guides, I have seen none of any special interest. The graphitic material is very impure and the specimens can be made to mark paper only with difficulty. A good example of the occurrence of this graphitic material occurs at Port Howard, at a fault in the fossiliferous shales of the Devono-Carboniferous.

This graphitic shale, when weathered, produces a black clay, which, at times, becomes incorporated with the peat. I have seen several specimens of peat containing graphitic material.

So far, then, as the Devono-Carboniferous rocks are concerned, I see no signs of the occurrence of important coal-seams.

With regard to the Lower Gondwana or Lafonian rocks, the occurrence in these strata of coal-like material, or bituminous shale, at Port Sussex, has long been known. The carbonaceous substance occurs fairly low down in the sequence of the Lafonian rocks, at an horizon above, but not very much above, the Lafonian Sandstone which overlies the tillite. This material was examined by Mosely, during the "Challenger" expedition, and he reported that "the beds of so-called coal were simply very bituminous layers among the clay-slates, sometimes becoming a sort of culm which might possibly answer to mix with coal and burn in a smithy fire but which could never be worked with advantage. The "graphite" was only the blackest samples of the same material."

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More recently the same material has been re-examined. The Rev. C. McDonald Hobley, a former Assistant Chaplain at Christ Church Cathedral, Port Stanley, collected some specimens at Port Sussex, East Falkland, which included the alleged "coal" and "graphite". These specimens were examined in September, 1917, by Mr E.G. Radley and Dr. H.H. Thomas of H.M. Geological Survey. In their report they said "We consider that the materials submitted have no commercial value, the hard black coaly substance being only carbonaceous shale and of no use as a fuel. Further, the contained graphite is so intimately mixed with impurity that it could not be mechanically separated."

With regard to that portion of the Lafonian Beds which lies above the deposits immediately associated with the basal part, i.e. the strata above the Lafonian tillite, Lafonian Sandstone and slaty and shaly beds associated therewith, I regret to say that, in so far as my investigations have proceeded, I have seen no evidence whatsoever of the existence of coal-seams, or even of seams of material to any degree carbonaceous or bituminous. It was reported to me that a "coal-seam" existed in the "camp" about an hour's ride (say 5 miles), north and slightly west of the settlement at North Arm (Bay of Harbours) I rode out to the spot and there saw an insignificant deposit of a peculiar black and shiny bog iron-ore (presumably limonite) occurring in the banks of, and on the bottom of, a small stream which had excavated a valley in Lafonian rocks. Hopes raised on that occasion have been dashed more than once, subsequently. Even the bog-iron ore, such as it is, does not occur in quantity sufficient to attract any attention. I regret to say that, considering the extent of the area which I have at present under survey, I have never examined a series of rocks so barren, from the point of view of their exploitation for included minerals.

It should be recorded, however, that I have not, so far, had opportunity to examine the Lafonian rocks in anything like detail. Nevertheless, I state now, with only a general knowledge of this formation, that, although I contemplate investigating these rocks in greater detail in the near future, I do not look upon them with any hope in reference to their coal-bearing possibilities.

I have indicated, in my general report, the evidence upon which I base my opinion that there are no strong grounds for hoping to find, in Lafonia, any great thickness of Lafonian Beds, above the basal tillite. The unfortunate thing is that (comparing the Falkland Lafonian with the Gondwana succession in Southern Karroo - these two areas apparently being the most closely comparable) one can only build hopes of finding coal-seams of any significance when strata equivalent to the Ecca and higher beds of the Southern Karroo are represented, and I have yet to show certainly that such is the case. It may be that my future work will lead to a more hopeful outlook, but I state now, that I do not build upon any such possibility.

Certainly I have found the *Glossopteris flora* in several places in Lafonia and, so far as I am aware, this is not found in South Africa below the Ecca Series. I found it, however, in greatest abundance at North Arm (Bay of Harbours, East Falkland) and the association of fossil-plants there occurring, whilst not affording conclusive evidence, nevertheless suggested to my mind an early type of the *Glossopteris flora*. Yet the Lafonian beds of North Arm probably occupy an horizon as high, or nearly as high, as any in the Falkland Islands.

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Had the Lafonian Beds of the Falkland Islands been let down into the older rocks by great faults, as Halle supposed, there would then have been strong grounds for expecting much younger Gondwana Beds in Lafonia. It is to be feared, however, that the non-existence of any such faulting gives the death blow to hopes of finding these younger beds.

It remains for me to discuss the matter of the alleged occurrence of "bitumen" in the Falkland Islands. It has been stated in correspondence, that there appear to be several outcrops of this material in the Falklands. I have made this point the subject of the most careful investigation and enquiry since I have been here, and have to state with regret that there is no evidence whatever of these alleged outcrops. A sample of the material under discussion (which I regard, personally, as cannel coal) was received at the Imperial Institute, from the Falklands in 1909. It was analysed by Mr T. Crook, who reported favourably upon it. During my stay here I have traced down the original specimen, a portion of which was sent home for analysis. It came from Crooked Inlet, on the Devono-Carboniferous portion of Hill Cove camp, West Falkland, and was picked up on the beach. Two other specimens have been referred to in official correspondence, viz. one from Lion Creek and the other from Bull Point, both these localities being in the southern part of Lafonia. In addition to these three specimens I have seen another which is said to have come from the beach at Ruggles Island. Further I have myself procured three other specimens from inhabitants, one from Spring Point (West Falkland) the second from Rocky Inlet (Christmas Harbour, West Falkland) and the third from a nameless creek at Port Stephens, West Falkland. The following points become apparent:-

1. The material is extremely rare. Local interest has been much attracted in reference to this particular substance since the time when Governor Allardyce requested a special look-out for it. I have found the shepherds etc., of the camp extremely ready and willing to keep a sharp look-out for any particular rock or substance which I signified was of any consequence, and have been assured on all sides that this "bitumen" has been sought for most diligently. In spite of this only seven specimens have come to hand.
2. The material is found both where Devono-Carboniferous rocks and also Lafonian rocks occur. Of the seven specimens known, four come from beaches where the surrounding strata are Devono-Carboniferous and three from beaches in the vicinity of Lafonian rocks.
3. The material is always found on the beach. The specific gravity of the specimen examined by Mr Crook was 1.01. That of another specimen examined by myself was 1.009. The material floats in sea-water and sinks in fresh water.

I give it as my opinion that the material is simply washed up on the beaches and may have travelled great distances. Every one of the seven known specimens shows some portion of its surface worn and battered and other portions apparently freshly fractured, but I do not think much can be made of these facts.

As I have said, I regard the material as cannel coal, and I surmise that it comes, probably, from some area of Gondwana rocks, but rocks/...

rocks on a higher horizon than any seen in the Falkland Islands. As to where that area may be seems to me idle to speculate upon. I have seen nothing at all like this "bitumen", "torbanite" or cannel coal anywhere in the bedded rocks of the Falklands either in the Devonian-Carboniferous or the Lafonian.

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31st May, 1921.

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