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Considerations Respecting Routes for an Antarctic Expedition

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(New Zealand), in April, 1903, to recruit men and officers, and fill up with coals and fresh provisions. She would then proceed with her magnetic survey across the Pacific, returning to this country in August.

This will be a very glorious achievement, even if one quarter of what is contemplated and suggested can be done; for the difficulties and dangers of the undertaking cannot be exaggerated. We who send our gallant countrymen forth on this hazardous enterprise are bound to see that all has been done that human foresight can devise to ensure their comfort and safety. It is necessary that there should be a second ship ready to proceed south in November, 1902, in the possible contingency of any accident, or of the detention of the *Discovery*. It is also very desirable that there should be sufficient funds for a third year. But the first of these objects is essential. There must be a tender to the *Discovery*—a second ship. The required funds must be raised. The feeling that this is necessary is becoming strong among those of our Fellows who have a sense of responsibility. I have just received a letter from a Fellow of this Society, who writes as follows: "On the assumption that the instructions for the conduct of the National Antarctic Expedition are definitely settled to the satisfaction of our Council, I shall be glad to contribute £5000 towards the provision of a second ship, the necessary tender to the *Discovery*." Another well-wisher has promised £500. We have thus had noble examples set before us. We are all bound to use our utmost endeavours to see that those examples are followed. It is our duty to see that all due precautions are taken for the safety of the gallant men who are going upon a perilous enterprise at our behest. *They* will do *their* duty, we know well. Let us do our duty by exerting ourselves in their interests. Then, when the time comes for the *Discovery* to start on her memorable voyage, with all on board resolved to do their utmost for the credit of Old England, we can, with a clear conscience, join in the hearty cheers of farewell. Then we can all raise the glorious cry, without anxiety, of "Southward Ho!"

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## CONSIDERATIONS RESPECTING ROUTES FOR AN ANTARCTIC EXPEDITION.

By Sir CLEMENTS R. MARKHAM, K.C.B., F.R.S., President R.G.S.

THE time has arrived for settling the plan of operations for the Antarctic Expedition; and I propose, after stating the objects laid down by the Councils of the two Societies, and offering some general observations, to pass in review the several routes which may be taken to reach the unknown region of the South.

The objects are stated in the report of our Antarctic Committee, which was adopted by the Council on February 12, 1894; and in the

Reports of the Antarctic Committees of 1887 and 1894, appointed by the Royal Society.

The main objects are to determine, as far as is possible, the extent and nature of the south polar land, to ascertain the nature of its glaciation and the condition of the ice-cap, to observe the character of the underlying rocks, and to make a magnetic survey south of  $40^{\circ}$  S. Much importance is also attached to meteorological observations, and especially to meteorological observations to the south of  $74^{\circ}$ . Deep-sea soundings with temperatures are also to be taken, and biological investigations are to be made.

The soundings and dredging work, outside the antarctic circle, can, however, be done at any time and in any vessel. It is not, therefore, a main object in a vessel specially built and strengthened for work within the antarctic circle; and for magnetic observations.

Without losing sight of the main objects of the expedition, it is desired by the Councils of the two Societies that as large results as possible shall be obtained for all the branches of science concerned. We cannot completely satisfy specialists as regards any one investigation, but all will be done that is possible to satisfy each, with due regard to the claims of others. There will be the work on or near the shore, and the work at sea. The first class of work includes (1) geographical discovery and exploration; (2) geology; (3) glaciation; (4) magnetic observations; (5) meteorological observations; (6) pendulum observations; (7) tidal observations; (8) inshore and land biology. Magnetic observations are especially important to ascertain the changes that have taken place since Ross's survey, and they should be carried to the most southerly latitudes attainable. The series of meteorological observations in winter quarters south of  $74^{\circ}$  S. possess more than ordinary importance with reference to the belief of leading meteorologists respecting an anti-cyclone. The work on board ship at sea includes (1) examination and survey of coast-lines; (2) magnetic observations; (3) meteorological observations; (4) deep-sea soundings; (5) marine biology. The subjects for investigation on shore are the most numerous and important. But we must arrange to give due attention to all. If the expedition continues its work for two years, and the ship winters, there would be ten months for the shore investigations, ten months for the work at sea, and four for the voyages out and home. With regard to the navigable period, Captain Larsen found the water on the east side of Graham island open in December. If the expedition lasts for three years, there will be a much longer time for the work at sea. The sea work will be continuous throughout the period of the expedition while at sea, whatever direction may be taken by the ship. It is, therefore, only necessary to consider the route with reference to the exploration of the unknown Antarctic lands. The exploration of the Antarctic Regions is also the object mentioned by the Treasury in announcing the Government grant.

Our expedition can in no sense be a reconnaissance. That work has been completely done. Indeed, all the antarctic voyages, except that of Ross, have been reconnoitring voyages along the edge of the pack. Our expedition must force its way through the pack. That is essential, and for this object the ship was designed and built. It must attempt a piece of definite work. The time at our disposal admits of no preliminary reconnaissance. It is also necessary that the ship should pass a winter in the far south, if the main objects of the expedition are to be attained. The German expedition will certainly winter. Sir James Ross saw that this should be done, and was anxious to find a position for winter quarters. In that respect, as well as in others, the advantage of a steamer over a slow sailing ship will be found to be very great. The idea of leaving a small landing-party on shore to pass the winter should be dismissed; as a weak party—and it must necessarily be weak—could not do a tenth part of the work that would be achieved by the whole force of the expedition.

The magnetic base of the expedition will be either at Melbourne or Christ Church (New Zealand), there being magnetic observatories at both places. The Germans will establish a magnetic observatory at Kerguelen island. The Argentine Republic, through the kind intervention of my friend Dr. Don Francisco Moreno, has undertaken to establish a magnetic observatory on Staten island.

In taking a general view of the Antarctic Regions, it is found that south of  $40^{\circ}$  S. there is very low atmospheric pressure all round the globe, with very large rainfall and snowfall, and strong westerly winds producing a current flowing to the east. But the winds south of  $74^{\circ}$  are from south and south-east, with surface currents in the same direction, so that the icebergs and the pack ice are continually drifted northwards during the summer. It is therefore assumed that there is a large anti-cyclone, with higher atmospheric pressure, far to the south; and that the south winds are attended by small precipitation. This, of course, means a considerable amelioration in the climate south of  $74^{\circ}$  or  $75^{\circ}$  S.; but no winter has yet been passed in so high a latitude. From this point of view, a winter south of  $74^{\circ}$  S. is, as I have already pointed out, an object of great importance.

It is very desirable to obtain some idea of the position and extent of the antarctic land, and it would seem that indications may be obtained from the position of the isotherm of  $32^{\circ}$  Fahr. air-temperature in summer. Where it is driven far to the north, the cause may perhaps be attributed to a great mass of frozen land on those meridians causing a high degree of cold; while in parts where it is far south a warmer region is indicated, caused by an extensive ocean with perhaps only a few islands. From  $80^{\circ}$  E. to the meridian of Greenwich this isotherm is as far north as  $56^{\circ}$ , and on these meridians is Enderby Land with its range of ice-cliffs, suggesting a very extensive land mass. But

from about  $45^{\circ}$  to  $90^{\circ}$  W. the isotherm is in lat.  $63^{\circ}$ , pointing to the landless Weddell Sea. So that the position of this isotherm possibly gives us some clue to the shape and extent of oceans and land masses far to the south of it.

The positions of extensive seas and land masses influence the position and movements of the polar ice-pack in its drift to the north. These would be more irregular in proportion to the extent of the sea over which they drift. In the Weddell Sea D'Urville found the pack in  $64^{\circ}$ , Ross in  $65^{\circ}$ , while Weddell himself had not reached it when he was in  $74^{\circ} 15'$ . Further east Ross found it in  $71^{\circ}$ , Bellinghausen in  $69^{\circ}$ , Biscoe in  $66^{\circ}$ . It varies also very much in character, in some places and times being loose and open, in others very close. There is very great difference in the position and character of the antarctic ice-pack in different seasons and in different localities; but the main difference, as regards navigation, is between a sailing vessel and a steamer, a difference which is almost immeasurable. There can be little doubt that a steamer might force her way through the pack on any meridian when there is open water to the south.

We know as yet very little of the antarctic lands, but we must use that incomplete knowledge as some guide for future work. The first question that arises is the source of the enormous icebergs which encumber the antarctic sea in such vast numbers. In the Arctic Regions, we know that the icebergs are derived from the discharging glaciers at the heads of narrow Greenland fjords. But the antarctic icebergs are on a much larger scale. Sometimes 1 and 2 miles in length, generally 150 to 200 feet high, they are flat-topped like the ice mass from which they are discharged. So far as we yet know, all antarctic lands have these ice masses ending in cliffs along their northern faces. Sir James Ross saw a range of bergs which had evidently broken off from the ice-cliffs stretching eastward from Mount Terror.

The range of ice-cliffs forming the termination of very extensive glaciers appears to be an invariable feature of the northern faces of antarctic lands. There is Enderby Land, which, from Captain Biscoe's description, is a long range of ice-cliff. There is Côte Clarie. There is the north side of Victoria Land, which Ross and McCormick describe as a long range of ice-cliffs stretching westward from Cape North. There is the long line of ice-cliffs extending eastward from Mount Terror, near the parallel of  $78^{\circ}$  S. for upwards of 400 miles.

These mighty glaciers, pouring their harvests of icebergs out into the seas which bound the northern coasts of antarctic lands, appear to be flanked on their eastern sides by ranges of lofty mountains running north and south — possibly on both sides, like Greenland. Biscoe reported them as black streaks seen through the mist to the east of Enderby Land. D'Urville saw them east of Côte Clarie. A lofty range of mountains flanks the eastern side of Victoria Land, and Ross was

almost sure that he could see high mountains beyond the eastern end of the great ice-barrier in  $78^{\circ}$  S.

A navigable sea may usually be expected on the eastern sides of antarctic lands, while the northern drift of ice may cause a similar lane of open water along the northern coasts in the summer. There may, therefore, be three reasons for open water in the antarctic seas: firstly, the currents drifting the ice away from the land; secondly, open lanes and pools caused by unequal rates of ice-movement in the pack, under the influence of winds and currents; and thirdly, the open water usually found north of the outer edges of the pack.

These general considerations apply to all parts of the Antarctic Regions. In examining the various routes by which the unknown area may be penetrated, it will be well to do so with reference to the four quadrants into which the Antarctic Regions have been divided for convenience of description: (1) the VICTORIA QUADRANT, from  $90^{\circ}$  E. to  $180^{\circ}$ ; (2) the ROSS QUADRANT, from  $180^{\circ}$  to  $90^{\circ}$  W.; (3) the WEDDELL QUADRANT, from  $90^{\circ}$  W. to  $0^{\circ}$ ; and (4) the ENDERBY QUADRANT, from  $0^{\circ}$  to  $90^{\circ}$  E.

## I. VICTORIA QUADRANT.

### *First Route.*

We turn first to the Victoria Quadrant, and find indications of land near the antarctic circle, from  $122^{\circ}$  E., where Balleny discovered Sabrina Island, a lofty mountain range covered with snow, on March 2, 1839, to the Balleny Islands in  $165^{\circ}$  E., also discovered by Balleny on February 12, 1839. The Balleny Islands are of volcanic formation, and have lofty peaks. Between these two points, Dumont d'Urville discovered Adélie Land in  $140^{\circ}$  E., lofty land nearly hidden by icebergs, on January 20, 1840. The French landed on one out of eight or ten rocky islets about a mile from the shore. Further west, in  $128^{\circ}$ , D'Urville sailed along a vertical wall of ice, 100 to 150 feet high, for twelve hours. He named it Côte Clarie.

Captain Wilkes, following in the wake of Balleny in 1840, reported distant mountains connecting the discoveries of Balleny and D'Urville and laid down a coast-line of vast extent representing land of continental proportions. But Sir James Ross found himself "nearly in the centre of the mountainous patch of land laid down in Lieut. Wilkes's chart." Sir George Nares saw nothing of Wilkes's supposed Termination Island when within 15 miles of it, and there were such discrepancies between the statements of Captain Wilkes and his officers that the matter remains in doubt. It is a question of great geographical interest; but we are only certain of Sabrina Island, Adélie Island with Côte Clarie, and the Balleny Islands. Ross believed that Wilkes's land was a chain of islands.

Sir James Ross had no doubt that the islands he sighted on March 3  
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and 4, 1841 (Russell Peak, Smyth Island, and Frances Island), were the same as the Balleny Islands. But Mr. Colbeck tells me there are two separate groups, not far from each other. Balleny gave the following names to the five islands he discovered; *Sturje*, *Buckle*, *Borradaile*, *Young*, and *Row*.

The isotherm of 32° Fahr. is as far south as 62° S., from 140° to 80° W.—a possible indication that Sabrina and Adelie are only large islands, and that any continental land is far to the south. In fact, there is a space of 250 to 300 miles in width between these indications of land near the antarctic circle and Victoria Land.

The north coast of Victoria Land commences with Cape Adare, the eastern point, a lofty headland of volcanic rock, in 71° 30' S. Thence the land trends north-west 120 miles to Cape North. In February, 1841, a solid pack extended for 8 or 9 miles from the shore near Cape Adare, rendering a landing impossible, while in 1895, 1899, and 1900, a ship was able to approach close to the shore. This is one example of the changes that take place in the position of the pack.

The next cape westward of Cape Adare is Cape Wood, and between there is a deep bay, which Sir James Ross named Robertson Bay. Here lofty inaccessible mountains rise almost from the beach. The northern extreme of land seen by Ross was named Cape North. The land then trends far to the south of west, but off Cape North Ross was stopped by a dense body of ice, on February 22, 1841. He was anxious to find winter quarters, but all the indentations of the coast were filled with ice of great thickness. Beyond, the line of coast consisted of a long range of ice-cliffs 200 and more feet high, with a chain of grounded bergs some miles in front of them; soundings in 180 fathoms. The ice-cliffs probably form a coast-line of considerable extent, and a dense pack of ice occupied the space to the north and west.

The Newnes Expedition wintered on shore, in Robertson Bay, from February, 1899, to February, 1900, and a valuable series of magnetic and meteorological observations was taken by Mr. Colbeck and Mr. Bernacchi. The position, so close under lofty mountains, and where the coast turns abruptly from east and west to north and south, probably has a climate which is quite abnormal. No attempt was made to explore along the coast to the westward.

The first route, in the Victoria Quadrant, would pass through the pack to Cape Adare, and then westward over the sea which is bounded on the south by the north coast of Victoria Land. The pack met with by Ross might be rounded, early in the season, at its northern edge, it might have moved, or it might be penetrated. The results of success in this direction would be of great interest both to geographers and magneticians. The extent of Victoria Land to the westward might be ascertained, and the questions connected with the indications of land on the antarctic circle between the meridians of 120° and 160° would

receive solution. On the other hand, there appear to be great accumulations of pack-ice in this direction.

*Second Route.*

The second route in the Victoria Quadrant is that indicated by the famous voyage of Ross, who was obliged to leave the work undone owing to the want of a steamer. In slow sailing-vessels it was not possible for him to seek out and make his way into secure winter quarters, so that he only pointed out the quantity of valuable work that might be done. Borchgrevink followed in Ross's wake. Only six landings have been effected, each for a few hours or less. These landings have been on Possession Island in  $72^{\circ}$ , Coulman Island in  $73^{\circ} 20'$ , Wood Bay in  $74^{\circ} 22'$ , Franklin Island in  $76^{\circ} 10'$ , near Cape Crozier in  $77^{\circ} 25'$ , and on the ice-barrier in  $162^{\circ} 30'$  W.—two by Ross and four by Borchgrevink. The work here remains to be done, and it is work of extraordinary interest. For nearly 300 miles there is a line of coast facing to the eastward, and therefore with a navigable sea along its shore. It is flanked by a range of lofty mountains running north and south, while in the far south is the active volcanic region of Mount Erebus. Then stretching away for hundreds of miles to the eastward is that famous ice-barrier, the scientific investigation of which is one of the chief desiderata of geographers.

In approaching this route, Sir James Ross entered the pack in  $66^{\circ} 55'$  S. and  $174^{\circ} 34'$  E. on the 5th, and reached open water on the 9th of January, 1841. There is reason to suppose that at least equal success might be obtained by a steamer early in December, which would at once proceed to the most eastern point reached by Ross along the barrier. The steam power may outweigh the greater closeness of the pack early in the season. At the most eastern points of Ross and Borchgrevink the pack was pressing against the barrier late in February of 1842 and 1900, but this may not be the case in another year, and the pack may not be impenetrable in December, when the frosts will not have cemented it together with young ice. In that case most important discoveries will be made to the eastward, especially if the land beyond the barrier turns to the south with an eastward face, and thus offers a navigable channel along its shore.

Later in the season there might be a thorough investigation of the ice-barrier and the interior ice-cap. Ross had concluded that the ice-cliffs could not be resting on the ground, after soundings at a depth of 420 fathoms and again at 250 fathoms. All this should receive investigation, and the character of the ice-cap should be studied. When a landing was effected in 1900, a distance of about 15 miles was reached by dogs drawing a sledge, and men on ski, along a gentle ascent of hard smooth snow. In the distance what appeared to be a hill proved to be hummocks of blue ice.



Unable to approach very near to inlets or bays for fear of being beset, Sir James Ross supposed them all to be filled with ancient ice, and to offer no winter quarters. But the *Southern Cross* was able to take refuge from the gales of wind far up Robertson Bay, and Wood Bay is also said to offer good winter quarters. Even if the ice in some of the bays never moves, that very fact will supply the necessary protection to a ship from drifting pack, especially if some kind of dock is cut.

McMurdo Bay is a desirable place for winter quarters, in full view of the great burning volcano. Here there is probably a better climate than at Cape Adare, because it is within the anti-cyclonic region. Thence journeys of the utmost importance could be undertaken, which would secure some of the main objects of the expedition. The volcanic region itself could be explored. A journey due south would enable researches to be made along the edge of the ice-cap, while a journey westward into the interior would be of equal importance, and would possibly effect co-operation with the Germans working in from the west. Wood Bay, however, is the best winter harbour, so far as we yet know.

This, then, is the route which offers the best prospect of securing the main objects of the expedition with the best chances of complete success and the minimum of risk.

## II. THE ROSS QUADRANT.

### *Third Route.*

We will next consider the Ross Quadrant, extending from  $180^{\circ}$  to  $90^{\circ}$  W. south of the Pacific ocean. In 1842, Sir James Ross entered the pack near the antarctic circle in  $156^{\circ} 28'$  W., and, after long detention from the ice and encountering some danger, he reached the ice-barrier in  $161^{\circ} 27'$  W. on February 23. From this point, looking to the east, mountains of great height were made out, occupying  $30^{\circ}$  of the horizon, with an undulating outline. There appeared to be much drifting pack to the eastward.

Captain Cook reached the edge of the pack in  $71^{\circ} 10'$  S., in long.  $106^{\circ} 34'$  W., on January 30, 1774. The pack consisted of loose or broken ice closely pressed together, and within it ninety-seven bergs were counted, like a ridge of mountains rising one above the other until lost in the clouds. Sir James Ross, Dumont d'Urville, and others have been of opinion that what Cook saw was land. But Captain Cook himself was much the best judge on that point. Possibly the bergs may have been grounded, and if so land would not be very far distant. But the way the ice was seen to drift from the *Belgica*, without check, when near Cook's farthest, seems to show that there is no land near that latitude.

A powerful steamer might penetrate through the pack between

Cook's farthest and the track of Ross. She would then reach land by steaming across the navigable water beyond, and effect a considerable extent of valuable exploration. Such an examination of the Ross quadrant would include work of the greatest interest and importance to science, but not without considerable risk.

### III. WEDDELL QUADRANT.

#### *Fourth Route.*

The Weddell Quadrant, extending from  $90^\circ$  W. to the meridian of Greenwich, is divided into three sections—the first, from  $90^\circ$  to  $60^\circ$  W., is occupied by the Dirk Gherritz archipelago; the second, from  $60^\circ$  to  $30^\circ$  W., embraces the Weddell sea; and the third, from  $30^\circ$  to  $0^\circ$ , includes the rest of the pack edge examined by Sir James Ross.

In 1599 one of a fleet of five Rotterdam ships was said to have been separated from the rest. She was named the *Blyde Boodschap*, commanded by Dirk Gherritz. It is stated in a French collection of voyages to the Straits of Magellan, published twenty-three years afterwards, that Gherritz was carried by tempestuous weather to  $64^\circ$  S., where he saw a land with snow-covered mountains. Gherritz is not recorded to have said so; his journal does not exist, so far as I am aware, and no longitude is given. If he did not sight the land until he was in  $64^\circ$  S., he certainly did not discover the South Shetlands, which would have been far to the north; nor is it credible that a vessel trying to enter Magellan's Strait could have been driven so far south. In Van Noort's *Description du pénible Voyage*, Gherritz is said to have been taken prisoner by the Spaniards at Valparaiso. Van Noort heard of him as a prisoner at Lima. He never appears to have returned to give an account of his voyage. The Cape Horn route was then unknown. Nevertheless the Dirk Gherritz archipelago is a convenient name for the South Shetlands and the numerous islands to the south, including Graham Island.

The only parts of the Dirk Gherritz archipelago which enter the antarctic regions are Graham Island and Alexander Island. The former was discovered by Captain Biscoe on February 14, 1832. He then saw a very high peak, which he named Adelaide Island, with a thin scattering of snow from the summit to a third of the way down, and the lower part buried in snow and ice. With reference to this bareness of the higher parts of some antarctic mountains, Arctowski observes that in making an ascent he passed through a belt of mist for the first few hundred feet, and above that there was an absolutely clear sky and dazzling sunshine, so that it is easy to see how the higher rocks become free of snow in summer, while those near sea-level remain covered.

In the following days Biscoe discovered several small islands further

north, and a long range of high mountains behind them. These form the backbone of Graham Island, which is long and narrow, extending on both sides of the antarctic circle. Further to the south, the Russian commander Bellinghausen had discovered Alexander Island in  $69^{\circ} 30'$  S. more than twenty years previously, in 1821. In February, 1898, the *Belgica* ran close along this western coast of Graham Island, noting the many rocks and islets extending to a considerable distance from the shore; but Alexander Island was inaccessible owing to the ice-pack. Arctowski describes the view obtained from a point at the edge of the pack. Graham Island seemed to terminate, the land turning towards the east. Alexander Island appeared to be a mountain mass, from which lofty and majestic peaks rose, with lower land to the south. The glaciers seemed to fail to reach the sea, but to coalesce together in one great ice-foot which discharges numerous tabular icebergs.

The *Belgica* wintered in the pack to the west of Graham Island, and drifted nearly as far as Cook's farthest, from the 75th to the 103rd meridian in lat.  $70^{\circ}$  to  $71^{\circ} 30'$  S. Over this area there proved to be a continental shelf 270 fathoms below the surface, and to the north an abrupt descent to 800 fathoms.

On this route there is little chance of penetrating the extensive pack in which the *Belgica* wintered, or of making any successful exploration on the western shores of Graham or Alexander Islands, which are likely to be encumbered with pack-ice within the antarctic circle. The continental land indicated by the shelf discovered by the *Belgica* is probably at a great distance to the south, for the isothermal line of  $32^{\circ}$  air-temperature in summer here comes down as far as  $62^{\circ}$  S.

#### *Fifth Route.*

The eastern shore of Graham Island offers a more easily navigable sea, caused by the ice drifting away from it, as would be the case with all antarctic lands having eastern aspects. It is so far north that it is not necessary to force a way through the main ice-pack before reaching the navigable lane under the lee of the land. In December, 1893, Captain Larsen, of the Norwegian ship *Jason*, got into this lane early in the season, and crossed the antarctic circle as early as the 3rd, reaching his furthest south in  $68^{\circ} 10'$  S. on the 6th. The pack was drifted to some miles from the coast, which consisted of a lofty ice-foot with high mountains above. But several deep fjords penetrated into the land through the ice-foot, where seals and king-penguins were abundant. Captain Larsen was stopped by pack-ice, and there would be little object in penetrating further, because when the south end of Graham Island was reached, the main pack would be encountered. In this part of the Antarctic Regions there is probably an ocean of vast extent.

*Sixth Route.*

The so-called Weddell Sea, which Weddell himself named King George IV. Sea, was a temporary opening in the pack during February, 1823, in this quadrant, to the east of Dirk Gheritz archipelago. Captain Weddell, in the brig *Jane*, of 160 tons, left the South Orkneys on his voyage to the south in the middle of January. He encountered many large icebergs between February 7 and 15, but on the 18th, in  $72^{\circ} 38' S.$ , not a particle of ice was to be seen. On the 20th he was in  $74^{\circ} 15' S.$ , with only three bergs in sight, but many whales and innumerable birds. There was a fresh southerly breeze, so he returned. The longitude was  $30^{\circ} E.$

This was a very remarkable voyage, for, though so far south, Weddell had not yet reached the edge of the pack. It was probably not far off, and would drift up during the last days of February and beginning of March with a south wind. There was no appearance of land, the numerous birds being signs of any open water, and not necessarily of water near land. Weddell's open water was the open water found near the edge of the pack, and had not the same cause for its existence as the navigable sea on the eastern side of Victoria Land, or as the lane of water to the east of Graham Island. There was just as little reason to suppose there was land to the westward of Weddell's position in  $74^{\circ} 15'$ , nearer than Graham Island, as there was to suppose its existence in any other part of his course south, where it is known not to exist. A little to the eastward Ross found the deepest part of the ocean—4000 fathoms.

The voyage of Weddell is exceptional. When Dumont d'Urville crossed his track, the ice-pack stopped him in  $64^{\circ} S.$  Ross, in 1843, found a continuous line of pack from Louis Philippe Island eastward, with heavy floes very closely pressed together. It was drifting fast to the north in January. Ross examined hundreds of miles of the pack edge without finding a single opening. He crossed Weddell's track in  $65^{\circ} 13' S.$ , finding a dense impenetrable pack. Sir Joseph Hooker was inclined to think that this pack was not the result of a summer northward drift of the winter ice; it was too dense for that, and there was never a trace of water-sky over it. His opinion is that, where there are vast areas of landless ocean, the pack moves over it, blocking up wide spaces for indefinite periods. But whether the main pack is found in  $64^{\circ} S.$  or to the south of  $74^{\circ} S.$ , it is certainly of immense extent in this part of the Antarctic Regions, and a vessel must force her way through it before any of the important exploratory results can be attained. This would take an indefinite time, with the danger of long detention. So that the Weddell route offers the minimum of results with the maximum of risk.

## IV. ENDERBY QUADRANT.

*Seventh Route.*

The Enderby Quadrant extends from the meridian of Greenwich to  $90^{\circ}$  E., and the circle is thus completed. Here the isotherm of  $32^{\circ}$  Fahr. air-temperature, in summer, reaches to  $54^{\circ}$  S., indicating an extensive mass of frozen land in the centre of the quadrant. The northern face of this land was discovered by Captain Biscoe in 1831. The land seen a year or two afterwards by Captain Kemp, a little to the eastward, was no doubt a continuation of the same land. In 1831 Captain Biscoe followed the edge of the pack, near the antarctic circle, encountering very severe weather during the month of February. The wind was strong, with snow-squalls, and he found himself in heavy seas amongst innumerable icebergs. On the 25th, when in  $58^{\circ}$  E., Biscoe sighted land at a considerable distance, but there was a closely packed mass of ice intervening. He made out lofty cliffs with a perfectly smooth surface; and says that "the cliffs bore the marks of icebergs having been broken from off them, as the bergs were exactly similar to the cliffs in every respect." The range of ice-cliffs was traced for many miles from the foretop, with a good telescope. This was on February 25. On the 27th land was again clearly distinguished, and the black peaks of mountains showed through the snow. It was named Enderby Land.

Here we have a long line of ice-cliffs forming the northern face of an extensive land, and flanked to the eastward by high mountains, as in Victoria Land.

The eastern third of the Enderby Quadrant, to the east of the land discovered by Biscoe, was visited by the *Challenger* in 1873. She met with dense pack in  $65^{\circ} 42'$  S. and  $79^{\circ} 49'$  E. on February 19. The antarctic circle was crossed in  $78^{\circ} 22'$  E., and the ship followed the western edge of the pack for 150 miles, proceeding eastward to within 15 miles of Wilkes's supposed "Termination Island." The soundings in the sea traversed by the *Challenger* gave a depth of from 1250 to 1975 fathoms. Westward of  $80^{\circ}$  E. very few icebergs were met with, but eastward of  $92^{\circ}$  E. they were very numerous. Their absence between  $70^{\circ}$  and  $80^{\circ}$  E., except close to the pack edge, was so marked that, coupled with their absence on the same meridians in lower latitudes, the conclusion was arrived at that there could be no land for a considerable distance to the south between  $70^{\circ}$  and  $80^{\circ}$  E., and that a high latitude could be reached in that direction between Enderby Land and Victoria Land.

Here, then, there appears to be an admirable route for successful exploration, with an open pack, a sea little encumbered by icebergs, and probably navigable water along the eastern coast of Enderby Land. It is the route selected for the German expedition, I believe under the

advice of Dr. Neumayer. The intention is, if possible, to winter on the west coast of Victoria Land, and to send travelling-parties to penetrate as far as Gauss's magnetic position. From these winter quarters there may be valuable co-operation with the English expedition wintering in Wood Bay or McMurdo Bay, both with regard to the magnetic observations and in other respects. No better route could be selected, and we must wish our German colleagues all possible success—a success which their careful organization, their close attention to details, and their wise and well-considered arrangements so well deserve.

For the English expedition the route must be selected which offers the best opportunities for securing the desired results within the time; it should be the route which leaves least to chance or to unknown conditions, and the one by which the least amount of risk is run. It is also desirable that it should be the one which is most favourably situated for co-operation with our German colleagues, and most conveniently placed with reference to the magnetic base, and to a head-quarters whence succour could be sent.

That route will lead to success. It is a matter of grave moment that no mistake should be made.

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## A SURVEY IN BAFFINLAND, WITH A SHORT DESCRIPTION OF THE COUNTRY.\*

By ROBERT BELL, M.D., LL.D., F.R.S., of the Geological Survey, Canada.

THE following paper will give an account of a survey of part of the southern coast of Baffinland, and of an exploration into the interior of that great island in 1897, both of which are shown on the accompanying map. The sending out of the steamship *Diana* by the Government of Canada in that year, to make further investigations as to the navigation of Hudson strait, afforded the Geological Survey of the Dominion an opportunity for two parties to go at the same time to examine the rocks and make topographical surveys on both sides of the strait.

The writer was placed in charge of the work on the north or Baffinland side, and Mr. A. P. Low of that on the opposite shore. We were provided with small yachts, 35 feet long, well built, and good sailers, but incapable of resisting ice-pressure. They had each a comfortable little cabin, a coal-oil stove for cooking, and accommodation forward for four seamen. The yachts, and a boat for each, were carried to the strait, at some inconvenience, on the deck of the *Diana*, and launched on the

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\* Map, p. 120. All names which had been given to localities in the area covered by this map are retained. The additional ones have been given by Dr. Bell as necessary for the purpose of description.