THE ANTARCTIC REGIONS

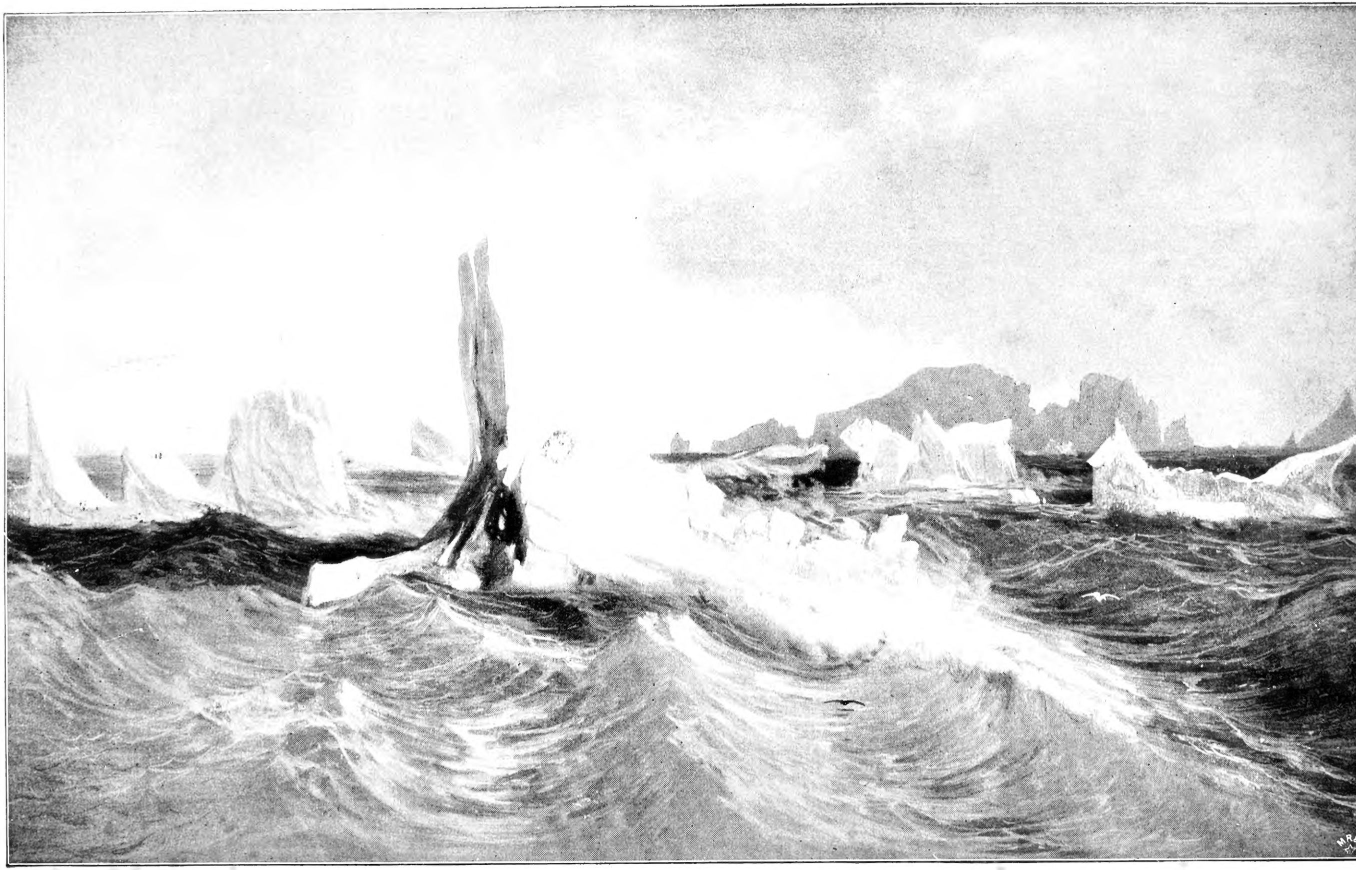
9/-

THE ANTARCTIC REGIONS

SOME OPINIONS OF THE PRESS

LONDON: SWAN SONNENSCHEIN AND CO., LTD.

NEW YORK: THE MACMILLAN COMPANY



The Inaccessible Islands (after Dumont d'Urville). [*Frontispiece.*

THE

ANTARCTIC REGIONS

BY

DR. KARL FRICKER

WITH MAPS, PLATES AND ILLUSTRATIONS IN THE TEXT

LONDON
SWAN SONNENSCHEIN & CO., LIMITED
NEW YORK: THE MACMILLAN COMPANY
1904

TRANSLATED

BY

A. SONNENSCHEIN

FIRST EDITION, *August*, 1900; SECOND EDITION, *May* 1904.

EDITORIAL NOTE.

LITTLE apology seems needed just at the present time for the publication of a new book, if only a translation from a foreign language, on the subject of Antarctic exploration. Germany and Belgium are actively fitting out expeditions under Government auspices, and in England private munificence has come to the assistance of the Learned Societies to whom a conditional Parliamentary grant of £45,000 has already been promised. Scotland, too, we hear, is fitting out an expedition to work in combination with the others.

This book, being at once comprehensive and concise, will enable the public to realise all that has been done in the past, and to estimate how much still remains to be done in the future, in the vast field of Antarctic exploration.

Since 1843, when Sir James Ross returned from the Antarctic, attention has been almost exclusively centred in Arctic exploration. The unexplored area around the North Pole has gradually receded, until in 1895, under Dr. Nansen, the high latitude of 86° 14′ N. was reached. This is 500 miles nearer the pole than the highest latitude —78° 10′ S.—attained by Sir J. Ross in the southern hemisphere. But since 1892 the tide of interest has turned, and the South Pole again offers a field of danger, difficulty, enterprise and scientific research to the explorer.

A Belgian expedition under De Gerlache left Antwerp in 1897, and the preparations for a splendidly-equipped German expedition, under the leadership of Herr Erich von Drygalski, are being rapidly pushed forward: the special ship building for it, under the advice of the Construction Department of the German Imperial Navy, is alone to cost £30,000.

Since going to press, Sir G. Newnes' expedition, under the scientific direction of Dr. Borchgrevingk, has returned, having attained the important scientific object of the location of the Southern Magnetic Pole—or rather the group of points of intense magnetic influence, of which a Magnetic Pole is now supposed to consist; longitude, 146° E.; latitude, 73° 20′ S. The voyage seems to have been full of unexpected discoveries, and of unique opportunities afforded by a whole year of steady work on shore, with the help of sledge journeys for making additional observations. Thus on 16th February, 1900, the *Southern Cross* reached the extreme southern limit of her voyage, and Mr. Borchgrevingk went on nearly due south by sledge for a day's journey, reaching latitude 78° 50′ S., the "farthest south" yet visited. The tale of that long and dreary Antarctic winter, 2,500 miles from the nearest point of land in Australia, will add one element of human interest that has not till now enlivened the records of southern exploration. In view of lectures and books dealing with the latest voyage, and also the results to be expected from the National Antarctic Expedition under Dr. Gregory as its scientific head, and Lieutenant R. F. Scott as commander, the present volume will, it is hoped, fulfil its purpose of rousing and stimulating interest in enterprises that specially appeal to British readers.

THE TRANSLATOR.

AUTHOR'S PREFACE.

When I was honoured with the inquiry whether I should feel disposed to undertake the preparation of the volume on *The Antarctic Regions*, some doubts and difficulties lay in the way of an immediate affirmative response. The gravity of the task, especially in the light of the very short time accorded to it, was from the first obvious, and all the more so because I had not the actual and personal acquaintance with the regions to be described that is exacted by the conditions under which such a work should, ideally, be undertaken. This drawback, it must be acknowledged, has relatively diminished in importance since the recent death of Captain Dallmann, for no one now in Germany has with his own eyes beheld the Antarctic world, and so far as adequate compensation for such drawback can be made, it has been secured by drawing everywhere and in the forefront upon all available sources in their complete and original form—a list of the more important of which will be found in the Appendix to this volume.

Another and a supreme difficulty, in the way of a satisfactory account of the Antarctic regions, is the remarkably scanty information that was collected during certain few voyages of exploration that spread over more than 100 years. The unavoidable gaps, however, drive home one important fact—the absolute necessity, in the cause of science, of voyages of Antarctic exploration. For this reason the history of voyages of discovery occupies a space that in any description of another geographical area would rightly be regarded as excessive. It would, however, be quite impossible to justify the scant knowledge possessed concerning the Antarctic regions unless all details were given.

The enforced brevity of the descriptions is, however, compensated for by the authentic illustrations. They are taken exclusively from works of travel; not a single one has been subjected to imaginative touches, still less to the invention of the delineator. My thanks are due to Herr Rudolf Fitzner for his selection of the numerous plates taken from the *Atlas Pittoresque* of Dumont d'Urville's great work, and also for his vigilant supervision in the production of both plates and text.

Besides the illustrations that have been taken from older works, the reader will find new ones, some now published for the first time. I owe Dr. Georg Neumayer, Privy Councillor to the Admiralty, Director of the German Marine Observatory, and a past master of Antarctic exploration, my cordial thanks for the ample assistance he has afforded from his store of scientific knowledge. Equal courtesy has been shown me by Dr. John Murray, D.Sc., LL.D., Ph.D., F.R.S., the eminent member of the *Challenger* expedition, and one of the editors of the magnificent series of volumes dealing with its results. The present work is embellished by numerous illustrations of icebergs from observations made on board the *Challenger*, Dr. Murray having kindly entrusted me with the water-colour drawings—some not before published—for reproduction.

The general map of the Antarctic regions is based in all essentials on the excellent large map by Vincenz V. Haardt, though some additions and corrections have been made by the Author, who has thus set forth his own conclusions, more particularly in connection with the extent of the land; his reasons are fully given in the text.

KARL FRICKER.

TABLE OF CONTENTS.

LIST OF ILLUSTRATIONS, MAPS, ETC.

FULL-PAGE PLATES.

ILLUSTRATIONS IN THE TEXT.

I. POSITION AND LIMITS.

The very word Antarctic indicates the situation of the region to be described in the following pages; it is the opposite, the antipodes, of the Arctic region: in other words, the tracts surrounding the South Pole, as those surround the North Pole. It is thus the polar cap of the southern hemisphere of our planet to which we turn our attention, and we immediately dispense with the limits indicated by longitude, since the region before us includes the whole circumference in the higher southern latitudes.

The inquiry as to the limits of latitude to be assigned to the Antarctic regions is not so readily met, and it is by no means easy to decide what may justly be considered its limits. A glance at the map shows that the terms Antarctic and southern polar zone cannot be strictly regarded as convertible terms. The latter is limited by the south polar circle, a purely mathematical line owing its significance to the relative position of our earth to the sun, and the consequently varying length of the day—a variation that (within the polar circle) lies between 24 hours and 0. On the other hand, the countries hitherto discovered round the South Pole, and unconnected with the land of any other portion of the earth, universally though only slightly exceed the limits of the polar circle in the direction of the equator. It is well known that the same difference is to be found between the north polar zone and north polar lands, since a large portion of Greenland as well as the essentially polar country of Baffin's Bay both extend to the south of the Arctic circle; yet it would not occur to any one to regard the southern section of Greenland outside the polar circle—scarcely, if at all, differing in its natural conditions from the northern section—as other than polar country. It is impossible therefore to assign limits to polar regions by a mere mathematical line, and they must be taken to include all regions having, in the first and foremost place, an essentially polar climate. But even so, the difficulty of determining the limits of the Antarctic region does not entirely disappear. A glance at the map between 50° and 60° S. latitude shows a number of islands, far distant from larger masses of land, such as South Georgia, the South Sandwich Islands, and the Bouvet Islands in the South Atlantic Ocean, the Marion Islands, the Crozet Islands, Kerguelen and Heard Island in the Southern Indian Ocean. All these islands lie to the south of a line within which the mean temperature of the warmest month scarcely reaches the point which has been accepted as the determining limit of the polar climate, *viz.*, 50° F. Moreover, this circle would include not only the Falkland Isles, not far distant from the coast of South America, but even a portion of the west coast of South America itself, and we should thus have to deal with too extensive a region under the heading of the Antarctic. Another and better definition and limit is readily found in the *distribution of ice.*

Upon all, or nearly all, maps representing the southern hemisphere the name "Antarctic Ocean" is entered all round the South Pole, although there is actually nowhere any land or even submarine elevation to justify such a limitation. On the contrary, the three great oceans of the earth, the Atlantic, the Pacific, and the Indian Ocean, completely merge into one another south of a line drawn from the Cape of Good Hope to the south coast of Australia, and only the narrow South American continent comes as an incomplete barrier between the Atlantic and

Pacific as far south as 56° S. latitude. As a matter of fact, therefore, the waters unite in one universal ocean, and their separation south of the Antarctic circle is in itself purely arbitrary. Nevertheless, it is quite allowable to retain the notion of a separate polar sea, if we thereby indicate the physical characteristics of the south polar regions. If now we define the southern polar sea as the region which is reached by floating ice-floes, and the Antarctic countries as the countries lying within this zone, we secure a working limit. Approximately it tallies with 59° or 60° S. latitude, although in the Atlantic it is somewhat lower, including, as it does, the islands and island groups of South Georgia, the South Sandwich and the Bouvet Islands. As undoubted Antarctic countries three regions are encountered, of which the first may include the islands and perhaps mainland lying to the south of the South American continent—the Dirk-Gerritz Archipelago with Graham's Land, Alexander Land, and Peter I. Island far away to the west. The most advanced station to the north and east is occupied by the South Orkney Islands in latitude 61° S. and longitude 45° W., in a latitude approaching that of Bergen or the northernmost Shetland Isles in the northern hemisphere, and somewhat west of the meridian of Rio de Janeiro, and of Cape Farewell, the southern extremity of Greenland. The southernmost point therefore of the north polar lands and the corresponding northernmost point of the south polar lands lie on the same meridian of longitude. These countries are washed on the east by the South Atlantic, and these waters received the name of George IV. Sea from their discoverer Weddell. The present author elsewhere proposes the name of Weddell Sea instead. Towards the north the land forms a southern boundary of the waters uniting the Atlantic to the Pacific, so that compared with the complete union of the Atlantic and Indian Oceans on the one hand, and of the Atlantic and Pacific Oceans on the other, this portion partakes of the nature of straits. The present author therefore proposes the name of Drake's Straits, in honour of the great English hero and navigator who was the first to investigate these waters. Finally, to the west, the extreme south-eastern portion of the Pacific Ocean washes the shores of Graham's and Alexander Lands, whose most distant accurately-seen point, Peter I. Island, is situated in latitude 60° S. and longitude 91° W.; approximately therefore on the meridian of St. Louis, or New Orleans, in the United States of North America.

A second, and according to present knowledge far less extensive, tract of country lies to the south of the Indian Ocean; these are the coasts known as Enderby Land and Kemp Land, occupying on the Antarctic circle about the space lying between 46° and 60° of E. longitude. In regard of the meridians it therefore corresponds in extent to Persia, though it must be borne in mind that in these high latitudes the distance between two meridians is scarcely the half of the same meridians in the mean latitude of Persia. Towards the west of the two coasts named above, it is conjectured that more land exists, but these doubtful appearances of land will be discussed completely further on.

Last of all there remains a third group of Antarctic lands, the largest of all, to the south of the Australian continent. Here land has been more or less distinctly seen over a region extending from 105° E. longitude to 155° W. longitude, therefore across upwards of 100°. The northernmost point of this tract is Cape Carr in about 65° S. latitude and 132° E. longitude, approximately on the meridian of the Japanese island of Kiusiu, or the western part of New Guinea. To the west of 165° E. longitude the land known as Wilkes Land lies close along the line of the Antarctic circle, to the east it apparently sweeps in two stretches towards the south, and bears the name of Victoria Land. The region connected with this far away to the south is known as the Great Ice Barrier, and the open bay of the Pacific between the barrier and Victoria Land is known as Ross' Sea.

Thus all the countries, or rather all the coasts, have been named which human discovery has up to the present brought to our knowledge of the Antarctic. As to the probability that renewed explorations will discover more and that all the parts named will be found to belong to one and the same south polar continent, or whether they are merely scattered island groups, these points will be discussed at the close of this work. In the present state of our knowledge, it would evidently be presumptuous to undertake the calculation of the area of the Antarctic land-surface. Taking the equal division of land and water in the hitherto unexplored area of the south polar regions for granted—a mere conjecture—Hermann Wagner gives 3,500,000 square miles as the extent of the land in the Antarctic regions, an area therefore equal to that of the continent of Australia with Oceana.

II. HISTORY OF DISCOVERY.

OPINIONS OF THE ANCIENT AND MEDIÆVAL WORLD RESPECTING THE FAR SOUTH. AMERIGO VESPUCCI.

It is a remarkable phenomenon that in most sciences the history of discovery repeats itself, and that deductive speculation presses forward far in advance of inductive investigation—in as far of course as both can be applied to a particular science—and often arrives at surprising conclusions, which frequently are entirely forgotten later on until time has proved them to be correct; on the other hand perfectly mistaken conceptions petrify into dogma in the course of centuries and are preserved intact until their error is proved by overwhelming evidence to the contrary. The history of geography forms no exception to this rule. Like almost all other sciences it is firmly rooted in the ground of ancient Greek speculations, and the opinions on which it was based dominated the whole period of the Middle Ages, partly through the medium of Arabic learning; and only a few choice spirits attempted to develop it in any spirit of progress beyond the most primitive conception. Just as Aristotle was the recognised authority in natural science, so in geography was the renowned physicist, astronomer and geographer, Claudius Ptolemy. It is to him that we owe, perhaps not the earliest, but certainly the most definite notion of an extensive southern continent on our planet, with cartographic representations of the union of south-eastern Asia with Africa in such a manner that the Indian Ocean is regarded as a closed inland sea like the Mediterranean.

It also assigned southern limits to the Atlantic Ocean on the west coast of Africa. Neither was Ptolemy the first to give expression to this view; his predecessors in the field of scientific geography—Seleucus, Eratosthenes, Hipparchus and Strabo—had at least held no different conception of the outlines of the Indian Ocean, and according to the opinion of many the conjecture can be traced back even to Aristotle. But the earlier geographers are justified by the fact that the outlines of the east coast of Africa were known to them only as far as the region of the lower ranges of the Spice mountains, at present known as Cape Gardafui, and they might therefore assume that the coast stretched still farther away to the east, an impression doubtless strengthened by the situation of the outlying island of Socotra. These conjectures, however, must have been given up in the case of Ptolemy; he knew from the singularly accurate sailing hand-books of the Greek and Arabian mariners who visited the east coast of Africa from Adana—the modern Aden—that the coast line ran not only south, but south-west, in their voyages to the extreme southern stations at which they stopped. These voyages generally ceased at the promontory of Rhaptum, probably the modern Kilwa on the coast of German East Africa. Concerning this promontory, some ancient sailing rules which have been preserved since the first century of the Christian era—the Periplus Maris Erythraei—state that "the universal and unexplored ocean stretches away beyond Rhaptum to the west, where, to the south of Ethiopia, Lybia and Africa, it unites with the western (*i.e.*, the Atlantic) ocean". The general direction of the African coast was therefore very well known, whether the knowledge was derived from the accounts of Arabian mariners, or from the traditions of the circumnavigation of Africa by Phœnician vessels in the sixth and seventh centuries before the Christian era. In any event, Ptolemy, through his firm hold of the dogma that the Indian and perhaps even the Atlantic Ocean was enclosed, was the originator of the views held with the greatest tenacity till only last century, respecting the existence of a great terminal southern continent. This *Terra australis*, either inhabitable or inhabited, and presumably the extreme boundary of the earth in the south, was proved by the discoveries of the great navigator James Cook to have no existence as regards its assumed character and contour.

In the Middle Ages, Arabic learning and science took the place of that of ancient Greece; indeed the Greek notions respecting the world owe their continued transmission and existence to oriental teaching. In Christian Europe this knowledge was limited to a few learned thinkers; while among the larger numbers of the comparatively educated, even in the days of the fathers of the Church, Greek science and speculation gradually sank into complete neglect and oblivion. Meanwhile the Arabs preserved not only the correct, but also the erroneous, teaching of the Greeks in the matter of geography. Above all, they held with pedantic obstinacy to the views of Ptolemy as to an enclosed Indian Ocean, even though they took its southern boundary to be merely an unknown country. Moreover, they made the almost unpardonable mistake of representing the African coast from Cape Gardafui onwards as stretching away to the east, so that the Sofala coast on their charts lay opposite to the island of Ceylon, and Madagascar even in the neighbourhood of the Sunda Isles. This dogmatism was all the more indefensible because the Arab sailors were perfectly well acquainted with the actual facts. Moreover, eminent geographers, whose own travels extended to the East African coast —for instance, the renowned Mas'udi (died 956)—emphatically declared that the direction of the coast as maintained by learned men was found by sailors to be entirely false. Nevertheless, the ancient opinion held its ground, and would have lived on much longer but for the general spread of knowledge in the west, based on the accounts brought back from voyages of enterprise and by numerous missionaries. The Italians first, and after them the Portuguese, navigated the west coast of Africa, and were enabled by the help of the compass to make more accurate outlines of the coast. As early as the end of the thirteenth century, two Genoese vessels set off with the object of discovering the passage to the Indies round Africa, though they never returned home. Thus the belief in the great Ptolemaic southern boundary had been entirely given up by navigators, indeed, an imaginary outline of Africa which came very near the truth was actually drawn. But geographers and cartographers found it impossible to entirely give up the old delineations; the German navigator, Martin Behaim, even after the discovery of the southern extremity of Africa in 1487 by Bartholomew Diaz, distorted the outlines on his celebrated globe in the year 1492. He gave the coast a markedly eastern direction, and by means of a huge repetition of the island of Zanzibar in addition to Madagascar brought the meridian out to that of the mouth of the Ganges.

One might suppose that the complete circumnavigation of Africa by Vasco da Gama would have proved the non-existence of the fabulous great southern land, and driven the idea from the minds and charts of contemporaries. On the contrary, however, the great Austral country reappeared after a few decades, more fantastic and extensive than ever. Of course, it did not correspond to the reports of seamen, but depended on the arbitrary exposition of isolated facts and observations by means of geography and cartography. Land, perhaps even only ice, was linked and set down together to form the great "Terra Australis incognita or "nondum cognita".

In the year 1500 an accidental and totally unexpected extension of the knowledge of geography took place. On a voyage to the East Indies the Portuguese admiral, Pedralvarez Cabral, took a westerly course, in order to avoid the calms in the equatorial zones in rounding the Cape of Good Hope. Thus the coast of Brazil was discovered. He took it to be an island, gave it the name of Ilha da Vera Cruz, and sent back one of his vessels to Lisbon with the news of his discovery. A flotilla was immediately equipped, and it set out in the following year to explore the coasts of the newly-found land. Under whose command this expedition was placed is unknown, but Amerigo Vespucci took part in it, probably as pilot. The letters of this famous Florentine to Pier Francesco di Medici are the only source extant for any information about this voyage. The survey of the coast line of Brazil itself, for which the name Terra Americi or America was proposed by the German geographer, Hylacomylus, in 1507, is of no interest here. Our interest centres in the land subsequently sighted, since this was possibly the very first discovery made in the regions defined above as Antarctic. Vespucci relates, not without ample reference to his own deserts, how the coast of Brazil was explored and named, from Cape St. Roque to the Bay of Cananea. There, for some unexplained reason, the further exploration of the coast was abandoned on the frontiers of the modern states of St. Paulo and Parana, and the expedition sailed into the open sea on the 13th (or—the accounts vary—the 15th) of February in a south-easterly direction. On the 3rd of April Vespucci reckoned that they had made 500 nautical miles (leghe in the old Italian accounts), equivalent in round numbers to 1800 modern nautical miles. Four days later, on the 7th of April, new land, inaccessible by reason of the cliffs, was sighted. "There were no inhabitants, doubtless by reason of the cold, against which all precautions are unavailing. We approached the coast and sailed twenty miles along it." The highest southern latitude reached was 52° or 50°—the readings in the editions of Vespucci's account differ.

The statements of the Florentine navigator have raised suspicion, if not doubt and uncertainty, since the history of discovery has been subjected to modern criticism. His testimony appeared untrustworthy, especially as he was supposed—probably unjustly—to wish to give his own name to the new continent. At length search was made for a country that he might perhaps after all have discovered; but in vain. In the direction indicated, *viz.*, S.E. of Cananea, there is no land whatever, so that the conclusion was arrived at that the whole voyage to high southern latitudes was an invention. Such a possibility is, however, not to be accepted, since there must have been persons enough among the members of the expedition—it consisted of three vessels—to have refuted the statements of the pilot. Neither is the supposition tenable that an error was made in giving S.E. as the direction instead of S.W., for the coast of Brazil stretches due south 250 miles from Cananea. The statements of Vespucci must therefore be accepted as correct, and fitted as nearly as possible to actual circumstances. Various conjectures, based on the latitude given, have been made as to the inhospitable coast seen by the Portuguese. The coast of Eastern Patagonia (A. v. Humboldt), the Falkland Isles—whose latitude and appearance fall in with the description—and finally the island of South Georgia (Varnhagen) have been suggested. The last seems worthy of acceptance. The objection to the Falkland Isles is the direction of the course given. The vessels, certainly, after leaving the Bay of Cananea, must have entered the region of the

Brazilian ocean-current, which here sets in to the S.S.W., but this would later on have carried them S.E. and E., especially in the eastern part, into which the Portuguese immediately steered. The Falkland Isles, on the other hand, are washed by the Falkland Island current with a direction of N. or N.N.E., which would also have carried the ships to the E. rather than to the W. Still less does Vespucci's short description serve for the east coast of Patagonia. The coast line certainly extends from Cape Tres Puntas to Hilly Point almost due north and south, and belongs to the peninsula to the south of the Gulf of San Iago. This line, however, reaches only a south latitude of 46° to 48°, therefore considerably to the north of the latitude indicated by Vespucci. Moreover, the course thither lies still farther to the S.W., and farther within the Falkland current than the Falkland Isles themselves.

If we regard the island of South Georgia as the land discovered by Vespucci or the Portuguese expedition, the larger number of data seem fairly to agree. In the first place the Portuguese steered to the S.E. from Cananea; of course they naturally fell in with the Brazil-current, which must have given such poor sailing vessels an appreciable southerly direction. But this might farther on be equalised, for the Brazil-current sweeps round to the east in the neighbourhood of 40° S. latitude. If the ships sailed on to the S.E. they would enter the region of the westward drift-current also tending east, and if the southerly course was continued they might easily reach the neighbourhood of South Georgia. The distance was estimated by Vespucci on the 3rd of April to be 500 leghe or 2050 miles, but, as before stated, land was not sighted till four days later, so that an additional and probably not inconsiderable distance must be allowed for. The exact distance of the Bay of Cananea from the north coast of South

Georgia is about 1760 nautical miles. If the roundabout course taken in consequence of the currents by the Portuguese ships is kept in mind, the statement neither of the distance nor of the direction would offer any serious difficulty. It is less easy to reconcile Vespucci's latitude with the latitude of South Georgia, which is 54° and 55° S. But even this is no insuperable obstacle, as Peschel points out that errors of three degrees of latitude on the high seas are by no means unusual in the reckonings of the first half of the sixteenth century. If such errors are made under the clear skies of the trade winds, they should cause no surprise if made on the stormy South Atlantic Ocean with its gloomy and misty weather. Indeed, it does not even appear that Vespucci's reckoning of 52° S. on the 3rd of April was intended to be applied to the land then lying farther south. Finally, the description of the coast of the country discovered points to the possibility that it was that of South Georgia. Vespucci says they sailed twenty leghe (eighty miles) along the coast, and the north coast between its two northernmost points, Cape Buller and Cape Charlotte, is of just this extent in South Georgia. A. v. Humboldt, who was warmly interested in this discovery by the Portuguese, and was of opinion that East Patagonia was indicated, found a difficulty in the statement that the ships sailed twenty leghe (eighty miles) along the coast. His explanation leaves the discrepancy untouched, but it entirely disappears when applied to South Georgia.

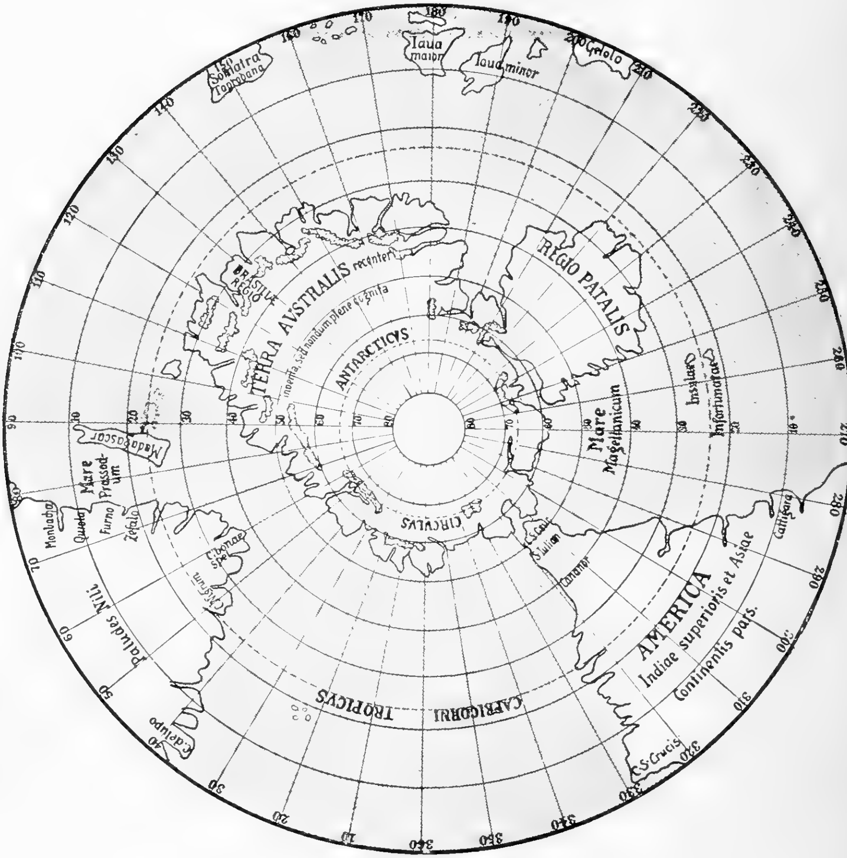
Another circumstance supports the case for the island—the mention of the severe cold, which seemed to exclude the idea that it was inhabited. This could not have been stated of the coast of East Patagonia even in the winter of the southern hemisphere (April corresponding to November with us). According to modern observations the mean temperature in the coldest month is about

41° F. Even the Falkland Islands have a mean temperature of 50° F. in April, while in South Georgia, the German Royal Bay station ascertained in 1881-2 that the mean, including twenty-three frosty days, fell no lower than 33° F. One remarkable fact Vespucci did not record, namely the snow-covering, for South Georgia is thickly covered with snow on the loftier heights, even in the summer. But this omission becomes less important if the times and their theories be taken into account. Of districts and regions lying beyond 50° N. only middle and western Europe were personally known to the great explorers who came from the countries surrounding the Mediterranean. To these the connection between winter and snow-covering would seem so ordinary as not to call for mention, and would be equally applied to the southern hemisphere. Moreover, Vespucci added to his account the remark: "It was winter in those regions," and he may have taken for granted that all was thereby included, and that there was no need to say more on the subject to his learned friend.

Probably the account of this voyage of discovery will never be quite clear, unless indeed further details were found in the Portuguese archives. However much it may be doubted whether the Portuguese squadron actually discovered South Georgia, the possibility still remains that even at so early a date the first real discovery of Antarctic country did take place. It certainly had neither direct nor indirect consequences, for it fell entirely into the background in view of the unexpected extent and extension of the Ilha da Vera Cruz, in other words, of the Brazils. For it was this very country that was described by Vespucci, in his accounts, as a "New World," while the discoveries of Columbus were still regarded as portions of the far east coast of the Old World, or its outlying islands. These accounts therefore secured to Vespucci the unmerited fame of being the discoverer of the New World, and gave first to Brazil and subsequently to the whole continent the name of Terra Americi or America. Still it is by no means certain that the southern and insignificant discovery made by the Portuguese vessels did not secretly revive and perpetuate the myth of the great southern continent bounding the oceans and covering in the South Pole.

THE NEW *TERRA AUSTRALIS* AND THE PROOF OF ITS NON-EXISTENCE.

Very soon after the exploration of the Brazilian coasts, several expeditions were made there, although the country had not the attraction of either gold or spices to offer. And these voyages seem to have been undertaken without the authority and probably without even the knowledge of the Portuguese Government. They are mentioned here simply because they revived the idea of the Ptolemaic Austral country, though now no longer supposed to be connected with either Asia or Africa, and projected farther across still unknown seas. At length a French vessel from Honfleur in Normandy, under the command of the Sieur Binot Paulmier de Gonneville, reached Brazil in 1504, though it cannot be ascertained at what point he landed. Gonneville, who brought back a young native on his return voyage, speaks in his account of the discovery of hitherto unknown "southern lands," and thus in the course of time these were sought to the south of the Cape of Good Hope instead of in Brazil. Somewhat later, about the years 1508-9, a widespread publication, obviously a translation from the Portuguese, appeared in Italy and Germany, called *Copia der Newen Zeytung aus Pressilgland.* This gave an account of the voyage of two Portuguese ships to the Brazilian coast. They were stated to have reached a latitude of 40° S., and to have found straits on the west. The importance of this account as a prelude to the discovery of the Straits of Magellan[1] cannot here be dwelt upon. It was, however, important as the starting-point for a representation of the *Terra australis incognita*, according to the imagination of the Nüremberg



Terra australis (after Schöner's globe of 1533).

geographer and astronomer, Johannes Schöner. In 1515 he constructed a globe on which the South American continent, or according to his own designation, America, really comes to an end in latitude 40° to 41° S. Thence

[1] More accurately "Magalhäes".

the coast diverges to the west and subsequently runs north. Separated from this southern extremity by a narrow strait lies a country designated as *Brasilie regio*, stretching far to the east and to the west, the coasts retiring in higher southern latitudes. The outlines of this purely hypothetical country were fantastic enough, and must have seemed still more so after Magellan's remarkable voyage had verified the existence of a passage to the west, though it was found to be 10° farther south than was indicated by the *Newen Zeytung*. Tierra del Fuego, on the south of the Straits of Magellan, was evidently part of the *Terra australis*, and its coasts were therefore prolonged by Schöner without any hesitation, so that they encircled the globe on the south. His learned successors improved on his drawings by adding greater variety to the coast line of the imaginary country. In many representations of the South Atlantic Ocean, a peninsula of the great Austral continent is indicated to the south-east of the Brazilian continent, between 50° and 60° S., with a coast running from west to east. This may be a mere coincidence, but it does not exclude the possibility of Vespucci's discovery on his third voyage having provided data for part of the coast of the otherwise imaginary country.

From this time forward the names of places in or near America were removed to a greater distance. On Schöner's Globe, for example, of the year 1533, the name *Brasilie regio* already embellishes the great southern country to the south of Madagascar. A later designer, Oronce Finé, had moreover the audacity to give the country the inscription: *Terra australis nuper inventa sed non plene examinata* (the lately discovered, but not completely explored southern land). A German geographer, one of the most celebrated of all, Gerhard Mercator, in the beginning of the second half of the sixteenth century drew the coasts of this immense continent with great precision, adding deep indentations as gulfs as well as outlying islands and ranges of cliffs. Here, too, is to be found what may again be merely a coincidence, a projecting coast in almost exactly the latitude and longitude of South Georgia, bounded by a deeply indented bay on the west, the Golfo de San Sebastiano.

The method of representing Tierra del Fuego as a peninsula of the southern continent is all the more surprising since from an early date it had been conjectured that it was an island. Four years after the return of the only ship saved from the fleet of the first great circumnavigator, Magellan, the second Spanish expedition, under the command of Garcia Jofre de Loayasa, passed through the Straits of Magellan into the Pacific Ocean in 1526. On entering the straits one of the vessels, the *San Lesmes*, commanded by Francisco de Hoces, was separated and driven south in a storm. It thus reached the Le Maire Straits, re-discovered ninety years later, separating Tierra del Fuego from Staten Island.[1] Although the explorers concluded that they had reached the extremity of the continent, they nevertheless made their way back without following up their discovery. Thus, this important discovery was for the time disregarded, and rendered no service either to navigation or to cartography.

A similar fate or worse befell Francis Drake, the first discoverer of Cape Horn,[2] and therefore of the southern extremity of the great western double continent. Instead of erasing from the map the southern continent presumably extending to the Straits of Magellan, the distorted account of Drake's voyage tended to confirm the error. There is a good account of Drake's voyage extant from the pen of his ship's chaplain, Fletcher. From the first simple statements made by him it is

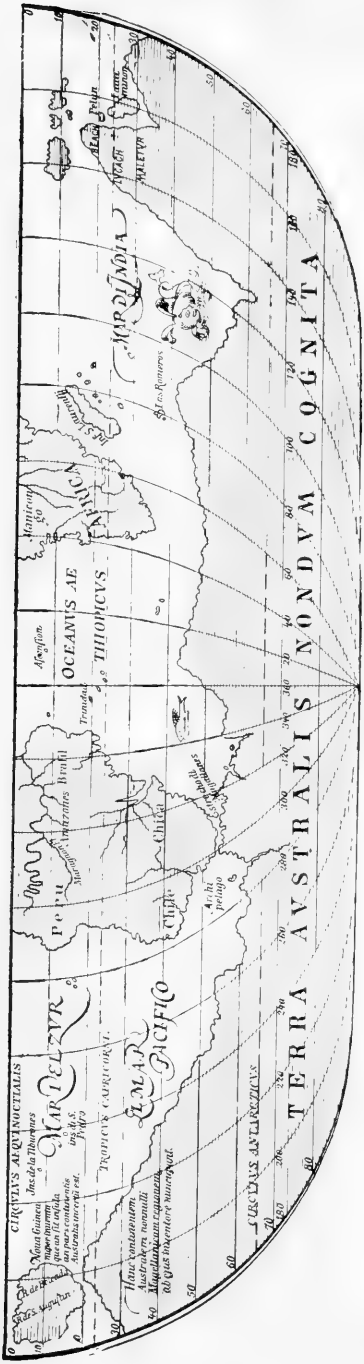
[1] More accurately Staaten Island.

[2] More accurately Cape Hoorn.

evident that Drake was not the first, as has been erroneously supposed, to cross the Antarctic circle. Drake left Plymouth with a fleet of five ships in 1577. In the following year he was from the 20th of August to the 6th of September in the Straits of Magellan. After sailing through and continuing a considerable distance to the north-west, his own ship was driven back by a violent storm to the W.S.W. until he found himself in latitude 57° S., and about 200 leagues from the opening to the straits. He again sailed to the east and came upon the islands belonging to the Tierra del Fuego region in latitude 55° S., where he rested for a few days. Compelled by a renewal of the storm he took refuge among the islands. Fletcher relates in *The World Encompassed:* "He came finally to the uttermost part of the land towards the South Pole, the extreme cape or cliff lying nearly under 56° S., beyond which neither continent nor island was to be seen; indeed the Atlantic and the Pacific Oceans here unite in the free and unconfined open". Fletcher tells of the intercourse with the natives of the island, dwellers in barks, describing the typical Tierra del Fuegan. In short, his description gives so clear and unmistakable a picture of the southern extremity of South America, that it seems an absolute marvel that Drake's discovery should have been entirely misunderstood for centuries. And what indeed was not made of it! A year before the account of his travels was published in the original English edition with the title *The Famous Voyage of Sir Francis Drake* (1599), a translation, or rather an adaptation of it, appeared in the compilation of Theodore de Bry. This writer turns the above-mentioned 200 leagues of longitude in the distance from the opening into the straits into 200 leagues of latitude in a southerly direction; the word "leagues" also was supposed by the translator to mean miles, which he identified with German or geographical miles. On this calculation there was therefore a difference of $13\frac{1}{2}°$ in the latitude, so that De Bry actually conveyed Drake to the Antarctic circle. To make the high latitude vivid to his readers, he interpolates a statement which is entirely a fabrication, and says that Drake observed that the night was of only two hours' duration, so that at the time of the December solstice the sun would remain above the horizon the whole twenty-four hours. This inference is manifestly based on the mistaken calculation of the latitude. Later translations and adaptations of De Bry's work only made matters worse, since they represented Drake as getting the information as to the length of the day from the natives, so that inhabitants were introduced into the countries in those high latitudes.

Such suggestions found a ready welcome among theorising cartographers, and the land discovered by Drake was forthwith removed to latitude 66° to 67° S. as part of the coast of the great southern continent, regardless of the objections raised by experienced mariners like Hawkins, or critical geographers like Clüver. Hawkins had been told by Drake that the passage round the southern extremity of the land was shorter than through the Straits of Magellan, and this was verified in 1580 by a Spanish vessel belonging to Sarmiento's squadron. Strangely enough, Mercator in his map of the world had in 1569 entered a deep bay in the latitude given above, placing it on the coast of his imaginary continent, to which he apparently gave increased precision by the addition of outlying cliffs and islands.

Scarcely twenty years later the champions of the connection between Tierra del Fuego and the southern continent seemed justified in their contention that Drake had discovered land in a high southern latitude. A vessel that had come through the Straits of Magellan was in the same way driven south and found land. In the year



Terra australis, after Ortelius (*Theatrum orbis terrarum*, 1571).

1599, at a time when the Dutch, acting on the offensive, began to attack and injure Spain in her colonies, a Dutch squadron of five sail, under the command of Jacob Mahn and Simon de Cordes, left Holland to attack the Spanish possessions on the Pacific. They were overtaken by the same fate as Drake, for on passing out of the Straits of Magellan on the west side they were dispersed by a violent storm on the 15th of September. One of the vessels, the yacht *De Blyde Boodschap*, under the command of Dirk (Theodoric) Gerritz, was driven as far as 64° S., where Gerritz sighted land. It was covered with lofty, snow-clad mountains which he compared to those of Norway. Without following up his discovery Gerritz again took a northern course to the coast of Chili, but missed the rendezvous of the squadron and was made captive by the Spaniards. In a letter to Olivier van Noort, the commander of a second Dutch squadron, he communicated his discovery, concerning which nothing more was heard. It has elsewhere been shown that although many circumstances seem to tell against the attaining of such a high latitude, there is no reason whatever to doubt Gerritz' veracity. It might be opposed on the ground that at the beginning of summer in the southern hemisphere the land is blocked by ice in latitude 64° to the south of Tierra del Fuego, that is to say, the western isles of the South Shetland Archipelago or Palmer Land. But as Gerritz came in sight of land in the second, third, or even the fourth quarter of September, for he reckoned by the old Julian calendar, the date of his discovery would doubtless be between the beginning and the middle of October. Now W. Smith, the second discoverer of the Gerritz Archipelago—as it has now been called—found it possible to approach the South Shetland Islands at that time of year, in 1819, without being at all inconvenienced by the ice. The advance in both cases seems to have been greatly assisted by favourable ice years. The land discovered by Gerritz was long inscribed as such on the maps, and was also transferred to the great southern continent until after Cook's voyages, when it as erroneously dropped from the maps altogether.

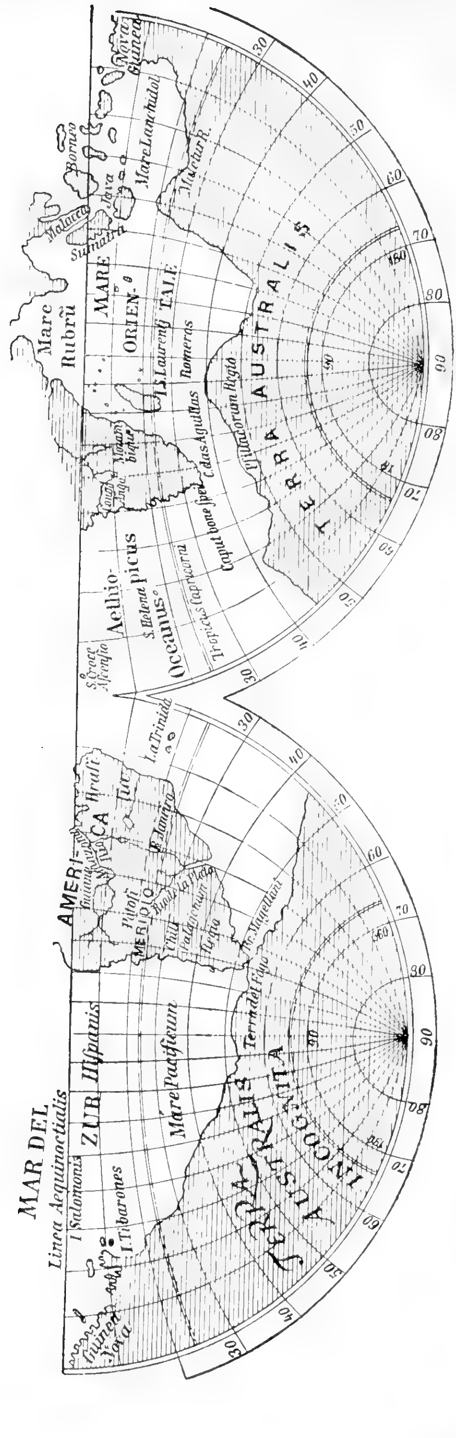
The subsequent use to which the Dutch account was put is seen in a later rendering of Gerritz' report. There the absurd statement is added that the land sighted seemed to stretch away to the Solomon Isles, which had been discovered to the south-east of New Guinea by Mendana in 1567, and were then lost to the world till 1768. It is impossible to decide when this interpolation first found its way into the account of Gerritz. It seems almost as if Mercator's map of the world of the year 1569 were responsible for it. The repeatedly mentioned coast of his southern land is here drawn as running from the western outlet of the Straits of Magellan to about latitude 66° S. and longitude 92° W. (he reckons from the meridian of the island of Corvo), and from here to latitude 19° S. and longitude 170° W. in almost a straight line, to a hypothetical region corresponding to Torres Straits between New Guinea and Australia (of course before the discovery of the straits by Torres). It is remarkable that Mercator, while indicating by a dotted line that the outline is hypothetical, gives a continuous line between 45° and 35° S., apparently fixing a coast that had been sighted. This might lead one to think of the first discovery of New Zealand, which perhaps fell to the lot of the Spaniard, Juan Fernandez (after 1563), who certainly discovered the island now bearing his name, the original of Robinson Crusoe's island. The news of a large inhabited country in southern waters would naturally tend to confirm the fixed tradition of a southern continent.

Two Dutchmen, Schouten and Le Maire, achieved what Drake, though he had rounded the cape subsequently named Cape Hoorn, had failed to do thirty-eight years before, *viz.*, the separation on the maps and in contemporary geography books of Tierra del Fuego from the great southern continent. It was not a pure zeal for discovery that prompted these two to find a passage south of the Straits of Magellan. They were intent on evading the monopoly of the Dutch East India Company, which gave the sole right of passage through the Straits of Magellan to Dutch merchantmen. On the 25th of January, 1616, they sailed through the straits named after Le Maire, the east coast of which was called Staaten Island, in honour of the States-General of Holland. The south coast of Tierra del Fuego was examined, together with the small outlying islands, which received names. The southern extremity was called Cape Hoorn in honour of Schouten's native town.

Nevertheless, even this voyage was powerless to entirely remove the southern continent of the maps from the waters in the region of Tierra del Fuego. When the greatest navigator of the seventeenth century, Abel Tasman, on his memorable voyage in search of the southern continent took an uninterrupted easterly course in latitude 45° to 49° S. after leaving the island of Mauritius, he unexpectedly came upon a mountainous country, on the 13th of December, 1642. This was the southern island of New Zealand (he had discovered the south coast of Van Diemen's Land, now called Tasmania, a few weeks before), to which the name Staaten Land was applied, on the assumption that it was connected on the east with the Straits of Le Maire. It was a mere chance that a few months later, in March, 1643, a Dutchman of the name of Brouwer found how small the extent of the South American Staaten Island actually was, and thus at last freed South America from all close connection with the mythical *Terra australis.*

But though it had thus vanished from the south-western Atlantic, from the Indian, and the western Pacific, or at least had been proved non-existent as far south as the fiftieth degree of latitude, the imagination of geographers still clung to the higher southern latitudes and to the possibilities of the vast region of the south-eastern Pacific, south of New Zealand, which was itself regarded as a portion of the great southern continent. Tasman's circumnavigation of New Holland (as Australia was first called), though at a great distance from land, had proved that this also was certainly not joined to the *Terra australis* of the maps and globes. In one respect important practical and theoretical results followed from the clear apprehension that South America was free, so to speak, at its southern extremity. This was the increase and spread of geographical knowledge in connection with the waters to the east and west of Tierra del Fuego and Patagonia. Up to this time vessels outward bound to the Pacific had been compelled to encounter the Falkland current sweeping north as they neared the Patagonian coast. When at last the dangerous passage through the Straits of Magellan lay before them, half the ships, as we are told by Peschel, turned back, and now there was the possibility of sailing round at a greater distance from the rocky shore of South America. Jacob l'Hermite as early as 1624, when commander of the so-called Nassau fleet, made the correct observation that on the voyage out from Europe the difficulty of rounding Cape Hoorn could be considerably diminished by going into a higher southern latitude. Farther south, east and south-east winds prevail, while in the neighbourhood of the Cape, west and north-west winds blow constantly and with great violence. L'Hermite himself had reached a latitude of 61° S., and could therefore speak from experience.

The immediate consequence of the greater facility in reaching the South Sea—as the Pacific was still almost



Terra australis, after Mercator (*Atlas minor*, *ex-officina* Joannis Janssonii, 1648).

exclusively called—was the great increase in the number of voyages made in it. The Dutch, English and French more especially showed increased activity and enterprise, and reached remarkably high latitudes. Not only did vessels press forward to the south, but also to the east, and one of these voyages brought about the discovery of South Georgia—or its re-discovery, if the Portuguese had really sighted the island on Vespucci's third voyage. In April, 1675, it happened that a mercantile expedition under Antonio de la Roché, consisting of two vessels from Hamburg, though not sailing under the Hamburg flag, was driven past the entrance to the Le Maire Straits, while homeward bound, by a violent storm and resistless current from the west. After several days' course towards the east an unknown snow-covered land arose before the eyes of the astonished travellers, and finding safe moorings they lay at anchor in a bay there. The storm kept them here for a fortnight; then the weather cleared, and another snow-clad country revealed itself to the south-east, separated from their anchorage by short straits about thirty nautical miles across. Through this the vessels sailed without paying any further attention to their discovery. The latitude is given at 55° S., while nothing can be made of the longitude. It was apparently merely a conjecture calculated with reference to Cape Hoorn, and La Roché's ships' reckoning had become confused owing to storm and the course of the current. For this reason it has been considered doubtful what the country discovered really was. The Falkland Isles and Beauchêne Island have been suggested, but surely incorrectly. The one corresponds neither as regards the latitude nor the covering of snow—indeed icebergs are mentioned in the account—while the other is merely an isolated rock thirty-seven miles to the south of East Falkland. *Per contra* La Roché's description applies fairly well to the western end of South Georgia and Willis Island lying outside. The only discrepancy is the breadth of the strait between the two—a matter of only six or seven nautical miles. The northernmost of the South Sandwich Islands might occur to one, although the description applies far better to South Georgia. The error in the latitude would be equally great in either case, as the north-western end of South Georgia and Willis Island are situated in latitude 54° S., and the most northern of the South Sandwich Isles in latitude $56\frac{1}{4}$° S.

For sixty-two years this remained the latest discovery in Antarctic regions, while latitude 60° S. was now more frequently crossed, and the first accounts occur of meeting with floating ice in southern waters. It seems strange that there are no earlier references to it, for the region of floating ice was entered in rounding Cape Hoorn. It is an equally strange fact that icebergs do not seem to have been mentioned by earlier travellers, not even by Abel Tasman. Many noteworthy voyages were made by daring pirates, who, under the name of buccaneers and filibusters, attacked the Spanish-American possessions, both on the Atlantic and South Sea coasts. Thus Bartholomew Sharp in 1681 reached 60° S. after previously encountering icebergs, likewise the *élite* of buccaneer society—at least those of English origin—when John Cook led William Dampier, Edward Davis, Lionel Wafer, Ambrose Cowley and others with the ship *Revenge*, west of Cape Hoorn, as far as 60° 31′ S. on the way to the Pacific provinces of south Spain. Part of the company returned under Edward Davis after it was broken up, and after he had discovered Easter Island he reached a latitude of 62° 45 S. in the Atlantic, on which occasion a large number of icebergs was observed. Easter Island naturally offered the cartographers a welcome opportunity for again laying down a portion of the great southern continent, and it figured on the maps, with considerable extensions, as Davis Land. This error continued even after the Dutch discoverer, Jacob Roggeween, in 1722, had verified that it was quite a small island, as can be proved from Homann's charts of the middle of the eighteenth century.

Latitudes similar to those of Davis were reached in 1700 by Woodes Roggers, *viz.*, 61° 53′ S., and Le Gentil de la Barbinais in 1716, as well as George Shelvoke in 1719, both of whom reached 61° 30′ S. Roggeween, as before mentioned, attained a latitude of 62° 30′ S. in 1722, and, it is even stated that one of his vessels, the *Thienhoven*, penetrated to 64° 58′ S. If correct, this is the highest before Cook, since Dirk Gerritz gives only 64° as his southernmost point. But it is possible that an error has crept in with respect to the southernmost point reached by the *Thienhoven.*

The year 1738 is memorable in the annals of Antarctic voyages of discovery, as it in a certain sense gave the impulse to the second great voyage of James Cook, and laid to rest once for all the belief in a southern continent lying within the temperate zone. It was a peculiar circumstance that the French *Compagnie des Indes* should have sent out an expedition to the inhabitants of the southern lands, and although it reached only comparatively low latitudes, it has a distinct claim to be regarded as the first real South Polar Expedition. It will be remembered that soon after the Portuguese discovery of Brazil, French vessels made their way there, and that the voyage of De Gonneville was recorded. On the return of this expedition, a young native, son of a chief, had been brought to France under promise to be brought back again. In consequence of adverse circumstances the young Indian never was sent back, but learnt French, was converted to the Christian faith, and married a lady of noble family. After nearly two hundred years, it occurred to one of his descendants to raise a claim to the territory of his ancestor in the southern lands from whence he came, and in this way fresh interest was roused in the nearly forgotten voyage of De Gonneville. It was not known that that southern territory was merely a part of Brazil; on the contrary, it was sought in the unexplored waters of the South Atlantic and Indian Oceans. In the firm conviction that fertile and populous countries would here be discovered, the company fifty years later determined to send out an exploring expedition consisting of two ships.

These were placed under the command of Lozier Bouvet who led the ship *L'Aigle*, while the *Marie* was commanded by Captain Hay. They left the harbour of L'Orient on 17th July, 1738, sought out St. Catharina in Brazil, and then steered to the south-east like the Portuguese squadron on the occasion of Vespucci's third voyage. As Bouvet on meridian 17° 40′ W. approached latitude 44° S. he was very eager to find the land indicated on the maps as *Terre de vue* or *Cape des terres australes*; but nothing presented itself. Later, he came to the conclusion that it must be either a small island which had remained concealed from him by mists, and which had been regarded as extended land by older navigators, or—what was doubtless correct—icebergs. With these he became better acquainted on the 15th of December in the latitude corresponding to that of Paris in the northern hemisphere, *viz.*, 49° S., in the shape of three great ice-islands, of which the largest, according to his reckoning, had a circumference of upwards of seven to ten miles, and a height of upwards of 1200 feet, estimates which betray his inexperience in ice-navigation. The immense extent of these gigantic masses of ice at first misled Bouvet joyfully to anticipate the neighbourhood of land. The dogma of the glorious lands of the southern seas was so firmly rooted in the imagination of that time that Bouvet was of opinion that the height of the icebergs, the origin of which so long remained enigmatical, was a proof of the altitude of the country "in which they came into existence, and highlands are always considered the healthiest".

On penetrating farther towards the south, the ships were however so closely hemmed in by pack-ice and floating ice that they were obliged to seek an outlet to the east. After sailing in this direction and to the south-east for several days, an apparently high and snow-covered land was seen by both ships to the north-east on 1st January, 1739. According to Bouvet's reckoning they were then in latitude 54° 20′ S. and longitude 4° E., and the land seemed to be in about latitude 54° S. and longitude 4° 20′ E. Following the devout custom of naming new discoveries according to the church calendar, it was called *Cape de la Circoncision.* The extent of land was certainly small, and the coast inaccessible on account of the pack-ice by which it was blockaded. Even after a delay of twelve days, the ships were unable to approach it near enough to effect a landing. On one clear day it was seen that the country was much more level to the south-east, and that in parts free from snow it was covered with forest or underwood. This delusive appearance—as in the Falkland Isles—is caused by the tussock grass, *Poa flabellata*, which gives an impression in the distance of being shrubs and bushes. In spite of the country appearing well-wooded, Bouvet did not consider it suitable for settlers, and it did not occur to him that it was only a small island. On the contrary, he was convinced that he had discovered a promontory of the great southern land, and retained the hope of finding Gonneville's coast farther away to the east. Therefore he sailed 1500 miles to the east, in a latitude of 57° S. approximately, constantly surrounded by ice, and without finding anything, and then took an equally fruitless course north in order to escape into open water. Now, however disappointing this voyage proved in general, and however futile in regard of its principal object, it must be conceded to brave Captain Bouvet that he was the first to sail a considerable distance east—8°-10°—south of the course of the great navigator, Tasman, and therefore he has a claim to be regarded as the pioneer of Antarctic exploration.

Bouvet's discovery was fated to bring important results in its train as far as both the French and the English were concerned, in spite of the repelling aspect of the newly discovered country and of the seas surrounding it. These results, however, waited silently in the background for thirty years, and in the middle of that period (1756) the island of South Georgia was discovered for the second or the third time, in the middle of winter, on the 29th of June. This time the discovery was made by a Spanish merchant vessel, the *Leon*, which sailed completely round the island in the south, and named it after the saint's day, "Isla de San Pedro".

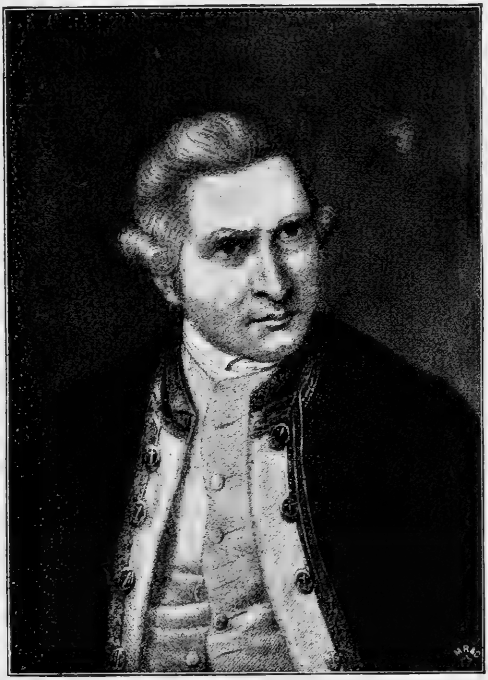
The discovery, however, was not immediately followed up, although it became known through the French account published by Ducloz Guyot, who was on board the *Leon* at the time. This account was incorporated in the writings and compilations of the eminent English traveller and geographer, Alexander Dalrymple, in a work published in 1770 on the subject of oceanic travels and discoveries. As it came out before Cook's return from his first famous voyage, he was probably acquainted with this last discovery of South Georgia.

After a brief lull in the progress of Antarctic discovery, a new period of activity set in during the seventies of last century. The times had greatly changed, natural science especially had received a new impetus, and a desire had become manifest to deepen as well as to widen our then knowledge of the earth as a whole. A perfectly new departure was for the first time made in equipping and sending out expeditions, not as on previous occasions by states and trading companies with the object of material commercial profit, but great undertakings for the furtherance of science, accompanied by a staff of learned men. The tasks now set were to determine the distribution of land and water in the less-known regions of the globe, to investigate all new natural phenomena, and especially to widen the knowledge of the sciences of modern times, namely biology, ethnography and sociology. Something like a division of labour was made between the English and French, whose Governments alone sent out numerous expeditions; the English devoting their attention principally to the surface of our earth and to new geographical discovery, the French to the scientific investigation of new phenomena. Meantime the French never relinquished the thought of discovering the great southern continent, so that we meet French vessels seeking Gonneville's country in the Pacific and Indian Oceans at the very time that the English Government fitted out its first great scientific expedition. There were pre-eminently two French undertakings by Marion and Kerguelen, otherwise unimportant, that set out for southern waters in the year 1771, and both had the good fortune to find land there.

Marion du Frezne, who originally was commissioned to take back to his home a young native of Tahiti brought to France by Bougainville, was first of all to visit Bouvet's Cape Circoncision and then New Zealand. He left Cape Town on the 20th of December, 1771, and steered his course south. But he was unsuccessful in finding either the apocryphal islands of Dina and Marsween, or Cape Circoncision. As compensation he discovered a new island on the 13th of January, .772, which seemed to him also to be a portion of the great Austral country. From this circumstance he named it

Terre d'Espérance. Ten days later he came upon an island group in the same latitude, $46\frac{1}{2}°$ S., of which the one on which he landed was named Isle de la Prise de Possession. The islands were certainly covered with snow at midsummer, and a great iceberg was seen : nevertheless Crozet, the commander of Marion's consort, concluded that it must be near a graminiferous country from his seeing a pigeon on the wing! Marion spent no time in exploring the islands or the country conjectured to be beyond, but shaped his course for Tasmania (then Van Diemen's Land) and New Zealand. Here he was killed by a native in revenge for the ineptitude of Surville, who had visited the coast almost at the same time as Cook three years before. The command of both ships was not taken over by Crozet as is frequently asserted, but by Duclesmeur, who brought them home.

As has already been stated, a second exploring expedition left France in 1771, under the command of Yves Joseph de Kerguelen-Tremarec. He was under orders to start from the Isle de France (now again Mauritius), and to steer towards the southern continent in latitude 45° S., and about the meridian of the islands of St. Paul and Amsterdam, to find a suitable harbour, and thoroughly to study the products of the country, its inhabitants, and their social condition. A member of the Paris Academy, the astronomer Rochon, was appointed to assist in setting down the topographical details. On the 16th of January, 1772, therefore, Kerguelen left the Isle de France, and a month later, on the 13th of February, he discovered, in latitude 50° S., land that, according to his conjecture, certainly formed a part of the great southern continent. A closer examination was not undertaken, as the weather was bad and the country entirely uninhabited. Kerguelen's opinion about the connection with the southern continent was shared by Paris generally, and the discovery was held to be of such great importance that a new expedition was determined on, with more detailed official orders to explore the continent. Kerguelen, in command of three vessels, in 1773 sought the land discovered a year previously, without, however, even ascertaining the extent of Kerguelen Island, as it is now called. Cook had sailed round on the south without ever coming in sight of land in February of the same year; indeed he missed also the



Captain James Cook.

Marion and Crozet Isles, of whose discovery he had heard in Cape Town.

James Cook was no novice in these waters. He was chosen commander of an expedition for the observation of a transit of Venus on the 3rd of July, 1769, after having greatly distinguished himself by his hydrographic charts of the St. Lawrence in Canada, and the coasts of

Newfoundland. Cook left England with the *Endeavour* in the summer of 1768, having three eminent scientists on board. Passing through the Straits of Le Maire, and round Cape Horn, he at once made for Tahiti in order to fulfil his first and principal task. Having accomplished this, he undertook a voyage of discovery to the practically unknown waters south of latitude 15° S., and east of New Zealand. He first discovered several island groups, and attained to a latitude of 40° 22′ S. on the meridian 174° 29′ E. without a trace of land far and wide. Then he shaped his course for New Zealand, which he completely circumnavigated, and verified not only as an island that was disconnected with a continent, but as really consisting of two islands. After laying all this down with the greatest accuracy, he turned to New Holland, laying down the east coast and Torres Straits (the first discovery by Torres had remained entirely unknown). Thus he gave the true outlines of the island continent which subsequently received the name of Austral Land, or Australia.

The remarkable results of Cook's first circumnavigation of the world determined the English Government to send him out in charge of a second expedition, larger and still more completely equipped. His task was to be the solution of the problem concerning the extent of the southern continent so emphatically insisted upon by the French navigators; indeed, Cook's achievement in sailing round New Zealand had already gone far towards disproving the extent attributed to it. He was this time placed in command of two vessels, the *Adventure* under Fourneaux' command and the *Resolution* under his own. The astronomers Wales and Bayley accompanied them, as well as the German naturalist Johann Reinhold Forster and his son George. At Cape Town the party was increased by the Swede Sparrmann. Cook made for Cape Town in the first instance, because he had determined on this voyage to carry out the plan of sailing in the high latitudes from west to east. The only navigator who can be in a sense regarded as his predecessor was Abel Tasman in the voyage which led to the discovery of New Zealand. Cape Town, with its resources, seemed to Cook the most favourably situated for completing the preparations for the long voyage through unknown seas, and here he heard the news of the latest discoveries made by the French (Marion and Crozet). On the 22nd of November, 1772, the ships left the Cape and took a course almost due south. Scarcely three weeks later, on the 10th of December, in latitude 50° 40′ S. and longitude 20° E., the first ice came in sight, an iceberg with the tabular form characteristic of the south polar waters, and with vertical sides. The farther they penetrated south the more numerous were the icebergs and the more difficult the navigation, owing to the prevalence of stormy weather and of sudden fog and mists. As early as the 14th of December the vessels were checked in their progress in latitude 54° 50′ S. and longitude 21° 24′ E., by a vast mass of drift-ice which compelled them to steer to the S.E. After several futile attempts they succeeded in going round the mass of pack-ice and drift-ice, and having reached a latitude 58° S., Cook steered to the west, constantly surrounded by field-ice and numerous icebergs, though the ice was not so thick as to prevent their forcing their way along. By degrees the field-ice disappeared, and Cook rightly conjectured that the great ice masses which had turned him from his course had drifted to the north, and that therefore there was no land of any extent between his present position—latitude 60° S. in round numbers—and the Cape. After he had reached longitude 9° 45′ E. on the 2nd of January, 1773, he again shaped his course towards the south-east, and soon came in sight of fresh icebergs.

On the 17th of January the *south polar circle was* *crossed* in longitude 38° 14′ E., the first time this had ever been accomplished. During this memorable time only one iceberg was in sight, but after a few hours of their farther progress south the ice increased to such an extent that it became impossible to continue their course: the whole surface of the waters as far as the eye could reach was covered from east to west by dense masses of ice, enclosing great icebergs. To the south-east of the ships rose a mass of ice that Cook estimated at sixteen or eighteen feet high, at least, perfectly flat, equally high everywhere, and of such extent that the end could not be seen from the top of the mast. This gigantic mass of ice, seen in latitude 67° 17′ S. and longitude 39° 35′ E., is particularly interesting, since it may have been a first sight of one of the great ice barriers from which glaciers and inland ice in the Antarctic regions break off in all directions into the sea. It is evident that Cook did not understand the meaning of this enormous mass of ice, though he seems to have conjectured that it was of considerable importance. He determined to give up the attempt to penetrate farther south for the time, as the summer was already half over, and it would have taken too much time to sail round the ice, "provided always that this course had been possible, which is very doubtful". He therefore again turned his course to the north-east, with the object of seeking the land discovered by Kerguelen, but in vain; for he explored in latitude 50° S., in longitude 58° to 65° E., but without seeing land at all. This is not to be wondered at, as the Island of Kerguelen is certainly not situated in latitude 49° S., but farther east, in longitude 69° to 71° E. Cook was, moreover, harassed by fog and stormy weather, during which the vessels were separated from each other on the 8th of March.

In order to turn to advantage the remainder of the southern summer season, Cook alone made another attempt towards the south-east, but only to find himself again in the region of drifting icebergs on the 16th of February, in latitude 57° 8′ S. and longitude 80° 59′ E. As early as the 24th he had reached latitude 61° 52′ S. and longitude 95° E., sailing among innumerable icebergs, when the masses of ice made it unadvisable to continue his course. He therefore turned to the east and sailed continuously about latitude 60° S. as far as longitude 148° E., whence he made for New Zealand on the 17th of March, which he reached on the 25th, hoping to complete his previous explorations. After meeting the *Adventure* there—she had arrived on the 1st of March without sighting either land or, with a single exception, icebergs —Cook took both vessels to the Society and Friendly Isles to give the crews a rest, returning to New Zealand towards the end of October.

New Zealand was left on the 26th of November, and the vessels started afresh on a voyage south. Since the non-existence of a continent to the south of the Indian Ocean had been proved, the regions of the southern Pacific were to be explored in the southern summer of 1773-4. Unfortunately, Cook did not resume his search at the point where he had ceased the year before: he did not press forward south from the southern extremity of Tasmania. Had he done so in favourable circumstances, he would doubtless have lighted on the coast of Wilkes Land. However, he crossed latitude 60° S. on the 11th of December on the meridian 174° W., therefore 38° of longitude distant from the meridian on which he quitted his position in latitude 59° S. the previous March.

It is remarkable that he did not encounter an iceberg till he reached latitude 62° 4′ S. and longitude 172° W., $11\frac{1}{2}$° farther south than after his first start from the Cape of Good Hope. But the number of icebergs rapidly increased, and gradually the drift-ice again appeared, though not as yet so dense as greatly to impede progress. However, on the 15th of December, in latitude 65° 52′ S. and longitude 159° 20′ W., the pack-ice grew so impenetrable and the fog so dense that it became necessary to retire somewhat to the north. It was not till the 20th of December that the Antarctic circle was crossed for the second time on the meridian 147° 30′ W. The southernmost point attained in these regions was latitude 67° 31′ S. and longitude 142° 54′ W., where thick pack-ice and numerous icebergs again obstructed the vessels. On the 23rd of December, in latitude 67° 20′ S. and longitude 137° 12′ W., it was no longer possible to break through the ice, and as the health of the officers and crews had suffered in consequence of their unceasing exertions in navigating the vessels, Cook found himself compelled to return north for a time. This he did with reluctance and regret, for having seen several brown albatrosses in this region of the heavy pack-ice he concluded that land could not be far distant.

Cook's retreat north continued to latitude 48° S., where, on the 11th of January, 1744, in latitude 47° 51′ S. and longitude 122° 12′ W., he resolved to venture upon another attempt to reach higher latitudes. This time he followed a course nearly due south, and encountered icebergs on the 20th of January in latitude 62° 34′ S. and longitude 116° 24′ W., which, however, grew less numerous during the few subsequent days, or disappeared altogether. On the 26th of January the Antarctic circle was again crossed on meridian 109° 31′ W., with but few icebergs visible, and apparently land in sight. On closer observation this was found to be a bank of dense fog, which at a distance had all the appearance of a mountainous country. By degrees the icebergs increased in number on their southern course, and in latitude 69° 38′ S. and longitude 108° 12′ W., field-ice again appeared, on which sea-tang covered with mussels was observed.

and an albatross feeding on them heartily. The icebergs now increased to gigantic size, their outlines clearly defined, and not worn by waves or weather, the sides vertical, the upper surface flat and covered with snow; one of them had an extent of three or four nautical miles. On the 30th of January a remarkably bright ice-blink was seen (this is the name given to the reflection of extensive tracts of ice against the misty sky), and the *Resolution* very soon reached the edge of the pack-ice. (The *Adventure* had separated from her consort as early as the 29th of October, 1773, and was not met again during the whole voyage.) The dazzling white mass of ice stretched away interminably towards the south, and presented a striking appearance. Immediately to the south of the ship there was a belt of pack-ice a nautical mile in breadth, *i.e.*, masses of ice towering above one another, between which numerous icebergs were wedged in. Behind this belt of pack-ice rose a perfectly compact, unbroken mass of ice, which seemed pretty level, and not very high, but rising towards the south, where it gradually disappeared on the horizon. In the distance Cook clearly distinguished in this mass of ice ninety-seven ice-hills, as he here calls them, many of them lofty. They exactly resembled mountain chains, one summit rising above the other till they were lost in the clouds. The place of the ship from which this wonderful appearance was observed by Cook was latitude 71° 10′ S. and longitude 106° 54′ W., by far the most southern point reached either before or for many a decade after. In the circumstances it was naturally perfectly impossible to attempt any advance. Cook himself held the opinion, which seems to have been shared by nearly every one on board, that this ice stretched away to the pole, and that it had for ages been connected with land in the background. He concluded that this was the vast store from which proceeded all the icebergs he had met farther north.

The presence, too, of penguins and other birds led the great explorer to conjecture that he was in the neighbourhood of land. In this, we must now admit, he was right, for there is scarcely a doubt that the ice-hills, which increased towards the south, so that one height always seemed to the eye to tower above the other, were nothing but ice-clad summits of land, while the level and rising mass of flat ice was the northern edge of the ice descending from the land into the sea.

Cook now rapidly retreated north, intending to find the land long ago seen by Juan Fernandez—a vain endeavour, since this had probably been New Zealand. He wished then to make for the Marquesas group, taking Easter Island on the way. The southern winter was spent in exploring and discovering, or rediscovering, numerous Pacific Island groups, such as the New Hebrides and New Caledonia. Thence he returned to New Zealand, and on the 10th of November started on the voyage to Cape Horn, keeping to latitude 50° to 60° S. He thus proved that there was no extensive continent in that part of the Pacific. After making surveys of the coasts of Tierra del Fuego and Staaten Island, he steered south-east to latitude 58° 10′ S. and longitude 53° 54′ W., to seek the Golfo San Sebastiano and its coasts, as indicated by Mercator and his successors. His search was of course fruitless, as no such land exists. On the other hand fortune favoured him in the rediscovery of the island of San Pedro, for which he next made, and which he really found on the 14th of January, 1775, and renamed South Georgia, regardless of the rights of previous discoverers. From the 16th to the 23rd of January the north coast was explored and laid down with all possible accuracy. In this undertaking they were greatly assisted by the shelter afforded by several deep bays. After exploring to the extreme east end of the island, and discovering various small islands and rocks as a continuation of the coast line, Cook steered to the south-west in order to make search for a possible continent in the central region of the South Atlantic. In longitude 31° W., he directed his course due south, and on the 17th of January sighted an iceberg in latitude 60° S. This was soon succeeded by several others and by loose field-ice, and as the number of the icebergs increased, Cook preferred again retreating to the north-east. On the 31st of January land was seen, which proved to be a group of lofty rocky and snow-clad islands. On penetrating farther north, more islands

Possession Bay, South Georgia (after Cook).

appeared, and in the distance a mountainous coast, to which Cook gave the name of Southern Thule. A nearer approach to the land, or rather to the chain of islands—as it was afterwards proved to be by Bellingshausen—was rendered impossible by the dense masses of ice by which the islands were surrounded. Cook was therefore compelled to rest satisfied with astronomically determining the situation of the islands while steering north. The whole group, so far as Cook discovered them, lying between latitude 57° and 59° S., and under longitude 26° to 27° W., received the name of South Sandwich Land. On the 3rd of February the *Resolution* took her course towards the east, for the purpose of looking for Bouvet's Cape Circoncision, having icebergs constantly in sight while keeping in latitude 58° to 59° S. as far as longitude 1° E. From this meridian Cook steered to the north-east till he reached latitude 55° S. and longitude 4° E., the position he had assigned to the Bouvet Isles; but without result. He now sailed due east until he, on the 23rd of February, reached the same place where he had been compelled to go east in December, 1772, to avoid the field-ice. This time he encountered but few icebergs, the last on the 25th of February in latitude 52° 52′ S. and longitude 26° 31′ E. On the 18th of March he reached the coast of the Cape, on the 22nd he anchored in Table Bay, and thus completed his second circumnavigation of the world. In regard of its success and its results, Cook's second voyage round the world was the greatest made since the first by Magellan and his successors. On the 30th of July of the same year Cook arrived in the roads at Spithead after a voyage of upwards of three years.

The result of Cook's second circumnavigation of the globe was of the greatest importance as regarded the knowledge acquired of its actual surface. His voyage therefore not only holds rank as the brilliant achievement of a great navigator, but in regard of its influence and consequences must decidedly be placed beside the discoveries of Christopher Columbus and his successors, to which it is indeed the obvious complement. If Columbus set out to find a new course to the well-known eastern continent, and found a new world instead of the narrow seas he expected, it was Cook who verified that, in place of the vast mythical southern continent that had loomed large since the palmy days of classic antiquity, the southern hemisphere of our earth was covered by boundless wastes of water, and that the preponderating surface consisted not of land but of sea. For the first time the true limits were set of the "Oikumené," the habitable countries of the globe. The only field left for exploration and discovery lay in the extension of North America to the north-west, and this also Cook achieved on his third and last great voyage, which ended with his death in Hawaii.

If now the results of the second voyage, so far as the great *Terra australis* is concerned, be summed up, it is found that Cook circumnavigated the earth in latitude 50° S., with the exception of the portions between longitude 57° to 65° E. and 159° to 180° E. Moreover, he traversed 115° of longitude in a latitude of 60° or higher, and three times crossed the Antarctic circle. These three points were, in round numbers, in longitude 30° E., between 135° and 146° W., and lastly between 102° and 109° W. In this last advance he attained to a latitude of 71° 10′ S., which for many a year remained, as before said, the extreme point reached in the southern hemisphere. Land he certainly newly discovered in the South Sandwich Isles, probably when pressing farthest south, and perhaps when first crossing the Antarctic circle, but he did not discover South Georgia nor succeed on this voyage in finding the French discoveries of Bouvet and Marion. This omission was made good at the beginning of his third voyage in December, 1776, when he found the Marion Isles (renamed Prince Edward's Isles after the Duke of Kent) and Kerguelen. The geographical position of both was at the same time accurately determined.

Cook therefore had proved the absence of a southern continent as previously imagined, and at the same time the preponderance of water in the southern hemisphere, though with smaller portions of land in the higher latitudes. He was the first to bring a report of the completely polar character of these apparently desolate ice-clad islands, destitute of all vegetation, as he was the first to relate the dangers of the great southern polar ocean, covered with ice and innumerable icebergs, obstacles which rendered the land unapproachable—"countries (we quote Cook's own words) condemned to everlasting rigidity by Nature, never to yield to the warmth of the sun, for whose wild and desolate aspect I find no words: such are the countries we have discovered: what then may those resemble which lie still further to the south? It is reasonable to suppose that we have seen the best, being the most northerly. Should any one possess the resolution and the fortitude to elucidate this point by pushing yet further south than I have done, I shall not envy him the fame of his discovery, but I make bold to declare that the world will derive no benefit from it."

FROM COOK TO BALLENY.

It seemed for a long time as if the course of events justified the doubt of the great British navigator as to whether the Antarctic regions, which he had opened up, would ever be sought out anew. The years which followed upon Cook's last voyage saw no new scientific exploration of the southern polar seas. Though it would be a serious mistake to suppose that the spirit of inquiry had relinquished the quest, more urgent claims had come into notice, the survey of the newly-found coasts of Australia and North America, as well as the innumerable islands scattered in the Pacific Ocean. Moreover, the lack of interest in the Antarctic regions was doubtless a result of the political situation in Europe. The conflicts of Republican and Napoleonic France and her allies, which wholly absorbed the resources of England and of France, completely paralysed all inclination for costly maritime exploration. For a long time the waters of the Antarctic seas were visited in their better-known regions only by seal hunters. Indeed, in South Georgia the sea-elephants and fur-seals were, in but few years after Cook's report, nearly completely extirpated by English and American hunters.

The only incident worthy of mention during the whole time between the voyages of Cook and the early twenties of the present century is the re-discovery of Bouvet's Cape Circoncision in 1808. This was achieved by two whaling vessels owned by the London firm of Enderby, the *Snow Swan*, commanded by James Lindsay, and the *Otter*, commanded by Thomas Hopper. The first saw land on the 6th of October, 1808, which he approached as near as the stacked-up ice would permit. According to observations and the ship's reckoning, the ship lay in latitude 55° 15′ S. and in longitude 4° 15′ E., only a few nautical miles from land. After an unsuccessful attempt to find an available harbour Lindsay left the island on the 13th of October, after Hopper also had sighted it on the 10th.

As chance appears to have played the principal part in the re-discovery of a forgotten land which neither Cook had succeeded in finding previously, nor James Clarke Ross was to succeed in finding subsequently, so chance apparently was the principal factor in finding the land once discovered by Dirk Gerritz. At all events, probability points that way, and it is certain that the English hydrographer, James Horsburgh, told the German geographer, Heinrich Berghaus, that the island group had been a station for American seal-hunters since 1812. The motive for keeping its existence secret was the desire to retain the sole use of the station for their own profit. Meantime nothing further was known of these islands, and it is owing to the English merchant captain, William Smith, that they re-entered the range of human ken. Smith had sailed far south in rounding

Cape Horn on a voyage from the River Plate to Valparaiso in February, 1819, and when in latitude 62° 30′ S. and longitude 60° W., discovered land. He put off an investigation of it till his return voyage in August of the same year. He verified the existence of a chain of islands between latitude 61° and 63° S. and longitude 58° and 63° W., lying in the direction from north-east to south-west. To these he gave the name of the New South Shetland Isles. After his subsequent return to Valparaiso he immediately communicated his discovery to Captain Sheriff, of the English frigate *Andromache* stationed there, and Captain Sheriff appointed a thoroughly competent officer, Bransfield, to accompany Smith on his return. Bransfield accomplished his task of laying down the land with the greatest care and accuracy. Smith and Bransfield determined the extent of the island group to reach 53° W., where the two isolated islands, Elephant and Clarence Island, lie. They then pushed further south on the meridian, 52½° W. to nearly 65° S., without, however, sighting the elevations of Louis-Philippe Land, which lay not very far to the west of their course.

Almost at the same time an American seal-hunting ship had appeared in these waters, the brig *Hersilia*, James Sheffield, captain, in search of the Gerritz Land laid down in the charts. Scarcely had the discovery of the island group and its wealth of valuable seals been made known, when the coasts swarmed with English and American seal-hunters, who rendered good service in determining the outlines of the land. Foremost among them was the able English navigator, James Weddell, also the Englishmen, Walker and Powell, and the Americans, Palmer, Pendleton and others, who had appeared with a fleet of thirty vessels in 1821. Before long the group of the South Orkneys, further east, was discovered, as well as a portion of the greater island chain, which extends further to the south of the South

Shetland Isles. These, which have been named Palmer Land and Trinity Land, are separated from the South Shetlands by Bransfield Straits; Louis-Philippe Land farther east was, on the other hand, not known till subsequently discovered by Dumont D'Urville.

In the midst of this swarm of seal-hunting vessels, two ships made their appearance in 1821, having left the Russian harbour of Kronstadt in 1819, presumably

Fabian Gottlieb von Bellingshausen.

without having been made acquainted with the discovery of Smith. The object of this expedition was to make a voyage of circumnavigation in high southern latitudes, the first since Cook's achievements. It was under the command of Captain Fabian Gottlieb von Bellingshausen, and the vessels, the *Wostok*, under Bellingshausen, and the *Mirny*, under Lazarew, had been sent out by the

Czar, Alexander I., with orders to push as far south as possible. In December, 1819, Bellingshausen sailed round South Georgia on the southern side, laying down the land as accurately as possible, and then steered towards South Sandwich Land. On his way he discovered a lofty island on the 3rd of January, 1820, in latitude 56° 41′ S. and longitude 28° 9′ W., and on the following day, two more discoveries were made. On one of them, Sawadowskji, there was an active volcano, and Bellingshausen gave the group the name of the Traversey Islands, in honour of the Russian Minister of Marine. On the 8th of January he had reached the northernmost portions of the South Sandwich group seen by Cook and named the Candlemas Islands. Bellingshausen laid them down accurately, as well as the remaining islands, and determined that they were not a portion of an extensive coast, as Cook had erroneously supposed, but all of them islands of small extent. To the south of the islands he first penetrated as far as 60° 30′ S. in longitude 28° W., but in consequence of the dense pack-ice he twice found himself compelled to recross latitude 60° S. The third time he crossed in longitude 7° W. and now sailed due south.

On the 28th of January the vessels had reached a latitude of 69° 21′ S. on the meridian 2° 15′ W. when they were stopped by an ice barrier, so that Bellingshausen was compelled to cruise towards the east; once again, when on meridian 1° 11′ W., he succeeded in penetrating to latitude 66° 25′ S. on the 2nd of February, to be again thwarted by the impenetrable ice. He in consequence steered north and north-east as far as latitude 65° S. and longitude 18° E. where wind and ice seemed favourable for another attempt to reach a higher latitude; successful in reaching 69° 6′ S. on the 17th and 18th of February, progress was again stopped by an interminable rampart of ice extending east and west as far as eye could see. The next day, when all attempts at further progress had been relinquished, and the course towards the north already begun, a kind of sea-swallow (Sterna) was observed, from whose presence Bellingshausen concluded that he must be in the neighbourhood of land. This occurred in latitude 68° 5′ S. and longitude 16° 37′ E. As far as 34° E. the ships now held a course somewhat south of 65° S. then the direction was changed to south-east again, so that under longitude 40° 56′ E. a latitude of 66° 53′ S. was attained. At the same time, however, the ice again grew so dense that further attempts to penetrate it appeared useless. This was almost exactly in the same region whence Cook had undertaken his first advance south, and had in like manner encountered an impenetrable barrier of ice. Here also Bellingshausen was of opinion that land could not be far distant, as he repeatedly observed birds not usually met with at any great distance from land. If only he had continued his eastward course five degrees farther he would of necessity have encountered Enderby Land, now accurately laid down. He continued his course along latitude 62° 30′ S. as far as longitude 69° E., crossed latitude 60° S. only under 88° E. in the latter part of March, surrounded by drift-ice, and now turned to Port Jackson, *i.e.*, Sydney, in New South Wales.

After spending the southern winter in the careful exploration and laying down of the Paumotu group, he left Sydney on the 1st of December, 1820, at the beginning of the southern summer, and steered south. On the 10th of the same month he fell in with the first icebergs in latitude 62° 18′ S. and longitude 164° 13′ E., and dense pack-ice soon after, enclosing numerous icebergs, one of which Bellingshausen estimated at (11 km.) nearly seven miles. The pack-ice compelled his keeping close to the edge towards the south-east, where the number of the icebergs increased, so that at one time upwards of a hundred were counted within sight of the ships. At length, on the 14th, the end of the pack-ice was reached, and open sea was seen to the south and east. After an interval of rather more than a week, during which the Antarctic circle was crossed, the pack-ice reappeared, enclosing gigantic icebergs, of which one is said to have had a length and breadth of eleven miles. On the 26th of December the pack-ice again completely blocked their course, so that a second return to latitude 60° S. in longitude 144° W. was necessary. The intrepid and indefatigable commander again steered to the south-east with the result that a latitude of 67° 50′ S. was again attained in longitude 120° W., and again the barrier of pack-ice stopped further progress on the 13th of January, 1821. The former expedient was again adopted. Bellingshausen returned to nearly 63° S. latitude and 103° W. longitude, crossing the Antarctic circle for the sixth time. Sailing along the edge of the pack-ice towards a remarkably bright ice-blink in the south, he reached the highest point attained during his voyage in latitude 69° 53′ S. and longitude 92° 19′ W., on the 22nd of January. He was, however, again obliged to return, owing to the increased density of the drift-ice and the danger of being surrounded and blocked in.

Steering to the north a small dark point was perceived towards the east on the afternoon of the same day. As the weather cleared this was seen to be snow-covered land, and the next day it turned out on nearer approach to be a steep, lofty island, estimated as having an altitude of upwards of 4,000 feet. It received the name of Peter I.'s Island, and the situation was determined to be latitude 68° 57′ S. and longitude 90° 46′ W. As Bellingshausen felt convinced that more land was to be discovered in this region, he steered to the east in about latitude 68° 30′ S., and actually had the satisfaction of sighting a coast, with a prominent cape in the distance, on the 29th of January. Meanwhile it was impossible to approach the land nearer than forty nautical miles out, so that all that could be done was to determine that the land evidently stretched away in a south-westerly direction and that, with trifling exceptions, it was covered with snow. The cape was found to be situated in latitude 68° 43′ S. and longitude 73° 10′ W.; it received the name of Alexander I.'s Coast. Unfortunately Bellingshausen did not endeavour to penetrate farther to the north-east, indeed he steered due north as far as latitude 60° S., and then made for the South Shetland Isles, of the discovery of which he had probably received information during the course of his voyage. Here he met some of the before-mentioned seal-hunters, Palmer among them, whose information doubtless was serviceable in laying down the islands. At length he steered north by way of the South Orkneys and South Georgia, and returned to Kronstadt in July, 1821, after a voyage of two years.

Although the achievements of Bellingshausen have not thrown those of Cook into the shade, they are nevertheless highly important. He certainly did not reach so high a latitude as Cook, having attained only to $1\frac{1}{4}°$ short of the point achieved by the English navigator. On the other hand, he six times crossed and recrossed the Antarctic circle, navigated no fewer than 243 meridians of longitude beyond 60° S. latitude, 46° being within the Antarctic circle; at several points he saw indications of land; in two cases at least he incontestably discovered land; and all this with two slow-sailing vessels, little fitted for progress in ice-bound waters. Concerning the further results of his voyage scarcely anything, unfortunately, is known. His rare work was published only in the Russian language, assuredly to the great loss of science.

Although Bellingshausen, as compared with Cook, had considerably diminished the probability of the existence of an extensive south polar continent by his circumnavigation, such narrowing of the probability within a comparatively small area followed a year later by means of the bold, energetic advance of James Weddell, the seal-hunter, who had already distinguished himself in his investigation of the South Shetland and South Orkney Isles. Weddell left the Thames on the 17th of September, 1822, and steered south; he had two small vessels at his disposal—the brig *Jane* under his own command, and the cutter *Beaufoy* under M. Brisbane. After a short, unavoidable detention at Puerto Valdes on the Patagonian coast he made for the South Orkney Isles, which he had seen the previous year, but without being able to examine them. On the 12th of January, when the ships were surrounded by numerous icebergs, the island group came in sight. Weddell utilised an eleven days' stay not only for seal-hunting, but for an accurate survey of the islands, not apparently being aware that this had already been very thoroughly done by Powell and Palmer during the southern summer of 1821-2. As several of Weddell's men thought they saw land far away to the south-east, from a mountain on the south coast of the principal eastern island, he set sail on the 23rd of January, 1823, in the direction indicated, but without result, for the expected land turned out to be nothing but an enormous number of gigantic icebergs. In spite of this disappointment, Weddell penetrated south as far as latitude 64° 58′ S., under longitude 39° 41′ W., returning, however, to the north in order to ascertain whether any land lay between the South Orkney and the South Sandwich groups, as he was inclined to believe. During this quest he was careful to avoid the course of the *Adventure* which, under Fourneaux' command, had closely approached the South Shetland and South Orkney groups, as well as South Georgia, in the southern summer of 1773-4 without, however, seeing them.

As soon as Weddell had reached the course taken by Cook to the west of the South Sandwich Isles, and had convinced himself of the non-existence of any land in the region he had just traversed, he again on the 5th of February shaped his course south under meridian 31° W. On the 10th of February the Antarctic circle was crossed after a passage surrounded by numerous icebergs, in longitude 32° 32′ W.—one of the icebergs covered with the rubble carried down to the sea giving the delusive appearance of land in sight. In latitude 68½° S. the imperilled ships were compelled warily to steer their course through countless icebergs; and yet, only four days later, on the 18th of February, in a latitude 72° 38′ S. not a trace of ice was to be seen, the sun shone bright from a clear sky, and the sea was literally covered with birds, especially stormy petrels. These conditions remained practically unchanged during the subsequent two days, and on the 20th of February the vessels had attained a latitude of 74° 15′ S. in longitude 34° 17′ W. Nowhere on the horizon was land to be seen, and the only objects visible above the level of the sea besides the ships were four little icebergs. Weddell would gladly have continued his course south in these favourable circumstances, but the condition of his ships crews and provisions, as well as the prospect of a long return voyage, compelled him to steer north again. The Antarctic circle was rapidly reached owing to the favourable winds mostly from the south, but here the former perils and delays of a region of innumerable icebergs were again encountered by the ships, and during a heavy storm on the 5th of March the little cutter was separated from the principal vessel. The two, however, happily met again in safety on the 12th of March in Adventure Bay, on the southern coast of South Georgia, where Weddell took the opportunity of letting his crews, who were suffering from scurvy, rest and recruit, and also of exploring and investigating the immediate neighbourhood of the bay. The actual winter was spent on the Falkland Isles, for which they set sail on the 17th of April, intending to winter there till the beginning of October. Weddell's plan was to load his vessels with seal-skins during the summer of 1823-4, having so far had but little opportunity on this voyage. To his great surprise he found the islands barricaded by a broad zone of dense pack-ice, so that it was impossible, in spite of strenuous exertions, to approach them. He saw himself compelled to sail for Cape Horn, and there to await the summer season. While he was engaged in the survey of the neighbourhood of the cape, the cutter had succeeded in reaching the South Shetland Isles and laying in a rich store of skins. In January, 1824, Weddell left the waters of Tierra del Fuego and returned to England by way of the Falkland Isles and Monte Video in July of the same year.

The results of Weddell's voyage, in spite of its comparatively limited extent, were nevertheless important. For one thing, he had ascertained that the newly discovered land in high latitudes to the east nowhere reached the meridian of 30°; secondly, he was the first to point out that after forcing a passage through the pack-ice, which is nowhere so dense and heavy as in the Arctic zone, and after a perilous passage through masses of numerous icebergs, the sea in the higher latitudes was singularly free from ice. His greatest success, however, must be admitted to be a moral success, for he broke the ban under which Cook had laid the Antarctic, not only in reaching the highest latitude attained by Cook, but indeed in surpassing him by three degrees, and this with two small, insignificant vessels. Moreover, his discoveries had been made by the way, as it were, without the ordinary preparation and outfit of an actual voyage of discovery. It would be unjust, indeed, to attribute to good fortune the results achieved by the intrepidity and fortitude of the skilful commander and his crews, and an unpleasant impression is made when the celebrated Captain, subsequently Admiral, Dumont D'Urville discredits Weddell's account, apparently because he was not successful in following his course himself.

For many years, in the region of the South Shetlands and the Dirk Gerritz Archipelago, seals continued to be eagerly hunted and exterminated. In the twenties, however, a scientific expedition appeared in these waters without any intention of adding to existing maps and charts by the discoveries of which they were in search. The *Chanticleer*, an English frigate commanded by Captain Foster, came to these islands, not for the purpose of searching for new Antarctic lands, but because they offered the best opportunity as being the southernmost land then known for completing the investigations begun in 1822 and 1823 by the eminent navigator and physicist, Edward Sabine. His observations on the pendulum and on magnetic variations had been carried on over the whole area of the Atlantic Ocean, with the exception of the higher southern latitudes, and it was intended, by completing the former, to secure data for arriving at an accurate knowledge of the form of the globe. Foster left Staten Land on the 21st of December, 1828, and on the 3rd of January, 1829, arrived in sight of Smith Island, the most westerly of the South Shetlands. Without, however, making any delay he steered due south through Bransfield Straits to the Trinity and Palmer Land groups, uselessly re-naming them Clarence Land, and landing to take possession at Cape Possession, a promontory on the probably very small Hoseason Island, which he took to be part of an extensive coast. The situation of the cape he determined to be latitude 63° 26′ S. and longitude 64° 6′ W. As early as the second day after, the *Chanticleer* made for the interior of

Deception Island, an almost circular volcanic crater island still showing active fumaroles. Here Foster remained till the 8th of March, when he hurriedly turned north without giving the least attention to the remaining members of the island group.

Far more important than this, the only scientific expedition—that of Bellingshausen excepted—was a voyage made by the seal-hunter, John Biscoe, in the service of the London firm of Enderby, and not a voyage of discovery at all. This took place in the years 1830-32. Biscoe, like Weddell, had two vessels, the brig *Tula* and the cutter *Lively*, and with these he left London for the Falkland Islands on the 14th of July, 1830. Leaving these on the 27th of November he, like Weddell, kept to the east, making search for the Aurora Isles. These were said to have been seen by the Spanish ship *Aurora* in 1762, by another Spaniard, the *Princesa*, in 1790, and by the Spanish corvette *Atrevida*, in 1794, somewhere about latitude 53° S. and longitude 48° W. However, neither Weddell nor Biscoe found a trace of these islands, and Biscoe now turned south, being the first since Bellingshausen, as far as is known, to make for the South Sandwich Islands. On the 10th of December, he met with icebergs in longitude 29° 15′ W., and about latitude 53° S., and lost sight of the little cutter for four days. On the 20th of December he sighted Montague Island from the east, and on the following day Bristol Island and Friesland Island, members of the South Sandwich group. After a vain attempt to penetrate the heavy field-ice to the south of these islands, Biscoe found himself compelled to steer north, after having crossed the 60th parallel of southern latitude. On the meridian of longitude 6° 20′ W., he recrossed the 60th parallel, and on longitude 2° 30′ E., he crossed the Antarctic circle; this was on the 21st of January, 1831, in an all but perfectly open sea. On the

1st of February a latitude of 60° 25′ S. was attained on meridian 13° E. longitude. Here, quite close to the region where Bellingshausen on observing sea-swallows conjectured that he was in the neighbourhood of land, Biscoe likewise saw various birds, that are said by experienced Antarctic navigators never to venture far out to sea, flying to the south-west. The water also presented a lighter appearance, and it was even supposed that land was visible, but this was by no means certain. Again on the 4th of February land was apparently repeatedly seen, but as the edge of the pack-ice here changed its direction it became impossible to follow up or investigate this doubtful appearance, and the vessels were obliged to take a somewhat more north-easterly course. The whole course towards the east had to be won by strenuous effort, for the direction of the winds and of the surface currents of the sea was almost entirely east and south-east towards the west or north-west; and, in addition, the ships were constantly hindered and opposed by the floating masses of ice. On the 19th of February, Biscoe and his ships were in precisely the place where Cook's progress had been stayed by a vast mass or wall of ice, and found themselves in precisely the same situation.

At length, on the 25th of February, when the vessels lay in latitude 66° 2′ S. and longitude 43° 54′ E., land was clearly seen, but it was unapproachable on account of the heavy field-ice. Here again was the closed, vertical ice barrier, which Biscoe, for height and appearance, compared to the North Foreland, a steep chalk cliff on the Kentish coast, upwards of a hundred feet high, overlooking the sea between Margate and Ramsgate. On the 27th of February, in latitude 65° 57′ S. and longitude 47° 26′ E., elevated country of considerable extent was seen, but surrounded by an impenetrable belt of ice. Biscoe attempted to break through this, encountering a violent storm of three days, during which the two ships were parted from each other, and Biscoe's vessel was driven 120 nautical miles to the N.N.W. Nevertheless, he was again successful in seeing land when on meridian 49° E. longitude, though unable to approach nearer than between twenty and thirty nautical miles. In consequence of the very serious effects of exposure and hardship on the health of the crew of the *Tula*, the leader felt it necessary to give up all further search and exploration, and to steer north for the island of Tasmania, reaching Hobart Town on the 7th of May. During this run two of the crew had died, and the rest were in so deplorable a condition through the ravages of sickness that the ship was worked by only three officers, one seaman, and one cabin boy. It is remarkable that Biscoe kept within the sixtieth parallel as far as longitude 81° E., and did not cross parallel 55° S. until he had passed meridian 118° E. longitude.

Biscoe remained in Hobart Town, where the *Lively* came in from Australia in August, till the return of the southern spring made a renewal of his voyage possible. He left the harbour on the 10th of October, 1831, and set out to hunt seals on the coasts of New Zealand and the Chatham and Bounty Islands. On the 4th of January, 1832, he again steered to the south-east, and very soon after crossing the sixtieth parallel of latitude on meridian 137° W., the usual harbingers of the Antarctic regions appeared in the form of icebergs. This was on the 25th of January, and six days later there were already a hundred in sight. On the 12th of February, in longitude 81° 50′ W., a latitude of 66° 27′ S. was attained, and here numerous birds were seen, as also whales, while even from deck—not merely from the mast-head—as many as 250 icebergs could be seen on all sides. On the 15th of February land appeared in the far distance towards E.S.E., and this, on the following day turned out to be an island, which was named Adelaide Island. Its situation was determined to be latitude 67° 15′ S. and longitude 68° 20′ W., and the explorations of the following weeks showed that it was one of an island chain scattered in the direction from E.N.E. to W.S.W., the outpost of elevated land which has been called Graham's Land, while the islands were subsequently called Biscoe Islands. After Biscoe had landed farther north on the west coast of Palmer Land, he turned to the South Shetland Islands where he barely escaped shipwreck, thence to the Falkland Islands, and then home to England. While in the Falkland Islands the two vessels parted company, and it was not till Biscoe reached St. Caterina in Brazil that he heard the news of the shipwreck of the cutter in the Falkland Isles, though happily the crew had been saved.

Biscoe's voyage is frequently overlooked, though unjustly, for in reality his efforts and his results, even if he did not push forward to so high a latitude as Weddell, have a greater value than Weddell's advance to the south. Biscoe completed a circumnavigation of the pole, for the greater part in high latitudes; he succeeded in this with two insignificant little vessels, augmenting considerably beyond any predecessor our acquaintance with the distribution of land in the Antarctic regions. He not only indicated, partly by discovery, partly by well-founded conjecture, the existence of land to the south of the Indian Ocean, but discovered the most extensive coast known previous to the discoveries of Wilkes and D'Urville, probably the connecting link between Dirk Gerritz Archipelago and Alexander I. Land. Biscoe's achievements met with generous recognition in Europe at the time, and the Geographical Societies of London and Paris conferred high distinctions on him. Messrs. Enderby's firm immediately placed two other ships at his disposal, to enable him to complete his investigations, and the Admiralty appointed Lieutenant Rea to take part in the expedition for the purpose of accurately determining the position of land by means of astronomical observations. However, Biscoe found himself obliged to withdraw from the command of the expedition at the last moment, and although it followed his plan, undertaking this time the voyage from east to west, it was already completely surrounded by the ice in the South Shetland Isles, one of the ships was crushed, and the other barely escaped a similar fate; this was in the southern summer of 1832-3.

Another seal-hunting captain, Kemp, fared better. In the turn of the year 1833, and in longitude $59\frac{1}{2}^\circ$ E., he succeeded in penetrating as far as latitude 66° S., and there saw land, named Kemp Land after him. Unfortunately, nothing further is known of his discoveries than what may be gathered from the British Admiralty Charts, where his course and the land he sighted are laid down.

Several years now passed before any fresh discovery was made in South Polar regions, nevertheless this is the place for making mention of the voyages said to have been made by the American, Morrell, whose accounts unfortunately still haunt our charts. Morrell states that on the 11th of January, 1823, having visited South Georgia and the Bouvet Isles and left Kerguelen behind, he, on the 1st of February, found himself in latitude 64° 52′ S. and longitude 118° 27′ E., in the very place, therefore, where Balleny and Wilkes distinctly saw land; Morrell, however, makes no mention of it. Now he steered to the west, and suddenly, without any indication of the course pursued and entirely without date, the vessel seems to have attained a latitude of 69° 11′ S., longitude 48° 15′ E., due south consequently of Enderby Land. Here, strange to say, a small number of icebergs was seen, no field-ice, and as a

Iceberg in the Southern Orkney Isles (after Dumont d'Urville).

[*Face page* 62.

matter of course, no land whatever; for land is an obstacle to the drifting north of field-ice and icebergs. Morrell now constantly steered to the west, of course along the high parallel of latitude 69° S., and in 69° 42′ S. passed the meridian of Greenwich on the 23rd of February. In continuation, the vague account seems to indicate that the South Sandwich Islands were reached a few days later, for already on the 28th of February, the Candlemas Islands—the most northerly of the group if Traversey Islands are excepted—were in sight; this would mean that within five days a distance of 1,200 miles had been traversed by a sailing ship in seas beset with ice. The islands appeared as "burning volcanoes," and the westernmost had "already been burnt down to the water's edge"! Nine active volcanoes altogether were observed—fire enough, Morrell thought, but none of the fuel of which he was in need. That is to say, he had sought out these islands in the hope of picking up drift-wood there, without any explanation whatever of the source from which he expected it to come.

On the 6th of March the exploration was concluded, and with the audacity that characterises him, Morrell, though the season was far too advanced, steered south-west in spite of it. On the 11th of March, after a dangerous passage through pack-ice, he is in a perfectly free and open sea in latitude 64° 21′ S. and longitude 38° 51′ W. On the 14th of March latitude 70° 14′ S. is attained—longitude not given—only a few icebergs are in sight, the water has a temperature of 44·06 F. and the air 46·9 F., and that at a time close to the equinoxes! The bold explorer is stayed in his progress under these favourable conditions by "circumstances" which are not more specifically described, though he is all the time confident of being able to reach, without difficulty, a parallel of 85° S. A course towards the north-west is taken, and land is seen the very next day, the east coast of the land already named New South Greenland by an apocryphal Captain Johnson, in a part across which James Clark Ross sailed without obstacle twenty years later. They land and explore for some distance; one point of the coast lies about latitude 67° 52′ S. and longitude 48° 11′ W., the northern extremity is said to be in latitude 64° 41′ S. and longitude 47° 21′ W., again a position unfortunately that Powell had already sailed over as early as 1821.

It is not necessary to dwell upon these travellers' tales—the parts instanced are amply sufficient to prove Morrell's lack of veracity; moreover, it would seem that the account of his travels published in New York in 1832 was withdrawn soon after Biscoe's discoveries were made known—at all events the book is very rarely met with. The account of Bouvet Island seems to have been appropriated from an account by Captain Norris, of whom mention has already been made. Captain Norris, with two ships, while in Messrs. Enderby's service, had found an island under latitude 54° 15′ S. and longitude 5° E. on the 10th of December, 1825, and this he called Liverpool Island. On the 13th of December he came upon another island, named by him Thompson Island, forty-five nautical miles to the north-east of the island previously seen, and upon this he found it possible to land. Both islands turned out to be of exclusively volcanic origin.

From this excursion into the realm of plausible fable we return to the sober narrative of Antarctic discovery. An interval of several uneventful years followed upon Biscoe's important and fruitful voyage, during which there is no noticeable achievement to record in the annals of Antarctic exploration. Not till the year 1838 did the meritorious firm of Messrs. Enderby again send out one of their most distinguished captains to explore such portions of the circumpolar seas as had up to that time still remained unknown. Appearances at least lead to the supposition that John Balleny must have worked out some such plan in his voyage between longitude 100° and 163° E. along parallel 60° of south latitude; for, with the exception of the distance traversed by Captain Cook from 100° to 121° E. longitude in a latitude of 60½° S., no vessel had as yet completed the circumnavigation of the pole so far south. It is true that only two very small vessels were placed at Balleny's disposal: the schooner *Eliza Scott* under his own command, and the cutter *Sabrina* under H. Freeman—the latter with its tonnage of fifty-four being scarcely larger than the ship's boat of a modern ironclad. On the 16th of July, 1838, Balleny left London and immediately shaped his course for the waters of New Zealand. After a visit to Campbell Island, south of New Zealand, where by a strange chance he met John Biscoe, he on the 17th of January, 1839, made direct for south-east and then for due south. Up to the 27th of January the ships continued sailing in this direction without encountering either land or ice, but on that date they saw their first iceberg in latitude 63° 37′ S. and longitude 176° 50′ E. Precisely in the place where Bellingshausen in December, 1820, had been compelled to return in consequence of the heavy pack-ice, Balleny, on the 28th of January, reached his easternmost point without serious hindrance in latitude 65° 30′ S. and longitude 178° 13′ E. Now he took his course towards the south-west, and on the very following day, in latitude 66° 40′ S. and longitude 177° 50′ E., he came upon the field-ice which shut in the southern horizon, studded with numerous icebergs. In spite of the drift-ice, which was not heavy, the ships continued their course next day, and on the 1st of February, in latitude 69° S. and longitude 172° 11′ E., they reached the edge of the heavy pack-ice, and were thus compelled to return.

After a nine days' sail, during which the ships had an arduous and toilsome task in working their way towards the west through the ice and against the wind, a dark mass was seen to rise on the horizon towards the south-west on the 9th of February. Balleny at once made for this, and after an hour the ships had approached within five nautical miles of it. At sunset it could be distinctly seen that the land consisted of three large islands, and as no attempt to land could possibly be carried out, Balleny was obliged to rest content with ascertaining and determining their position. According to his observations, the west cape of the middle one lay in latitude 66° 44′ S. and longitude 163° 11′ E. All three islands, which were subsequently named after their discoverer, were almost entirely covered with snow, and on all sides glaciers descended to the sea.

Baffled by the ice, Balleny now turned to the north-west, beyond the 63rd parallel of latitude, observing numerous whales and sea-birds on his course. As, however, the ice diminished, he again commanded a south-westerly direction, and on the 27th of February he found himself in latitude 64° 37′ S. and longitude 130° 22′ E. On the 2nd of March the drift-ice largely increased, and with it the number of birds seen; at the same time land showed in the south, towards which Balleny steered next day. He encountered an immense number of icebergs of colossal size, while in the south-west the ice closed in completely, with land clearly visible beyond. A storm meanwhile prevented Balleny's nearer approach, and drove him to flee from the dangerous proximity of the pack-ice. At the time land was seen the ships were in latitude 65° 25′ S. and longitude 118° 30′ E., and no doubt can exist as to the correctness of Balleny's observations, for Wilkes distinctly saw land from the same place when there a year later. Balleny thought he saw land some days previously, on the 26th of February, when in latitude 64° 40′ S. and longitude 137° 35′ E., but finally concluded that it was only a fog-bank over the icebergs. Here, too, the subsequent investigations of Dumont D'Urville verified the existence of land. Influenced by the advanced time of year and the large numbers of icebergs, Balleny determined upon his return. He sailed to the north-west and crossed the 60th parallel of S. latitude on meridian 100° E. on the 14th of March, encountering violent storms on his further course, in one of which, while the schooner suffered severely, the little cutter disappeared, leaving no trace behind. He returned to London on the 17th of September, still in time to communicate particulars of his discoveries to Captain James Clark Ross, who was on the point of sailing for the very regions from the exploration of which Balleny had just returned.

4. DUMONT D'URVILLE, WILKES, ROSS.

Balleny may to a certain extent be regarded as the forerunner or pioneer of a succession of brilliant scientific voyages of discovery to the South Pole, which we are now in its entirety accustomed to regard as the great era of Antarctic exploration. It was not a mere matter of chance that this period was now entered upon, although Balleny's voyage across the untried tract of southern sea within the 60th parallel of latitude may perhaps be regarded as such. It was not chance, for just at this time one branch of physiographical knowledge stood in the foreground as a subject of universal interest, a subject that actually pointed to the poles of the earth in connection with its wider development, and that could not be successfully studied without explorations north and south—the subject of terrestrial magnetism. The high theoretical and practical importance of such study had for a long time been recognised, and above all others Alexander v. Humboldt was indefatigable in exercising his powerful influence in furthering the scientific investigation of this particular subject.

Sabine, and then Foster and others, had taken the opportunity given by their travels of observing magnetic declination, inclination, and intensity in different places, with the view of determining the length of the seconds pendulum. Humboldt next prevailed upon the Russian Government, in the year 1829, to erect a long line of magnetic observatories extending from the Baltic to Pekin. The oscillations of the magnetic needle were now everywhere eagerly watched, but the lack of a connected series of observations in other parts of the globe, and more especially in the southern hemisphere, began to make itself seriously felt. Humboldt now, by means of an open letter to the Royal Society of London, called upon the scientific representatives of the Power whose territories are most widely scattered over the surface of the globe, to erect fixed magnetic stations everywhere in the British Colonies. The Royal Society readily agreed to share in these investigations of terrestrial magnetism, perhaps lest the renown attaching to them should become the exclusive possession of Germany and Russia. However that may be, the Royal Society gave a ready response, and not only determined on the erection of fixed stations for magnetic observations themselves, but in the year 1838 called upon the Government to send out a scientific expedition to the Antarctic regions. This was to be specially designed for observing and investigating terrestrial magnetic elements in the higher southern latitudes; and, if possible, to discover the southern magnetic pole—the real North Pole—of the globe. The Government promptly responded to these wishes, and determined that two vessels of suitable size, the *Erebus* and the *Terror*, should be placed at the disposal of the Royal Society. The man best capable not only in

England, but anywhere, of securing brilliant results for the expedition, John Clark Ross, was appointed leader. He was the more eminent nephew of an already eminent uncle, John Ross, and was theoretically and practically well fitted for the post. Born in 1800, he accompanied Edward Parry on three of his great Arctic voyages as early as 1819-25. Then during the years 1829-33 he spent four winters amid Arctic ice on his uncle's great polar voyage, having on this occasion reached the northern magnetic pole. Latterly he had been engaged in a coast survey of the shores of Great Britain. By study, training, and experience, he had developed a high degree of scientific aptitude, and he must be regarded, not only as a remarkable hydrographer and skilful polar navigator, but as a physicist of the first rank in the domain of meteorology and terrestrial magnetism.

Meanwhile Ross's expedition, though far and away the most important, was by no means the only one which at that time had for object the exploration of the south polar regions. Two great expeditions had left their native shores before Ross set out, purposing to investigate and solve a number of problems, and among them those connected with meteorology and terrestrial magnetism in various parts of the globe, and more especially in the Pacific Ocean. Their undertaking included an extension of their voyages to the southern polar seas, and more especially the region due south of the South Shetland Isles. The one expedition had been sent out by the French Government in 1837 under the command of Jules Sébastien César Dumont D'Urville; it consisted of two corvettes, *L'Astrolabe* and *La Zélée*, the latter commanded by Captain Jacquinot; the other, under orders from the Government of the United States, was a squadron of five vessels, the *Vincennes*, the *Peacock*, the *Porpoise*, the *Sea Gull*, and the *Flying Fish*, under the command of the American lieutenant, Charles

Wilkes, as commodore, which left Chesapeake Bay in 1838. As already stated, both expeditions had been designed for purposes other than merely polar exploration, both commanders having equipment suitable to other purposes. Dumont D'Urville was doubtless an excellent navigator and hydrographer; this he had abundantly proved during two voyages round the world, both with remarkable results, but he was not best fitted for navigating polar seas, and openly gave expression to his dislike of the enterprise. Neither were his vessels properly fitted out for this purpose, in spite of the ingenious invention of one of his officers, who had strengthened the bows of the vessels against the ice with plates made of a sort of brass, though to be sure the armour came off at the first encounter. Dumont D'Urville's crews moreover were in no way equal to the hardships of polar voyages, as was proved by the sad mortality among them. The same may be said of the American expedition in regard of the ships and the absence of polar experience, although it showed a far braver front than the French in like circumstances. Both expeditions therefore were immeasurably behind that of Ross in these particulars, while he was not only one of the most eminent of polar navigators himself, but was able to select his own officers and crews solely for their fitness, and finally, his vessels were specially prepared and protected for the purpose of polar navigation. Nevertheless, both Dumont D'Urville and Wilkes, especially the latter, largely contributed to an extended and scientific knowledge of the Antarctic regions.

D'Urville first spent some time at the end of 1837 in surveying portions of the region of the Straits of Magellan, leaving these waters on the 9th of January, 1838, to steer south. He frequently emphasises that it was the primary object of his expedition to follow Weddell's course as far as was possible, and to exceed it if practicable; the discovery of new land was merely secondary. The first ice was seen on the 15th of January in latitude 59° 20′ S. and longitude 55° 10′ W.—broken fragments of an iceberg—and soon after, an iceberg appeared in sight. After this D'Urville steered between the South Orkney Isles and the Elephant and Clarence group, reaching the edge of the pack-ice, fast breaking up in the sunshine, on the 22nd of January, in latitude 63° 39′ S. and longitude

Jules Sébastien César Dumont d'Urville.

44° 47′ W. However, the ships sailed timidly along the edge of the ice, which extended to the north-east. On the 24th of January the place was passed—latitude 63° 23′ S. and longitude 42° 57′ W.—which had been seen almost entirely clear of ice on the 1st of March, 1823, by Weddell. The detailed, nay trivial, description which D'Urville gives of the ice-edge is extremely tedious reading: we will therefore spare the reader a further account.

After wasting a number of days in trying to find a passage through the pack-ice, he sighted Cape Dundas, the easternmost point of the South Orkneys, on the 26th of January. He followed the north coast of the island group till the 29th of January, and then steered north as far as latitude 58° 45′ S. Meeting with but little ice, he again turned south. This was on the 1st of February, but after two days the increasing quantity of ice filled him with dread, and on the 4th of February he had practically again reached the pack-ice in latitude 62° 20′ S. and longitude 37° 8′ W. For several days D'Urville this time tried to

Ice Structure in the South Orkney Islands (after Dumont d'Urville).

break through the ice, then he gave up every further attempt and turned round to the west—more or less persuaded that Weddell's account was an invention. On the 20th of February he again came in sight of the South Orkney Islands, and he landed on Saddle Island ; on the 25th of February Elephant and Clarence Islands were passed on the south, and on the 26th Bridgeman Island, which is a small volcanic island, and was just then in active eruption.

Since it was not D'Urville's object more nearly to investigate the South Shetland Isles, the highest point of which came in sight on the north-east, he steered on to the S.S.W., the quantity of ice increasing, and the icebergs growing more numerous. On the 27th of February several small rocky cliffs were seen rising amid the ice, to the great surprise of all. This again occurred a few hours later further west, latitude 62° 57′ S., in the part therefore where, on the chart of the Englishman Laurie, Hope Island had been laid down. The further the ships pressed forward, the more land now became visible; it was, however, soon after obscured by mist. As the weather again cleared, it was possible to get a general view of the land, the existence of which was certainly known previous to D'Urville, and the general outlines of which had been laid down on the charts. Nothing of the particulars of the older charts could, however, be recognised, although the situation, in part at least, corresponded to the earlier indications on them, so D'Urville felt himself justified in regarding the land before him as his own discovery. Towards the east it appeared as a connected, low-lying, and uniform whole; on the west it had the appearance of three islands. The voyage was continued westward next day in sight of land, the clear weather making a more accurate survey possible. It appeared completely covered with ice and snow, and elevated; in the south several high summits were observed, of which one received the name of Mount Jacquinot. Another, situated rather more to the south-west and about 3000 feet in height, was called Mount D'Urville; and a third, to the north-east of both, Mount Bransfield. All these heights lie on a mass of land called Louis-Philippe Land, to the east of which, separated by a strait, Joinville Land is situated.

On the 2nd of March it was possible to approach much nearer to the land under Mount D'Urville by entering a bay that cuts into the land in a semicircle. Towards

W.S.W. land could still be seen in the far distance, evidently already a part of Trinity Land, but between these distant heights and Louis-Philippe Land a broad arm of the sea seemed to lie, the Orleans Channel, which the vessels passed by in mist and rain. On its western shore they again came upon a group of five cone-shaped islands, entirely free from snow, with heights varying from 320 to 480 feet. During a short interval the weather cleared, and an extent of land was seen behind the islands, but soon mist and rain again set in so heavily that safety seemed to urge standing off from the land, or rather from the Dumoulin Isles, as they had been named. On the 4th of March the weather was better, and permitted a view of Louis-Philippe Land and of Trinity Land, with its snow-clad elevations, as well as of the Orleans Channel. On the 5th of March, however, D'Urville gave up all further search, steered past Deception Island, and through Boyd Straits, between Smith Island and Snow Island, to the north.

It is greatly to be regretted that D'Urville made no attempt to visit and to lay down the coasts of either Trinity Land or Palmer Land; for, as he himself admits, the condition of the ice in Bransfield Straits was very favourable. It would also appear from his own account that even the Orleans Channel was not entirely impassable; nay, from the remarks of his officers, one may conclude that the Channel was free from ice, and that the attempt to sail in was not made merely on account of the advanced season and the consequent shortening of the daylight. In any event, it must be admitted that D'Urville did not achieve what might have been achieved. He was anxious to quit the inhospitable polar regions for kinder skies, under which, after the squadron had put into Chilian harbours, he spent the two subsequent years in important undertakings of various kinds.

It is not impossible that D'Urville would have abstained from any further activity in the higher southern latitudes, had he not been prompted by national vanity once again to enter upon the hateful polar regions. In a negative sense, he certainly had performed the task expected of him, *viz.*, the attainment of a higher latitude than Weddell on Weddell's course. It is extremely probable that, like Wilkes, he had had news in Australia, if not earlier, of the intended expedition of J. C. Ross in search of the magnetic South Pole. Hoping to anticipate Ross in this important discovery, he probably sought out the regions to which Ross had originally been sent out. That the region where Balleny had seen land, and where D'Urville and Wilkes found extensive tracts, should have been chosen as the goal of Ross's voyage, was a consequence of the calculations of Gauss of Göttingen. This great mathematician and physicist assumed, on the basis of theoretical considerations, that the magnetic South Pole was to be found in approximately latitude 66° S. and longitude 146° E., in the neighbourhood, therefore, of D'Urville's Adélie Land.

On the 2nd of January, 1840, D'Urville left the harbour of Hobart Town in Tasmania, where the celebrated North Polar navigator, John Franklin, at that time resided as governor of the island, and steered due south. In the neighbourhood of latitude 51° S. he made unsuccessful search for an island, entered on many charts as Royal Company Island, since its existence is very doubtful, and it is probable that an iceberg may have been mistaken for an island. The first ice was encountered on the 16th of January in latitude 60° S., and it again caused D'Urville the keenest anxiety lest the ships should again meet the impenetrable pack-ice. His apprehensions, however, were entirely unfounded, for on the 18th of January the vessels had reached latitude 64° S. without having seen any ice but the five large icebergs on the date already mentioned. From their regular tabular form, which entirely corresponded to the bergs of Louis-Philippe Land, D'Urville correctly concluded that he was no longer far distant from land. The following day the number of icebergs visibly increased; at the same time the distant coast of unknown land could be distinctly seen. The day had been clear, and the additional heat affected the icebergs surrounding the vessels in all directions, streams of water running down everywhere from the thawing ice. The wind had at the same time completely gone down, and this

Icebergs to the north of Adélie Land, 18th January, 1840 (after Dumont d'Urville).

rendered a nearer approach to the land impossible. Many of the officers, indeed, still doubted whether it was land they saw; while on their convoy, the *Zélée*, they had been sure of it the day before.

It was not till the afternoon of the 21st of January that they were able to get nearer to the land; the coast itself was still covered with countless icebergs, which had obviously detached themselves only a short while before. The further the ships pressed forward the more the number of bergs increased, and the more tedious the passage through the channels between them became, where the echoes multiplied and repeated the officers' words of command. At length, after several hours, the ships reached open water on the coast, only a few nautical miles from the newly-discovered land. This extended south-west and north-east to the horizon, completely covered with snow, and rose gradually to the south in elevations of from 3,000 to 3,600 feet. On the further passage along the coast to the west a chain of small rocky islets was discovered, and on one

The *Astrolabe* and *La Zélée* on the coast of Adélie Land on 20th January, 1840 (after Dumont d'Urville).

of these a landing was effected, and possession of the newly-discovered land was taken for France by the unfurling of the tricolour. From here it was possible to see that here and there single rocky summits stood out beyond the frozen covering of the land, and it was also possible to collect a few specimens of rock and stone, and from these to draw conclusions concerning the petrographical character of the country. Now, at length, when absolutely no doubt remained as to the actual *terra firma* of their discovery, the land received the name of Terre Adélie, in honour of the reigning queen, consort of Louis Philippe.

On the following day D'Urville continued the course hitherto pursued westward along the coast, the frozen covering of which was broken by numerous ravines, and called the bay, from which this peculiar characteristic of the inland ice had been observed, Baie des Ravines. The icebergs in this region frequently showed signs of peculiar colouring, blackish and dark red, obviously indicating earthy matter present in the ice. D'Urville attempted to secure drifting pieces of this ice, but without success, for a strong current along the coast bore the ships rapidly along to the west, and rendered it impossible to lower the boats. The progress of this course was suddenly and unexpectedly arrested by pack-ice, the first seen in these waters, which moved in a northerly and then easterly direction; and, therefore, made further coasting to the west quite impossible. D'Urville therefore found himself compelled to tack to the east in the teeth of a rising and violent wind, in order to extricate himself from the bay formed round him by the pack-ice. One advantage the storm from the east certainly secured, and this was the loosening of the pack-ice. Thus the ships were enabled, though at a considerable distance from shore, to continue their westerly course after escaping from the pack-ice, and retreating to latitude 64° 48′ S. Near this place the French vessels, to their unbounded astonishment, saw a ship looming through the mist, which turned out to be a brig flying the American flag, and steering upon them at full speed. D'Urville commanded more sail to be set on the *Astrolabe*, a very slow sailer, to enable her to join the American and exchange news. But apparently this manœuvre was misunderstood by the American, for she quickly turned south and was soon out of sight. It was one of the ships of Wilkes's squadron, the *Porpoise*, commanded by Hudson, which, to the surprise of both sides, here encountered D'Urville's ships on the 29th of January.

When on the 30th of January the snow, which had gradually succeeded to the dense fog of the previous day, diminished and the sky cleared, the look-out announced pack-ice to the south. D'Urville made for it, but saw on his nearer approach that it was not pack-ice at all, and that the outer edge of the ice was of an entirely different character. It descended in perpendicular walls of 90 to 140 feet high to the surface of the sea, and thus formed a gigantic barrier, stretching far away to the west. Here and there, however, local indentations corresponded to the icebergs piled up in front of them, and here attaining a greater height than had previously been met with. In the far distance capes and bays were discerned, but all these variations in the coast outline ended in the perpendicular ice barrier. The vessels sailed along this wall for a distance of seventy to ninety miles without seeing any height rising above the elevated snow-covered plain. The height, moreover, precluded all possibility of getting a detailed view of the interior. On the evening of the day which had been wholly given up to the examination of this coast, a promontory was reached, from which the ice extended in a south-westerly direction, apparently far beyond the horizon, as was conjectured from the marked ice-blink in that quarter. D'Urville was confident that this ice barrier was connected with land, to which he gave the name of "The Clarie Coast" (Côte Clarie). Even on the following day he pursued his course along the barrier, but only to be stopped by actual pack-ice, the edge of which stretched away to the west and north-west. Without any further attempt to circumvent this, he turned north, satisfied with his results, which included numerous meteorological and magnetic observations—the latter having as far as possible been made on the ice. After a few days the last ice lay behind him, and he made for Hobart Town to recruit after the hardships of his polar voyage, returning to France in the same year, 1840.

All that has been said of D'Urville's first attempt to penetrate the Antarctic regions may be repeated here. According to the conclusions arrived at from reading his own account, it appears that a determined leader, with a firm resolution from the very outset to make an important advance, would certainly have achieved greater results than D'Urville. It is greatly to be regretted that having the advantage of being a week earlier than Wilkes, he

Discovery of the Clarie Coast, 26th January, 1840 (after Dumont d'Urville).

should not have profited by the south winds observed by Wilkes in the beginning of February, for continuing his explorations along the coasts stretching to the west. It must, however, be taken into account that the health of his crews gave cause for anxiety and alarm, and compelled his return, during which he again lost a number of his men through illness and death.

D'Urville claimed as his discovery the coast now known by the name of Wilkes Land. He was, however, not the first to see land in these regions, and must yield the palm to Balleny who also saw D'Urville's Côte Clarie, although he subsequently concluded it to be merely a cloud bank, while he certainly found Sabrina Land farther west. Of this fact D'Urville could not possibly have any knowledge, as Balleny did not return to Europe till the autumn of 1839, when his discoveries were made known, and the news could not have reached Tasmania and Australia by the time D'Urville and Wilkes started for the higher southern latitudes. Neither was Wilkes' attempt his first in these waters; like D'Urville he had begun his exploration of Antarctic land and sea from the south of Cape Horn, and the chronological order of discovery necessitates an account of his first Antarctic voyage.

After an exploration of the coasts of Tierra del Fuego, Wilkes had assembled his squadron in Orange Harbour and divided his forces so that he himself on board the *Porpoise*, and the *Sea Gull* under Lieutenant Johnston were to explore the South Shetland Isles as well as Palmer and Trinity Land, while the *Peacock* under Captain Hudson, and the *Flying Fish* under Lieutenant Walker, set out for the waters to the west of Graham's Land and Alexander Land. Wilkes doubtless deprived himself of a great portion of the success he, and especially the two latter ships, might have achieved by postponing his voyage to the very end of February, 1838. The voyage of the *Porpoise* and the *Sea Gull* contains no event of any importance. On the 1st of March Wilkes met the first icebergs, and shortly afterwards land came in sight, the small Riddley Isles, the out-posts of the northern point of King George Island, the easternmost of the actual South Shetland Isles. The next day, Bridgeman Island was passed in foggy weather. It was in a state of volcanic activity and the sulphurous fumes emitted were distinctly perceived as they were carried by the wind. On the 3rd of March, Louis-

Philippe Land was seen, the highest summit being regarded by Wilkes as identical with the Mount Hope of the seal-hunters, and consequently not to be claimed as a discovery of his own. Great masses of ice rendered a nearer approach to the land impossible, and Wilkes therefore missed seeing the Orleans channel, so that Louis-Philippe Land seemed to him to be the extreme east of Palmer Land. Without any further attempt to

Charles Wilkes.

get nearer land, Wilkes now returned to Orange Harbour, taking the channel between Elephant and Clarence Islands.

According to Wilkes' directions, Johnson first made for Deception Island, where he remained a week, occupied with observations of a general nature and an exploration of the island, at that time in a state of great fumarole activity. The *Sea Gull* again left these waters on the 17th of March, and also reached Orange Harbour after a stormy voyage on the 22nd of March.

The course of the other two vessels yielded comparatively far more important results. In consequence of the bad weather they were separated soon after leaving Cape Horn, and as they did not again meet in the position agreed upon, Hudson, with the *Peacock*, sailed first south and then south-east. He encountered no icebergs till the 11th of March, in latitude 64° 27′ S. and longitude 84° W. ; after this they rapidly became more numerous and rendered progress very troublesome. On the 20th of March, on meridian 90° W., he had attained a latitude of 68° S. and came upon pack-ice, not far, therefore, from Bellingshausen's Peter I. Island, of which, however, he saw nothing on account of the thick fog. He now steered west, and on the 25th of March, when in longitude 97° 58′ W. and latitude 68° S., to his great delight he fell in with the *Flying Fish*. As fresh ice was beginning to form, and the days were growing perceptibly shorter, both ships started from here on the return voyage, the *Peacock* seeing the last iceberg in latitude 62° 30′ S. and longitude 87° 40′ W.

During the voyage of the *Peacock*, Lieutenant Walker with the *Flying Fish* first cruised about for several days, after they were separated, in the position determined on for a rendezvous. Then he steered south with the object of finding the position in which Cook had reached his highest southern latitude on the 30th of January, 1774. On the 18th of March he came upon a heavy mass of pack-ice in latitude 67° 30′ S. and longitude 105° W., on the 21st of March, surrounded by many icebergs and in sight of the pack-ice, he had penetrated to latitude 68° 41′ S. and longitude 103° 34′ W., and on the 23rd of March he succeeded in crossing the 70th parallel of southern latitude in longitude 100° 16′ W., only five degrees farther east than Cook. But what was even more important than the latitude attained was the view on the further side of an extensive mass of pack-ice enclosing numerous icebergs, and of land, or at all events the appearance of land. Unfortunately it was impossible to examine further whether it actually was land. The advanced time of year, as already stated, favoured the formation of fresh ice, and there was not a moment to be lost in extricating the vessel from her position if the risk of being helplessly frozen in was not to be encountered. Fortunately the retreat was favoured by moonlight, so that Walker was not compelled to lose the lengthening nights while his ship lay to. On the 24th of March he had reached latitude 69° 6′ S. and longitude 96° 50′ W., and on the 25th of March the meeting with the *Peacock* occurred. The two vessels sailed together as far as latitude 60° S., where they separated, the *Flying Fish* to make for Orange Harbour, the *Peacock* steering for the Chilian coast. Thus this advance to the south, spite of its short duration, and spite of the advanced season, attained important results by means of at least one of the ships. It had reached a high latitude, and had made it probable that land extended to the east of that seen by Cook. If we take into consideration that these ships, like those of D'Urville, were manned by crews having no experience of polar navigation, and that the vessels themselves were in no wise prepared for it, we must admit that they were decidedly successful, especially as they were almost constantly opposed by mist and storm.

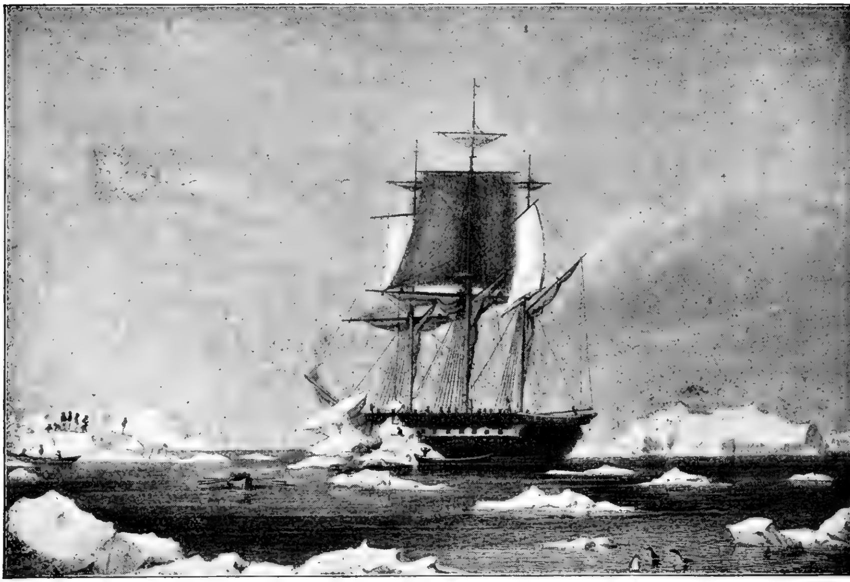
After Wilkes had spent the year 1839 in valuable and varied research in the waters of the Pacific, he determined to utilise the approaching southern summer of 1839-40 for a second attempt with his squadron in Antarctic waters. As before said, he may have been prompted by news of the expedition to be made by Ross. He, like D'Urville, knew the plans of Ross, but he was not yet acquainted with the discoveries

Landing at Adélie Land (after Dumont d'Urville).

[*Face page* 84.

already made by Balleny, and was consequently justified, like D'Urville, in regarding himself as the discoverer of these regions. The four vessels started from Sydney on the 27th of December, 1839—the *Sea Gull* had been wrecked in the summer of 1839—touched Macquarie Island, and looked for Emerald Isle, which they could not find as indicated in latitude 57° 15′ S., longitude 162° 30′ E. The *Flying Fish*, commanded by Lieutenant Pinkney, was separated from the other three soon after they set out; while these, the *Vincennes* under Wilkes himself, the *Peacock* under Captain Hudson, and the *Porpoise* under Lieutenant Ringgold, met after a short separation at the edge of the pack-ice. Wilkes had met the first iceberg on the 15th of January, 1840, in latitude 61° 8′ S. and longitude 162° 32′ E., and on the evening of the following day, after a favourable run, had come upon the edge of the pack-ice in latitude 64° 11′ S. and longitude 164° 30′ E., and found it heavy and thickly studded with icebergs. Wilkes steered to the west along the edge of the ice in the *Vincennes*, and on the 16th of January fell in with the *Peacock* and the *Porpoise*. It was here, in longitude 157° 56′ E. and latitude 66° S. that, according to Wilkes' account, land was decidedly seen by all three ships. Driving snow and fog shut in the view towards the south during the next few days, during which an unbroken course to the west was held. On the 19th of January, the weather being good, land was most certainly seen lying S.S.E. and S.W. from the *Vincennes* in latitude 66° 20′ S. and longitude 154° 30′ E. On the same day land was seen to the south-west by the *Peacock*, also appearing, when first observed, high above an iceberg which lay on the line of sight. Wilkes gave the name of Peacock Bay to the bay apparently sweeping inland.

As the vessels sailed on to the west, vast masses of icebergs gradually took the place of field-ice almost entirely. After Wilkes had run past Peacock Bay, on the 22nd of January, without being able to enter it—three days, therefore, after its discovery by Hudson—he, on the 23rd of January, in latitude 67° 5′ S. and longitude 147° 30′ E., again saw land, and this time it lay to the east and west of a deep and broad indentation made by the sea; he named this Disappointment Bay, and, continuing his course across it, reached latitude 67° 5′ S. and longitude 147° 30′ W. The next few days were



The *Vincennes* in Disappointment Bay (after Wilkes).

very stormy, and progress through the numerous icebergs became very perilous; moreover, the outlook was obstructed by snowstorms and dense fogs, so that land was not again seen till the 28th of January—the eastern portion of Adélie Land, discovered seven days previously by Dumont d'Urville. On the whole, Wilkes had hitherto constantly sailed in company with the *Porpoise*, from which also signs of land had been observed on the 22nd of January, as well as icebergs and portions of icebergs laden with fragments of rock and stone rubbish. On the 23rd the two vessels came in sight of each other, also on the 27th, but from this date forwards the *Porpoise* hastened on to the west in advance of the *Vincennes.* Of the two other ships, the *Peacock* had an accident on the 23rd of January, in latitude 65° 55′ S. and longitude 151° 19′ E., her rudder being injured by the thick ice. In consequence of this she was partly unable to obey the helm, and consequently came into collision with an iceberg, so that she was compelled to leave the polar seas without delay and make for Sydney, which was reached on the 17th of February. Pinkney, in the *Flying Fish*, had first seen icebergs on the 18th of January; on the 21st he had reached the edge of the pack-ice, in latitude 65° 20′ S. and longitude 159° 36′ E., and then steered to the west, keeping, on the whole, to the north of the other ships. On the 23rd he, too, saw the land elevations observed by the others; but for the rest saw no land whatever, not even by Peacock Bay, which he approached pretty closely on the 30th of January. This is accounted for by a violent snowstorm which raged from the south-east on that date. As far as longitude 143° E. he held to the edge of the pack-ice; then, however, he steered again to the north, and returned to Sydney by New Zealand.

The other two ships meantime pursued their arduous course with undiminished spirit. On the 30th of January Wilkes again saw land. He succeeded in breaking through the field-ice in a narrow channel and in reaching the open water, on which he approached the dark cliffs of Adélie Land, within half a mile of the very point where its first discoverer found the outlying coast islets. According to Wilkes' estimate the land here extended east and west to a distance of fully sixty nautical miles from his position in latitude 66° 45′ S. and longitude 140° 3′ E. Wilkes here gave the whole of the newly-discovered lands the name of the Antarctic Continent, and the bay in which he rode he called Piner's Bay. Several of the officers appeared to think they could see smoke rising from the summits of the mountains, but Wilkes was of opinion this effect was produced merely by snowdrift. Wilkes' success in pushing forward to the very coast took place at the same time as the meeting of the *Porpoise* with the French vessels as already related. The *Vincennes* as well as the *Porpoise* now steered on to the west, being prevented by the violent snowstorm of the following day from sighting any land. On the other hand, the *Porpoise*, on the 1st of February, and the *Vincennes*, on the 2nd, saw the vertical ice barrier already seen by D'Urville—Wilkes' observations making their position latitude 66° 12′ S. and longitude 137° 2′ E. On the 2nd of February Wilkes sailed the whole day in uninterrupted view of land, which he was able to approach for a short distance from the position indicated above. It was everywhere closed by the ice barrier, which Wilkes judged to be 160 to 200 feet high. On the 3rd of February a violent storm beat back the ship to the north; on the 6th Wilkes was again in sight of the ice-wall, and was able on the 7th clearly to see the elevated land beyond it, and to observe that both the ice-wall and the land made a sudden deviation to the south. This point, situated in latitude 64° 49′ S. and longitude 131° 40′ E., and named Cape Carr by Wilkes, is identical with the western extremity of D'Urville's Côte Clarie.

The *Vincennes* attempted on the 8th of February to follow the course of the ice barrier beyond Cape Carr to the south, but was unsuccessful owing to the enormous number of icebergs. Land was lost sight of, and was not again seen till the evening, when it appeared in the far distance from latitude 65° 3′ S. and longitude 127° 7′ E., when it was named North's Highland.

On the 10th of February, when the *Vincennes* was in latitude 65° 27′ S. and longitude 122° 35′ E. land (Tottens' Highland, identical with Balleny's Sabrina Land) again appeared, though not distinctly, and again on the 12th of February. A high snow-covered mountain chain was seen at a distance of sixteen to twenty-three miles, which was named Budd's High Land, and was situated in about latitude 65° 20′ S. and longitude 112° 16′ E. Many icebergs covered with fragments of stone were found on the edge of the pack-ice, and led Wilkes to hope that a landing might be effected, a hope that was frustrated by the completely closed pack-ice. The land was again distinctly seen on the following day from latitude 65° 37′ S. and longitude 106° 40′ E. at a distance of twelve to fourteen miles, and received the name of Knox's Highland.

On the following day, February the 14th, the *Vincennes* found it possible to approach the land to within a distance of eight to nine miles. The day was fine and clear, and allowed of land being seen to a great distance from the ship's position in latitude 66° S. and longitude 106° 19′ E. According to Wilkes' estimate a coast of ninety miles in extent was visible, and the elevation, which was completely covered with snow, might approximately reach 2,800 feet. Several icebergs, again thickly covered with stones and broken rock, were observed in the neighbourhood of the coast; and as a landing could not be effected, the largest accessible iceberg was visited for the twofold purpose of making magnetic observations on it, and of collecting specimens of the stones lying in immense masses upon it. In the middle of the part visited a small tarn of melted ice-water was discovered, from which the vessel was replenished with fresh water. On the 15th of February land was lost sight of, as the north-westerly drift of the pack-ice compelled Wilkes to take the same course.

Nevertheless the rubble on the numerous icebergs still indicated that land could not be very far distant. The sea was remarkably smooth, and above all showed no signs of surf or breakers, so that Wilkes conjectured that a large mass of field-ice lay to the north of his course: indeed he hoped to be successful in reaching Enderby Land along the coast. In this he was, however, disappointed on the following day, when, surrounded by icebergs laden with *débris* he was compelled by the pack-ice to steer north. All these experiences were repeated on the 17th of February, when he apparently saw land from latitude 64° 1′ S. and longitude 97° 37′ E., but this he terms "appearance of land" and not land positively seen. It lay towards the south-west, and seemed to extend towards the north. In spite of its doubtful appearance Wilkes named it Termination Land, and we shall return to the subject later on in discussing the advance of the *Challenger*. Wilkes continued his search for land in these regions for several days, in the midst of grave difficulty occasioned by the pack-ice; but on the 20th of February, when in latitude 62° S. and longitude 102° E., he gave up the useless quest and steered back to the north, unhindered by the pack-ice which here took a westerly direction. He returned to Sydney Harbour on the 11th of March.

We now return to the *Porpoise*, which we left at the point where the meeting with Dumont d'Urville's vessels took place on the 30th of January. Two days later she also came upon the vertical wall of ice, which her commander, Ringgold, describes in the identical terms used by Wilkes and D'Urville. On the 2nd of February Ringgold was able to enter the bay on the west side of Côte Clarie and to press forward as far as latitude 65° 24′ S. and longitude 130° 36′ E., without, however, coming upon land even there. A violent storm arising compelled him to turn north in order to avoid the region of the greater number of icebergs, and it was not till the 10th of February that he again crossed parallel 65 in longitude 110° 54′ E. On the next day, and subsequently, numerous icebergs, with *débris* of rock and stone, were observed, but land itself did not again come in sight. Ringgold kept his course along the edge of the pack-ice up to the 14th of February, when he found himself on meridian 100° E.; then in latitude 63° S. approximately he again steered east, and once more attempted to push forward south on the 21st of February in longitude 121° 30′ E., but without any result beyond that of penetrating to latitude 65° 15′ S. At length he too left the inhospitable and stormy regions of Wilkes Land and returned to Sydney, seeing his last iceberg as far north as latitude 55° S. and longitude 140° E.

The results of this expedition are of great value, even after all allowance has been made for the achievements of Balleny and Dumont d'Urville. A succession of more or less connected groups of land had been seen—though it was premature to regard them as an Antarctic continent—over an extent which exceeds the length of the Ural Mountains, if moderately estimated at nearly 1,500 miles, and equals the length of the west coast of Greenland, from Cape Farewell to Upernivik. Those who are of opinion that only small scattered islands were seen, must not forget that Wilkes was greatly harassed by fogs and storms, that land could be seen only in really good weather, and that, given continuous fine weather and a clear sky, Wilkes would certainly have discovered more. In any event it is a mistake to regard the discoveries of Wilkes as apocryphal, as was done by Ross, or to omit placing them on the chart. The discoveries made a year previously by Balleny, and those simultaneously made by Dumont d'Urville, are telling proofs that the land seen by Wilkes was an actual fact.

Before the expeditions described had set out for the south, the internal and external equipment of the two vessels destined for James Clark Ross's three years' expedition had already been vigorously taken in hand at Chatham. Preparations were completed by the end of September, and on the 30th of September, 1839, Ross, as leader of the expedition, left England from Margate Roads, on board the *Erebus*, of which he was commander. The commander of the *Terror* was Francis Crozier, who subsequently accompanied Sir John Franklin in the same vessel and lost his life in 1845. Madeira, the Canaries, the Cape Verde Islands, St. Paul's Rocks (lying near the equator between Africa and South America), Trinidad (longitude 29° W., latitude 21° S.), and St. Helena were visited, and simultaneous magnetic observations were made, *i.e.*, at the same time as at all the observatories scattered over the earth. On the 17th of March, 1840, the expedition reached the Cape of Good Hope, and remained there till the 6th of April for the purpose of establishing a permanent magnetic observatory. On resuming their voyage, Prince Edward (or Marion) Island and Crozet Island were visited, without landing, and on the 6th of May Kerguelen Island came in sight. It was not till the 15th of May that they made Christmas Harbour, discovered and described by the first to visit it, Kerguelen, and subsequently by Cook. Here the ships remained till the 20th of July, busily occupied with extensive magnetic observations.

At length, on the 16th of August, Hobart Town in Tasmania was reached, where Ross, according to his instructions, again erected and established a permanent magnetic observatory. Here, too, he was met by the news that he had been anticipated by Dumont d'Urville and by Wilkes in the exploration of the regions in which it was conjectured that the South Magnetic Pole was situated. Wilkes, indeed, conveyed to Ross the tracing of the

James Clark Ross (after a steel engraving in the possession of Dr. G. Neumayer).

[*Face page* 92

original chart, in which he had laid down the outlines of his "Antarctic Continent". Ross was naturally and justifiably surprised and annoyed to find his purposes thus forestalled by commanders who were well aware of the preparations for fitting out the expedition under his own command. Fortunately, much had been left in his instructions to his own judgment, and he therefore resolved to select another passage southward, feeling that it was inconsistent with the traditions of British exploration to follow in the footsteps of other nations.

Ross therefore determined to penetrate to the south, far to the east of the course of these explorers, on meridian 170° E., the meridian on which Balleny two years previously had found the sea comparatively open in latitude 69° S. It was therefore to be expected that he would pass further south than had been possible to either D'Urville or Wilkes. On the 12th of November he stood down the Derwent River, the splendid harbour of Hobart Town, and first shaped his course for the smaller island groups off the coast of New Zealand for the purpose of making magnetic observations. On the 20th of November the Auckland Islands were reached, where the expedition stayed till the 12th of December, and on the 13th of December, Campbell Island, where a four days' stay was made. On the 24th of December the 60th parallel south was crossed on meridian 170° E., and on the 28th, in latitude 63° 20′ S. and longitude 174° E., the first iceberg came in sight, rapidly succeeded by numerous others of large size and with tabular summits. The experienced Arctic navigator was struck by their uniformity, differing in this respect from the icebergs of the Arctic seas. Many bergs and much loose ice were passed, and on the 31st of December, when the ships were in latitude 66° S. and longitude 171° 50′ E., a strong ice-blink in the sky to the south pointed out the situation of the pack.

Ross steered through the loose drift-ice to the edge of the heavy main pack on New Year's Day, 1840, crossing the Antarctic circle in his passage, but owing to the thick weather he was obliged to haul off without penetrating into the pack-ice. Meantime, although this obstruction had been met with in a lower latitude than had been anticipated, this circumstance had no dispiriting effect on the explorers, for they had also expected to find it much more impenetrable than it proved to be. The next day a strong breeze with thick snow showers led Ross to stand off again, but after sailing one degree north, and nearly three to the east, he, on the 4th of January, determined to push the ships into the ice, which was rapidly drifting north. From the 4th to the 9th of January the way was pursued through the pack without the clear sea being discernible. Early on the 9th of January the open water was again reached in latitude 69° 15′ S. and longitude 176° 15′ E. When the fog, which had prevailed since the 8th, cleared off on the following day, no trace of ice was any longer to be seen from the masthead, and a latitude of 70° 23′ S. on meridian 174° 50′ E. was attained.

In these circumstances Ross conjectured that the land seen by Wilkes and Dumont d'Urville consisted only of small islands, and that he would be in a position to approach the magnetic pole by sea. The dip had already indicated that this lay, not in the place predicted by the calculations of Gauss, but considerably further south.

Ross now shaped his course south-west, directly for the magnetic pole; but that very evening a strong "land-blink" appeared, and this in the morning proved to be a lofty mountain chain covered with perennial snow. At his approach the peaks seemed to open out and extend to the right and left across the whole horizon, and it seems that the whole range had actually been previously seen by means of the refraction of light at the remarkable distance of a hundred nautical miles. On the evening of the 9th of January the ships had approached to within two and a half miles of the shore, which was lined by heavy pack-ice. The summits of the mountain chain rose to elevations of from seven to ten thousand feet above sea-level: the highest, a conical peak, was named Mount Sabine, and the whole chain, running south-east and north-west, was named Admiralty Range. The mountains were completely covered with ice and snow, and everywhere gigantic glaciers filled the intervening valleys, projecting many miles into the sea, and ending in abrupt, perpendicular ice cliffs. A promontory below Mount Sabine, partly free from snow, was named Cape Adare, and from this projection the land made a sudden bend to the south. The magnetic dip, *i.e.*, the angle that the perpendicularly balanced needle makes with the horizon, had now increased to 87°, according to which the magnetic pole was placed in latitude 76° S. and longitude 145° 20′ E.

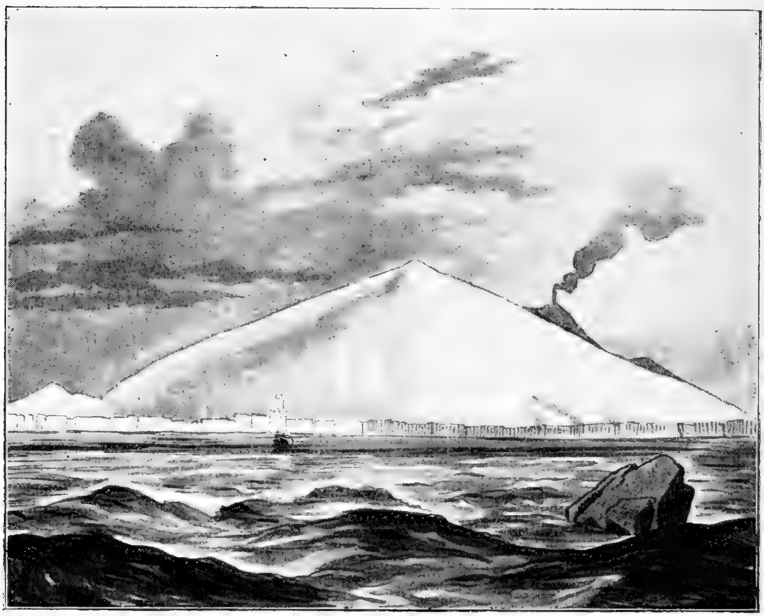
Ross still had hopes of circumnavigating the land on the south and thus reaching the pole, and with this object he resolved to steer along the east coast towards the south. On this course he found a number of small islands of volcanic origin; and on one of these, in latitude 71° 56′ S. and longitude 171° 7′ E., he landed on the 12th of January, naming it Possession Island. During the four succeeding days the vessels were twice compelled by violent snowstorms to stand off towards the east into the open sea, so as to avoid the perils of the shore and the pack-ice. The summits of the lofty mountain chain, here estimated at upwards of 10,000 feet high, remained almost constantly in sight, and even at a distance of 140 miles were clearly recognisable, so that many, not accustomed to estimating distances from land, would have thought themselves only thirty or forty miles off. In the intervals of bright sunshine the land presented a wonderful appearance, the ice-girt heights standing out in sharp contrast high above the rolling clouds. On the 20th and 21st of January the ships were in the neighbourhood of Coulman Island, and land, with lofty elevations, was again seen far to the south south-west. The loftiest mountain, far exceeding all others in the south polar regions in height, was named Mount Melbourne. Its outlines bore a great resemblance to those

Mount Minto and Mount Adam (after Ross).

of Mount Etna, though its elevation exceeds that of the Sicilian volcano. A further progress south caused the land to the west to gradually disappear, for an extremely broad belt of ice made the approach along the coast and the pack-ice most undesirable. Ross now steered due south, crossing the highest latitude attained by Weddell on the 22nd of January, and on the 26th land again came in sight. On the following day this was discovered to be an isolated island, small but elevated, and to this the name of Franklin Island was given. A perilous landing was effected, and the position found to be latitude 76° 8′ S. and longitude 168° 12′ E.

On further progress south, land appeared in the same direction, in the radiance of the midnight sun, seemingly consisting of a number of small islands. Meanwhile the further the ships advanced the higher the apparent islands rose on the horizon, and it was soon evident that they were the summits of lofty mountains forming a coast which seemed to extend east and west. These summits were cone-shaped, and although it was first supposed that the summit of one was surrounded by masses of snow-drift, it was soon seen that these clouds consisted of smoke, ejected at irregular intervals by the mountain itself, and that the totally unexpected spectacle of an active volcano presented itself in these high latitudes. The reflection of the lava was distinctly seen over the crater, and some of the officers even thought they saw streams of lava proceeding from the summit. This volcano was named Mount Erebus, and its height was estimated at 12,400 feet, while a smaller one, Mount Terror, lying to the east, 10,900 feet high, appeared to be no longer active; its sides, however, were more free from snow than those of its greater neighbour. To the north of Mount Erebus lay a small, elevated, round island named Beaufort Island, while a promontory at its foot was called Cape Bird, and another at the foot of Mount Terror, Cape Crozier.

It had been remarked, at the very first approach to land, that an apparently low white line extending from the eastern point of Mount Terror was continued eastwards till it was lost to the eye on the horizon. On nearer approach this proved to be a perfectly perpendicular cliff of ice, between 150 and 200 feet above sea-level, perfectly flat and level at the top, and without fissure or promontory on its seaward face. In the distance beyond, only the summit of a lofty range of mountains could be seen, apparently extending southward as far as latitude 79° S., Cape Crozier being situated in latitude 77° 25′ S., longitude 169° 10′ E. This range received the name of the Parry Mountains. On account of the height of this ice cliff it was impossible to determine what lay beyond it, and Ross was obliged to content himself with sailing along the lofty barrier. Progress south was



Cape Crozier and Mount Terror (after Ross).

necessarily out of the question ; indeed, Ross says that he might as well have tried to sail through the cliffs of Dover as southward through the icy mass, which in height and conformation resembles them. From the 28th of January onwards Ross altered his course to the eastward ; on the next day 100 nautical miles' run along the vertical ice cliff had brought no change in its appearance or direction. Here Ross found it advisable to increase his distance from the barrier, as with a light wind the northerly swell drifted the vessels gradually towards it. Before long, snow showers set in, continuing through the following day, and, as there seemed no prospect of progress towards the south-east along the ice barrier, Ross was obliged to steer north-east, so as to pass over as great an extent of space as possible in the open sea with the steady wind. On the 31st of January pack-ice was encountered, and the ships entered it and penetrated it for a distance of twelve or thirteen miles, but, as it grew closer and the wind stronger, Ross again stood back to the westward for the night in the open sea. On the following day the ice was again penetrated to the southward, and on the 2nd of February the ice was again in sight without any change whatever in its appearance. A near approach was, however, quite impracticable owing to the heavy outlying pack-ice.

Since Ross was of opinion that some time must still elapse before the ice seen to the north-west of Mount Erebus and Mount Terror would break up and clear away north, he determined, after consulting with Captain Crozier, to trace the course of the great barrier for some distance towards the east, and then to renew the attempt to reach the magnetic pole by sea. On this day, the 2nd of February, the vessels reached the southernmost point attained during the southern summer of 1840-1 in latitude 78° 4′ S., and about longitude 173° 20′ W. The ice barrier was here about 125 feet high, and extended as far as eye could see to the east and west; the face of it was probably in latitude 78° 15′ S. The course eastwards was, therefore, continued, and on the 5th of February a W. longitude of nearly 167° was reached in latitude 77° 18′ S., but the ice was found so closely packed that the vessels could make no way, and had some difficulty in extricating themselves towards the west. As soon as this was accomplished Ross steered a southerly course along the edge of the pack-ice, on the 7th and 8th of February, passing a berg with a large rock frozen in, and at midnight the ships were again near the ice barrier. Here they saw an indentation towards the east—the only bay worth naming, and, as the heavy pack-ice lay at some distance to the north, it was possible to approach the ice cliffs within a quarter of a mile. These here showed a very striking conformation, for while the height of the cliffs was 150 feet, the projecting peninsula of ice ended in a cape 170 feet high, and the connecting isthmus between the two elevations attained only a height of scarcely fifty feet. This lower portion, therefore, afforded a favourable opportunity of viewing the upper surface of the enormous mass of ice from the mastheads, and it appeared perfectly level and smooth. From every projecting point of the ice-cliffs gigantic icicles depended, a proof that it occasionally thaws, which would not suggest itself with a midday midsummer temperature of only 14°F. In consequence of this low temperature and the sheltered position, young ice formed so rapidly that the ships were in danger of being enclosed. Fortunately, the breeze, aided by the strenuous exertions of the crews in breaking up the ice, was strong enough to enable the ships to regain a freer space. Scarcely had this been accomplished, when the west wind set in ; had this occurred half an hour earlier, the expedition, wedged in between the barrier and the pack-ice, would have been enclosed and compelled to winter there.

The ships now took a course to the northward until latitude 76° S. was reached. Their passage was greatly obstructed by pack-ice and young ice, while the severe cold of the north wind quickly froze and closed all openings and channels in the pack, driving it southwards. A violent snowstorm set in on the 12th, during which the ships barely weathered an extensive chain of very large icebergs, probably aground. The thick falling snow prevented their seeing any distance, and the waves moreover, as they broke over the ships, froze as they fell on the decks and rigging, and covered all, even the men's clothing, with a thick coating of ice. When on the 13th of February the weather cleared, and it became evident that every further examination of the pack-ice was fruitless, Ross determined to make one more attempt to reach the magnetic pole, and to seek a harbour in which to pass the winter. Nearly three weeks had elapsed since they had come nearest to the pole at Franklin Island, and it seemed reasonable to hope that the pack-ice to the N. and N.W. of Mount Erebus had in the main drifted off to the north. On the 16th of February the great volcano again came in sight, and the weather growing very clear it was evident that Erebus and Terror were connected with the main land (Victoria Land), and were not on islands, as had at first been conjectured. To the west of Cape Bird, a deep bight extended to the west, the shores of which could be distinctly traced connecting Mount Erebus with the westernmost point of Victoria Land reached by the ships in latitude 76° 12′ S. and longitude 164° E. Ross had attempted to penetrate the tough, newly-formed ice coloured by an infinite number of rust-brown diatoms, in an effort to reach the west side of this bight, when he came upon such heavy closely-packed ice as to cause him to desist when within ten or twelve nautical miles of the low coast. This involved their giving up at the same time the anticipated exploration of a low point of land with an islet off it, which seemed likely to afford a suitable harbour for wintering in. There was no prospect at that advanced season that any more of the land ice would break away, and consequently no chance of reaching the coast and finding a secure refuge for wintering in. Ross therefore relinquished the attempt to approach nearer to the magnetic pole, which he calculated was only 160 nautical miles distant, as the magnetic dip was 88° 40′. The cape with the islet off it, which had seemed suitable for winter quarters, received the name of Cape Gauss.

At a great distance from the low coast line, a range of mountains was seen. These were of great elevation, and evidently the connecting range between Mount Melbourne and Mount Erebus. They received the name of Prince Albert Mountains, in honour of the Prince Consort, while the whole extensive tract of country had already been called Queen Victoria Land. There was nothing left but to retrace their way through the pack and the young ice into the open, and the success of the laborious work seemed very problematical, for the young ice had increased in thickness very fast. When the breeze freshened, the vessels were able to make some way; at other times the boats were lowered and the young ice broken by rolling them, for the surface was not strong enough to support a party of men to saw a passage for the ships. In this way they at length emerged into clear water on the morning of the 19th of February, and hastened northward, keeping, as far as possible, near the edge of the ice. This already extended so far to the east that the coast line between Cape Gauss and Mount Melbourne, or more correctly Cape Washington, entirely disappeared below the horizon, while the chain of the Prince Albert Mountains remained constantly in sight far away in the west. Near the edge of the pack-ice either an island or a large berg, covered with rock and *débris*, was passed, and named Doubtful Island, as it was impossible to ascertain its true character. Even Mount Erebus remained in sight clearly above the horizon, in spite of its being 150 nautical miles distant, and while Mount Melbourne was again in view. To the north of this lofty summit the pack formed a much narrower belt off the coast, so that it was possible to approach the land much nearer than in January. A passage between the land and Coulman Island was nevertheless not practicable, and as Ross resolved to make an attempt to land at Cape Adare, and the coast to the north of Coulman Island had been examined on his passage south, he stood towards the cape without delay. But even here a near approach was impossible, because a dense body of ice already extended to some distance from the shore, and Ross therefore determined to follow the coast along the Admiralty Range to the north-west as far as was possible. In this they were successful as far as the extreme point named Cape North, from which the land appears to trend to the south-west. The closed young ice here intercepted further progress to the westward, and the coast by Cape North was once more carefully examined in the hope of finding a suitable harbour for the ships to winter in. In this hope they were disappointed, for the indentations of the coast were everywhere completely filled with glaciers, and the coast consisted of perpendicular ice cliffs, varying from two to five hundred feet high, and before them a chain of stranded icebergs of great extent. Ross, however, spent several days narrowly examining this northern portion of Victoria Land, and in clear weather, on the 24th of February, he was so fortunate as to see that, although the land extends from Cape North in a south-westerly direction, a barrier of ice stretches due west from the cape to the horizon, corresponding in appearance to the formidable barrier to the east of Mount Terror.

After the relations of the north coast of Victoria Land had thus been made plain, the leader of the expedition resolved to steer northwards, and in this way to determine whether any land lay between Balleny Isles and Cape North. On the evening of the 28th of February Victoria Land sank below the horizon at a distance of eighty miles, and on the following night the Aurora Australis was seen for the first time. On the 2nd of March, land was seen to the W.N.W., apparently two islands, which Ross named Russell Peak and Smith Island. An attempt was made to approach them, but the ice was so dense that the mere attempt was attended with difficulty and danger, and a speedy retreat was effected. On the 3rd of March, the land was nearly veiled by clouds, but it reappeared quite distinctly in the S.W. and was easily recognised, by the peculiar form of Russell Peak, as the land previously seen; from this position it was evident that there were three islands; and the third was named Frances Island. Ross found that the position of the group was approximately latitude 67° 28′ S. and longitude 165° 30′ E., and this circumstance leads to the conjecture that these were possibly the Balleny Islands, even although the position given by Balleny varies considerably from that of Ross. The weather was too bad and the vessels too far distant from the land to allow of Ross making an accurate and satisfactory observation, but he was certainly of opinion that the two groups were close together. After this sight of land he crossed the Antarctic circle, steering west in order to come upon the eastern extremity of the land laid down in the chart of the "Antarctic Continent" sent him by Wilkes. The 5th of March was a splendidly clear day, and land of any elevation could have been seen at a distance of seventy nautical miles, but nowhere was anything to be seen, so that Ross concluded that Wilkes and his men, being novices in polar regions, had been deceived by the appearance of a bank of clouds. This opinion seemed confirmed on the following day, when far to the S.S.W. of Mount Erebus, an indication of land was seen, exactly in the direction of the Balleny Isles, now distant seventy or eighty nautical miles, and besides this the vessels actually sailed over the place where Wilkes had laid down land in his chart.

Not content with this investigation, Ross was determined to spend the rest of the summer, or rather the short autumn of the south polar regions, by making an approach to the place where, according to Gauss, the South Magnetic Pole lay. At the same time, he had not the slightest hope of reaching the spot itself, for the lateness of the season and the condition of the ice rendered the attempt impracticable. For this purpose he steered west and south-west as far as meridian 146° E., continuous magnetic observations being made. The highest latitude attained was 65° 10′ S. on meridian 144° 56′ E. After the line of no variation had been determined in these higher latitudes, the vessels shaped their course for Hobart Town, which was safely reached on the 6th of April. As far north as latitude 54° S. the nights had been illuminated by splendid displays of the Aurora Australis, and the last iceberg was seen in latitude 53° 30′ S.

The first task Ross set himself on his arrival in Hobart Town was to refit and prepare his vessels. On examination it was found that they had sustained scarcely any injury during their long and arduous polar voyage. It was also found that their stores and provisions of every kind were in good preservation, and that nothing had suffered from the great differences of climate passed through, a proof of the care and thoroughness with which the equipment and provisioning of the expedition had been carried out. Best of all, the voyage had been free from sickness or casualty of any kind, and every individual of both ships returned in perfect health and safety, thanks to the unceasing care of their commander. Their stay in Hobart Town lasted till the 7th of July, the time being filled up with eager scientific examination of the island in many directions; among others, Ross was occupied with fixing a permanent mark for showing the mean level of the ocean, in accordance with suggestions made by Alexander v. Humboldt. Leaving Hobart on the 7th of July, the ships reached Sydney on the 14th. Their stay here till the 5th of August was principally occupied with simultaneous magnetic term observations. To complete his task, Ross then went to New Zealand, where he lay in the Bay of Islands, near the northern end of the northern island, from the 17th of August to the 23rd of November, waiting here until the season should be sufficiently advanced for a fresh start for the high southern latitudes. On the date named, the ships weighed anchor, and on the 30th of November sighted Chatham, or Warekauri, Island, though they were unable to land owing to the stormy weather. On the 16th of December they met with their first icebergs in latitude 58° S. and longitude 147° W., five degrees further north than the previous summer, but decidedly further south than bergs were first encountered by Cook and Biscoe in these regions. Ross had kept to an eastward course thus far on account of his terrestro-magnetic observations, but on reaching the meridian of 146° W. he determined to change his course to due south. He expected to discover land from the low latitude in which the first icebergs were met, and, in any event, to reach the eastern point of the great ice barrier, so as to resume his explorations of the previous summer where they had been interrupted. The circumstance that but few icebergs were seen during the day after their first appearance, and that the vessels attained a latitude of 61° 3′ S. on meridian 146° 3′ W., caused Ross to hope that the progress south would be rapid. On the evening of the same day, however, a strong ice-blink appeared in the sky to the south-east, and announced the neighbourhood of pack-ice, and early on the next morning, the 17th of December, the main pack was reached. As the edge seemed pretty open Ross at once ran into the pack, but after penetrating about thirty nautical miles, the ice became so heavy that further progress became impossible, and he was compelled to steer to the south-west. The struggle with the ice, which was constantly drifting north, continued till the 2nd of February, 1842, when in latitude 67° 29′ S. and longitude 159° 1′ W. the vessels at length emerged into an open sea. They had been compelled to make their way step by step for forty-eight days in the face of appalling difficulty and with ceaseless labour, and while thus engaged in forcing a passage south they were constantly carried northward by the pack. Several times, while in the close pack-ice and surrounded by icebergs in addition, they weathered violent gales, in one of which, on the 19th of January, 1842, both ships suffered severely, especially the *Terror*. Her rudder was completely destroyed, and it was, therefore, necessary to fit a spare rudder with incalculable exertion while she lay in the midst of the ice.

While the ships themselves had advanced only 375 miles in the fifty-six days during which they were involved in the pack-ice, Ross estimated the breadth of the belt of pack-ice which had drifted past northwards at no less than 1,000 nautical miles. The greatest disadvantage connected with the tedious crossing of this enormous belt of pack-ice arose from the great loss of time, for while Ross in the previous year had reached as far as the eastern extreme of the great ice barrier by the 2nd of February, he had this year not even reached the 68th degree of S. latitude, and it therefore became imperative to press forward south, lest the summer season should be altogether lost. Meanwhile it was as yet impossible to keep to a due southerly course, as the pack edge still trended south-west. It was not till the 16th of February that the extreme western point of the pack was rounded in latitude 75° 6′ S. and longitude 172° 56′ E., enabling the ships to steer south-east, and on the 22nd of February, shortly before midnight, the great ice barrier again came in sight. No stay near it could, however, be made; the young ice was rapidly thickening again and the belt of broken fragments of pack and icebergs was closely cemented together in an impenetrable mass at the foot of the ice barrier. In the course of the 23rd they were within one and a half nautical miles from the face of the barrier, surrounded by icebergs and heavy pieces of ice covered with stones, raising the hope that land would soon be seen. The ice barrier itself was here distinctly different in appearance from that observed the previous year farther west. Its outlines were more broken and full of indentations, the elevation, too, was different from that previously noted. It was found that the height was here only 105 feet above the sea, and this decreased towards the east to eighty feet, though it rose again farther east. The southernmost point reached by the vessels, a point that has remained the *highest southern point of the earth* attained to this day, was latitude 78° 10′ S. and longitude 161° 27′ W., while the face of the ice cliff lay one minute further south.

Ross attempted to penetrate along the barrier to the eastward, and had the satisfaction of getting a view of the surface when he came to the lower part of the face. It was seen that it gradually rose to the south till it presented the appearance of lofty snow-covered mountain ranges. Although Ross and his companions were fully persuaded that they saw elevated land, he put it down only as "an appearance of land," lest some subsequent navigator should prove him to have been mistaken. From this point, however, all further progress to the east of the barrier had to be relinquished, for it here diverged to the north-east and the main pack pressed against it, and an immediate return was decided upon, especially as the winter was already setting in, with great severity at these high latitudes. Ross therefore sailed back northwards, and it was soon evident that the south-western edge of the pack-ice was still extending from south-east to north-west, though in the higher latitudes it was situated considerably farther east than in the middle of the month on the voyage south. As it was, the westernmost point of the pack reached longitude 180° W. in latitude 70° S.

After this point had been reached Ross steered directly northward, for he had resolved to approach Cape Horn along the 60° parallel, if possible, and then to round it and make for the Falkland Islands with the object of wintering there. This course had the advantage of being the shortest, and of affording Ross the opportunity of completing his magnetic observations in high latitudes. On the 6th of March the Antarctic circle was recrossed on meridian 170° W., after a period of sixty-four days within it, a period that must be regarded as exhibiting one of the most heroic and difficult achievements in the whole history of south polar navigation. Three days later the 60th parallel of southern latitude had been nearly reached on meridian 156° W., and as little or no ice had been seen for some days, Ross, thinking the vessels safe, and anxious to gain time, ventured upon running all night. The whole expedition came within an ace of perishing in consequence of this sense of security, for during the night, from the 12th to the 13th of March, just as Ross, warned by small driving blocks of ice, had made every arrangement for rounding to during the night, a large iceberg was seen through the heavy snow shower ahead of the *Erebus* and close to it. The vessel was immediately turned, but the next moment it was seen that a collision with the *Terror* was unavoidable. The *Erebus* lost her bowsprit and topmast through the shock, and the two ships, entangled by their rigging, were violently dashed against each other in the huge breakers raging and foaming against the berg. At length the *Terror* got clear, and finally the *Erebus* was extricated, by an extremely hazardous expedient, from her perilous situation, where her yard-arms were actually striking the face of the iceberg. Scarcely had this been accomplished when a second berg was seen to be quite close, but by another skilful manœuvre the ship was brought through the channel between the two bergs, and under their lee, where the *Terror* had already rounded to in safety. At daybreak it appeared that the ships had safely escaped through the only opening in a chain of icebergs extending right across the horizon. After this perilous adventure the two vessels steered on eastwards with favourable winds and without any important event, passed Cape Horn on the 2nd of April, and on the 6th of April reached the Falkland Isles. Here they cast anchor in Berkeley Sound before Port Louis, which was at that time the principal settlement in the group of islands.

The five months' stay in the Falkland Isles came to an end on the 8th of September. It had been utilised for making terrestro-magnetic observations, and as Ross wished to obtain further observations near Cape Horn, the vessels steered on this course as their first destination. On the 19th of September Cape Horn came in sight, and on the evening of that day the ships anchored in St. Martin's Cove, a favourable harbour in Hermito Island. After completing their magnetic labours, and marking the level of the sea, St. Martin's Cove was left on the 7th of November for the Falkland Islands, which were reached on the 13th of November, and a stay of a month entered upon. After the usual scientific observations had been made, and the mean level of the sea fixed by a mark, the *third* voyage to the high southern latitudes was begun on the 17th of December. For this voyage Ross had arranged a double, or rather an alternative, plan. He intended first to attempt a southern course on meridian 55° W., for he hoped in this manner to reach the probable south-eastern continuation of Louis-Philippe Land, where the open water between the coast and the pack-ice might enable him to penetrate still further to the south or south-east. If this proved impracticable he determined to reach the south by following Weddell's track further east. Steering towards Clarence Island, which could not be seen owing to the thick weather, the first iceberg came in sight in latitude 61° S. and longitude 52° 10′ W. On the following day the ships were surrounded by numerous icebergs, and the same afternoon they came upon the edge of the pack-ice in latitude 62° 30′ S. and longitude 52° W. The pack appeared tolerably open, but, as before stated, Ross was desirous of reaching the open water on the coast without delay, and he felt obliged to avoid the danger of getting the vessels beset in the pack-ice by steering along its edge to the west. On this course the icebergs everywhere were for the first time seen thawing and in a state of rapid dissolution, a process that had not been observed on the two previous voyages. On the 28th of December the east coast of Joinville Land, not previously seen, came in sight. An outlying small but lofty islet was named Etna Islet from its striking resemblance to the Sicilian volcano. The land was mostly covered with ice and snow, and in one place a huge glacier, several nautical miles in breadth, descended to the sea from a height of 1,200 feet, ending in a vertical cliff 100 feet in height. Further south a number of low, rocky islets were encountered off the coast, the Danger Islets, of which the southernmost, discovered on the 29th of December, and about 600 feet high, received the name of Darwin Islet.

Ross was desirous of avoiding these dangerous islets and cliffs, as well as a vast number of stranded icebergs in their immediate vicinity, but the heavy pack-ice very soon compelled him to seek the coast. On the next day it was seen that the southern extreme of Joinville Island is situated in latitude 63° 30′ S., and that the coast extended thence to the westward. A wide gulf opened in this direction, surrounded by ice and snow-covered land on the north, west, and south-west. To the north rose Mount Percy, the highest summit on Joinville Land, with an elevation of 3,700 feet above sea-level. To the north-west it appeared that there was a channel between Joinville Island and Louis-Philippe Land. It was impossible on account of the ice to penetrate into the wide bay that had been named Erebus and Terror Gulf, and thus Ross had to content himself with steering along the margin of the ice to the south-west.

On the 1st of January, 1843, the ships were in latitude 64° 14′ S. and longitude 55° 54′ W., where a beautiful view of the land lying to the south and south-west was obtained in fine, clear weather. To the west towered Mount Haddington, 7,000 feet high, the highest summit of this region, and like nearly all the others of volcanic origin. Not far from its foot rises a precipitous island, named Cockburn Island, with a height of 2,760 feet, and a diameter of barely twice that measurement. For five days the vessels cruised in this region, now surrounded by ice, now deprived of all outlook by dense fog. At length on the 6th of January Ross landed on Cockburn Island, and took formal possession of it in the usual manner. The island was found perfectly clear of snow, and to be of volcanic formation; and the assistant surgeon of the *Erebus* (subsequently the renowned botanist, Dr. Hooker) was able to collect nineteen species of plants growing there. It lies at the entrance to a deep bay, formed by Mount Haddington in the west, and Seymour Island and Snowhill (about 2,000 feet high) in the east. After sailing round the latter, it was found that Mount Haddington forms the southern extremity of Louis-Philippe Land, united to Snowhill by an enormous mass of glacier ice. The whole western and southern side of Snowhill Island was enclosed by a low belt of ice, and in the neighbourhood of the land, evidently stranded, were clustered gigantic icebergs, some from four to five nautical miles in diameter, and 200 feet high. From these enormous dimensions Ross concluded that they must have come away further south from some loftier barrier than any he had yet seen in this reigon of Antarctic country. A further advance along the south coast of Snowhill and Louis-Philippe Land was found to be quite impossible, for fixed land-ice extended along the coast, and to the west, south and south-east, as far as eye could see. A struggle to penetrate the pack to the east led to the ships being beset by the close pack from the 9th of January till the 4th of February. Moreover, in its northward drift, the pressure of the main pack against the land was very great, and the formation of young ice in the water previously open was very rapid, rendering it quite unnavigable. The ships were frequently exposed to very severe ice pressure, and it was not till the 4th of February that they emerged into open water in latitude 64° S. and longitude 54° W.

The attempt to penetrate southwards close to the land, and in this way to make new discoveries, had, therefore, to be finally relinquished, and Ross was thrown back on the alternative plan he had made for this third Antarctic voyage, that of following Weddell's course. He therefore beat to the eastward along the pack edge, which lay on the whole between 64° and 65° of S. latitude; on the 12th of February land was apparently seen in latitude 65° 10′ S. and longitude 48° 30′ W., but it seems to have been very doubtful, since Ross does not mention it in the account of his voyages, and has only entered it on his chart. On the 14th of February, in latitude 65° 13′ S. and longitude 40° 50′ W., Weddell's return track was crossed, but the ships were unable to penetrate the dense, heavy pack; they therefore con-

8

tinued their progress along the edge to the north-east, until the northern extremity was reached on the 22nd of February, in latitude 61° 30′ S. and longitude 22° 30′ W. Soon after it became possible to press forward to the south, and after Ross had entered the Antarctic circle on the 1st of March, in longitude 8° W., in a comparatively open sea, he again, on the 5th, met with the heavy pack, in which the holes and channels were already covered with newly-formed ice. The highest latitude he succeeded in reaching was 71° 30′ S. in longitude 15° W., not quite three degrees short of the latitude achieved by Weddell 18° farther west, but two degrees higher than the point reached by Bellingshausen 13° farther east. The advanced season and the unfavourable condition of the ice imperatively demanded an immediate return north, and after the ships had weathered another furious storm, on the edge of the pack on the 6th and 7th of March, the Antarctic circle was recrossed for the last time on the 11th of March. Ross had determined to ascertain accurately the exact position of Bouvet Island on his return voyage to the Cape of Good Hope, and consequently held a N.N.E. course, but all his efforts to find it remained as unsuccessful as those of Cook before him. The last iceberg was seen on the 25th of March in latitude 47° 40′ S. and longitude 10° 51′ E., and on the 4th of April the ships anchored in Simon's Bay. They left again on the 30th of April, and after touching at St. Helena, Ascension, and Rio de Janeiro, and staying some days in each, the expedition reached Folkestone on the 2nd of September, 1843, after an absence of nearly four years. The vessels and their crews were in a perfectly sound and satisfactory condition, and of the 152 men who had started only one did not return. This was the quartermaster of the *Erebus*, who fell overboard and was drowned during a gale off Cape Horn the previous year.

The voyage of James Clark Ross, of which a short account has thus been given, must be regarded as one of the most brilliant and famous of all voyages of discovery that have ever been made. It is certainly remarkable that, as compared with other travels and voyages, that of Ross should be so much less universally popular. While the achievements of such men as Barth, Nachtigall, Livingstone, Stanley, Wissmann, in Africa, and in higher latitudes, to name only a few, Parry, Franklin, Kane, Weiprecht and Payer, and Nansen, have excited the greatest and most widely-spread enthusiasm and interest, the voyages of the younger Ross in the Antarctic regions have never attained the wide appreciation they deserve, however high the estimation in which they have always been held by the scientist. The reason of this is, doubtless, to be found in the fact that for the public the greatest element of interest is invariably to be found in man himself, and that for the larger number of readers the chief attraction in travel centres in the contact with new tribes, whether on the equator or near the pole; nor is the account of the life led by explorers in their own narrow circle during the isolation of the polar winter found to be less attractive. Descriptions of this sort are entirely absent from Ross's *Travels*: his south polar voyages were dedicated entirely to scientific research in desolate tracts; they were made in vast regions uninhabitable by man, and consequently devoid of the element most eagerly sought after by a public always on the alert for something new. Perhaps it is not beyond the mark to say that this lack of human incident, coupled with an ignorance of the actual problems of scientific polar navigation and discovery, have co-operated to retard and check an intelligent interest in polar exploration.

In the domain of science the results of Ross's travels constitute, not so much a revolution as the first strictly accurate data for modern geographical reasoning, to say nothing of our extended knowledge of the distribution of land and water in the Antarctic regions. The principal task, that of reaching the southern magnetic pole of the earth, remained undischarged; it was a problem to which, in the utter absence of a suitable harbour in which to winter, there practically was no solution. On the other hand, Ross succeeded in determining and locating this pole with extreme accuracy, and, moreover, the magnetic observations constantly and conscientiously carried on in the most difficult and adverse circumstances afford such a mine of information, that to this day the material for our knowledge of the magnetic conditions of higher southern latitudes is almost exclusively drawn from it. But besides his terrestro-magnetic researches, scarcely a single branch of physiography was neglected by Ross; on the contrary, all were considerably extended by him. His meteorological observations still retain the greatest value, and in addition to the study he made of the condition of the air in regard of temperature, moisture and density, he gave equal attention to the temperature of the sea. At times numerous soundings were made to ascertain the temperature and specific gravity of the water at various depths. That these have become worthless was no fault of Ross's, and must be attributed to the imperfections of the deep-sea thermometer of those days. The soundings still give the data for conclusions concerning the bed of the ocean for vast regions in the Antarctic seas. In like manner the observations made by Ross on the condition of the ice of the Antarctic regions still remain invaluable in the study of physiography.

That he added enormously to the previous knowledge of south polar exploration by his discovery of Victoria Land, and by his course along the great ice barrier for hundreds of miles, attaining the southernmost point of the globe as yet seen by the eye of man, need scarcely be insisted upon here. And although he was not so fortunate as to set foot on the newly-discovered continent, or, to speak more modestly, on this enormous mass of land, he was able by means of his voyage to prove that in two places in the highest southern latitudes land covered with mountains of volcanic origin exists, and among them one volcano in an active state of eruption. The voyages of Ross also contributed to the extension of biological science by his deep-sea dredging, proving, what appeared not only amazing but incredible, the existence of living coral insects in the depths of the icy southern polar seas. And, lastly, he contributed to the industrial welfare of his fellow-creatures by the discovery of countless numbers of whales in high latitudes, as well as of islands thickly covered with the guano of the penguin, which may in the future become as valuable and important as the kryolith pits of Greenland. And above all, Ross has shown the world what may be achieved in those inhospitable regions by a competent, energetic leader, and has proved it with ships that had no power of self-propulsion, spite of all their excellence and fitness. If any man deserves to be regarded as the hero of Antarctic exploration surely it is James Clark Ross.

VOYAGES AFTER ROSS UP TO THE PRESENT.

The great period of south polar discovery came to an end with the return of Ross from his third Antarctic voyage, and all that has been achieved since can soon be told. The first event worthy of mention is the voyage of an American, William G. Smiley, captain of a seal-hunting vessel, one of the very few that continued to hunt along the nearly depopulated coasts of the South Shetland Isles and of Palmer Land. His voyage is contemporaneous with the second voyage of Ross, as he landed on Deception Island in February,

1842. Here he had the good fortune to find a self-registering thermometer which had been placed there by Captain Foster in 1829, and which indicated a minimum temperature of $-5{\cdot}08°$ F.[1]; the index being somewhat out of order had failed to register the maximum temperature. The most important result of the voyage, however, was the verification of the fact that Graham's Land and Palmer Land were not joined together; for Smiley, according to his instructions, sailed completely round the latter, thus becoming the forerunner of the German navigator, Captain Dallmann, in the discovery of Bismarck Straits.

Far more important than the voyage or voyages of Smiley is the enterprise of the *Pagoda*, commanded by Lieutenant Moore. As Moore had received instructions to make magnetic observations south of the 60th parallel of latitude, and between meridians 0° and 100° E. longitude, where none had been made by Ross, Wilkes, or Dumont d'Urville, his voyage may be regarded as complementary to that of Ross. Moore left Simon's Bay on the 9th of January, 1845, met his first iceberg on the 25th in latitude 53° 30′ S. and longitude 7° 30′ E., but was as unsuccessful as either Cook or Ross in finding the Bouvet Islands. Parallel 60° S. was crossed on the 30th of January, in longitude 3° 45′ E., and almost simultaneously such heavy pack-ice was encountered that Moore was compelled to steer S.E. instead of S.W., more especially as the edge of the pack could be seen far away to the south. A peculiar rock was here observed, a mass of about 165,000 cubic feet, the summit of which was covered with ice and showed no movement, while a heavy surf beat all around it and the rock itself bore visible traces of the action of the breakers. Moore immediately took soundings, and it seemed as if the

[1] The original gives 20·6° C., which has been translated as $-20{\cdot}6°$. [THE TRANSLATOR.]

bottom was reached at a depth of 1,150 feet, but the rapid course of the vessel rendered a repetition and verification of this measurement impossible. On the 5th of February the Antarctic circle was crossed in longitude 30° 45′ E., and on the 11th the highest latitude attained during the voyage, latitude 67° 50′ S. and longitude 39° 40′ E., was reached, but at the same time such heavy pack-ice was encountered that further progress south was out of the question. Land, or indications of it, was not seen, probably in consequence of the dense fog. For some time Moore attempted to approach Enderby Land, but was hindered and thwarted by violent storms from the south-east, so that he was compelled to take a course towards the north, frequently hard pressed by the numerous and huge icebergs. Up to the 10th of March, where the parallel was crossed in longitude 98° E., Moore remained in latitude 60° S., and then he reached latitude 64° 15′ S., but one degree east of the spot where the *Challenger* twenty-nine years later attained her highest southern latitude. As the vessel had suffered somewhat severely, and the ice in latitude 55° S. and longitude 110° E. rendered further progress south-east impossible, Moore steered north, and reached King George's Sound in Western Australia on the 1st of April.

This was the last voyage in Antarctic regions for close upon twenty years; meantime discoveries were made in the region of the drift-ice. Dougherty Island, found by Captain Dougherty in 1841, in latitude 59° 20′ S. and longitude 119° 45′ W., was first declared to be merely an iceberg, but it was subsequently seen and verified by Captain Keates in 1859. The scattered groups of the Heard and Macdonald Islands, between latitude 53° 1′ S. and 53° 14′ S., and longitude 72° 32′ and 73° 53′ E., were discovered and rediscovered by a number of navigators, more particularly by the eminent German physiographer, Georg Neumayer, though first seen by Captain

Heard in November, 1853. The cause of the peculiar and remarkable phenomenon that so many merchantmen took their course through these desolate and isolated waters just at that time is to be found in the fact that the course to Eastern Australia and New Zealand lay along the lower parallel, a course that led past the Heard Islands. At a subsequent period it was abandoned owing to the great dangers to be apprehended from icebergs.

A lull, therefore, set in both in Antarctic discovery and in the utilisation of the natural wealth of the Antarctic seas till the summer of 1873-4, when a German navigator, Captain Dallmann, with the ship *Grönland*, encouraged and sent out by the German Society for Polar Navigation, again sought the waters of Bransfield Straits and the neighbouring region. The charts of these seas were considerably altered and modified by Dallmann's explorations, more especially in the western portions. He circumnavigated Trinity Land and proved its inconsiderable extent to the south ; he also showed that Palmer Land is separated from Graham's Land by a broad channel, the Bismarck Straits, with the group of Kaiser Wilhelm Islands at its western extremity.

This renewed interest in the Antarctic regions was entirely due to the indefatigable energy of George Neumayer, now the eminent director of the German Naval Observatory. With the assistance of King Maximilian II. of Bavaria he made his second voyage to Australia in 1856, in order to found and direct an observatory for maritime meteorology and terrestro-magnetism, the Flagstaff Observatory at Melbourne. Even at that time he was entirely convinced of the absolute necessity for Antarctic exploration, not only in the interests of universal physiography, but more particularly in the development of the two before-mentioned subsidiary sciences. Thus, he, in 1864, began a long course of lectures, addresses and scientific articles on Antarctic exploration, first in

Australia and subsequently in Europe. It is to be regretted that his efforts and exertions were productive of no result beyond establishing a complete unanimity of opinion in the scientific world ; the means for carrying out an expedition were not forthcoming in Germany ; neither the State, nor scientific societies, nor private endeavour, seconded Neumayer's unceasing activity. At length, after nearly twenty years, the *Challenger*, commanded by Sir G. Nares, set out on a cruise south of Kerguelen Island, as advocated by Neumayer, continuing his course through the opening between Enderby Land, Kemp Land and Wilkes Land. This course had always been recommended by Neumayer as likely to be successful, because no vessel had previously attained a latitude much beyond 64° S., and it was known that between meridians 60° and 90° E. only a remarkably small number of icebergs had been observed. This seemed to indicate a warm current setting southwards, rendering a progress towards the pole comparatively hopeful. It was probably in consequence of the impetus given by Neumayer that the celebrated "Cruise of the *Challenger*" was entered upon in the southern summer of 1873 and 1874, destined to garner such full and such remarkable results for our increased scientific knowledge of everything connected with the geography of the Antarctic regions. The expedition undertook an exhaustive scientific investigation of Kerguelen Island and of the Heard group, and then sailed south in order to complete their researches in deep-sea dredging in Antarctic waters. An actual voyage of discovery had not been planned ; indeed, the *Challenger* herself had not been fortified for ice navigation, or even for any long stay in the drift-ice. On the 11th of February the vessel left Corinthian Bay on the east of Heard Island, and on the same day, in latitude 60° 30′ S. and longitude 78° 30′ E., the first iceberg was seen, though not followed by many others until the 13th of February. On the 14th of February the icebergs became very numerous, and the vessel ran into the open pack-edge in latitude 65° 30′ S. and longitude 80° E.; this closed in completely towards the east on the next day, but appeared more open towards the south. Sailing along the edge of the pack, a latitude of 66° 40′ S. was attained on the 16th of February, and the Antarctic circle, therefore, crossed in longitude 78° 30′ E., the expedition meantime being favoured with very clear weather, in spite of which no land was seen. Nares now steered east in order at least to sight the western extremity of Wilkes Land, and reached latitude 64° 18′ S. in longitude 94° 47′ E., without hindrance from the pack-ice, though here again it made its appearance. On the 25th of February the *Challenger* was able to approach to within fifteen nautical miles of the assumed position of Wilkes' Termination Land, but, spite of clear weather, no land was visible either to the east or to the south. Nares now held his course north and north-east, and after weathering several severe storms in the ice saw his last iceberg on the 4th of March, in latitude 53° 17′ S. and longitude 109° 23′ E., and reached Melbourne on the 17th of March.

Although the time spent in the Antarctic Polar Seas was remarkably short, and no actual discovery was made, the observations made of the temperature, the salinity, the depth and the sediment at the bottom of the sea, as well as of the minute forms of marine life, nevertheless remain the most important in their results of any that have been made in higher latitudes. The same remark holds good of the investigation into the nature and the size of icebergs; nay, it may even be affirmed that the few days spent by the *Challenger* in the higher latitudes have, thanks to improved methods, contributed more to our knowledge on these subjects than all the previous expeditions put together. It is, therefore, a matter of surprise, in the face of such striking results, that, if the Belgian expedition under De Gerlache be excepted, no second undertaking of the kind should have been set on foot. Since the absolute necessity for Antarctic exploration has been insisted upon on all sides, more especially in England and and in Germany, as essential to an extended knowledge of scientific physiography, it is certainly most remarkable that not even a similar short advance should have been undertaken, to say nothing of a fully-equipped South Polar Expedition. It is true that the great International Polar Exploration during its year of activity secured two stations for observations in the southern hemisphere, but one was in Tierra del Fuego, in latitude 55° S., and the other, the German one, was situated on the north-east coast of South Georgia in Royal Bay, in latitude 54° 30′ S. The results attained by both were highly important, and advanced the investigation of terrestro-magnetism no less than that of meteorology; nevertheless both were too far distant from actual South Polar regions, and in other directions they could not possibly compensate for the absence of exploration and research in high latitudes.

Ten years passed away before the idea of a voyage to Antarctic waters again arose, but not this time in the interests of science. The results of the whale fishery in the Arctic seas had for a long time steadily fallen off; indeed, some of the more important kinds of whales had nearly died out owing to the ruthless havoc made by steamers from the northern whaling stations equipped with harpoon guns. In consequence of this, two Scotch whaling captains, David and John Gray, published a memorial in which they dwelt on the large number and gigantic size of the Greenland, or very similar, whales observed by Ross in the waters to the east of Louis-Philippe Land. This suggestion fell on good ground, and in the beginning of September, 1892, four ships belonging to the Dundee Whale Fishing Company left their native harbour for the whale fisheries in the waters indicated. Two of the ships carried thorough and scientifically trained medical men, Charles W. Donald, on board the *Active*, and W. S. Bruce, on board the *Balena*, both amply provided with scientific instruments by Leigh Smith, the eminent Arctic navigator, and the Mæcenas of polar exploration. Burn Murdoch, the artist, also embarked on board the *Balena*. The vessels first sailed for the Falkland Islands, quitting them again at the beginning of December, and hunting for whales, but without adequate success. Their course was constantly east and south and south-east after leaving Joinville Island and Louis-Philippe Land. The only addition to previously ascertained topographical knowledge made by this expedition was the verification of the chart, made by Ross, of the southern outlines of Joinville Island, and of the channel, thirty miles long and from two and a half to five miles wide, separating the island from the mainland. Captain Robertson of the *Active* circumnavigated the whole island by means of this channel, which was tolerably free from ice, and named it Dundee Island. The channel he called Firth of Tay in its broader half extending in a south-easterly direction, the narrower south-western end receiving the name of Active Sound. The coast lines of the Erebus and Terror Gulf were also more accurately laid down than had been possible to Ross. Dr. Donald also effected a landing in Active Sound on the shore of Joinville Island. On the whole, the condition of the ice seems to have been highly favourable, but the main object of the voyage prevented any thorough investigation of the land, clearly proving that a whaling expedition cannot be utilised as a voyage of modern exploration. The meteorological observations made during this voyage were so far valuable that they established the facts that in this Antarctic region south and south-east winds play an important part, and that in these somewhat northerly latitudes the maximum temperature of the southern midsummer is a very low one. The observations made of the icy covering of the land, which was closely approached, also verify what had been previously ascertained, though in higher latitudes. Towards the end of February the Dundee whalers again left these waters, the last iceberg being seen by the *Active* on the 25th, near Elephant Island, in very nearly the same latitude as that in which the first had been sighted near Clarence Island on the 18th of December.

The Dundee vessels had not been alone in their undertaking of the southern summer of 1892-3. The Norwegian whaling steamer *Jason*, commanded by Captain Larsen, and commissioned by the Hamburg Oceana Association, had appeared simultaneously in the same waters. This was the same vessel that had taken Nansen to the east coast of Greenland for his celebrated journey across the country. Larsen had arrived at the same time as the Scotchmen, and had also left the unprofitable seas at the same time, but had kept a somewhat different course. He had sailed by the South Orkney Islands, on one of which he landed, steering south, considerably to the east, therefore, of the other ships. From Seymour Island to the west of Mount Haddington, where a landing was effected, valuable fossils were brought, and Dr. Donald considered that Captain Larsen manifested a lively interest in discovery. While the Scotch vessels, disappointed in their attempt to meet the profitable whalebone whale in southern waters, gave up all further effort in the icebound Antarctic seas, Larsen left the harbour of Sandefjord, on the 12th of August, 1893, commissioned by the Oceana Company to make a second attempt in seeking out the Dirk Gerritz Archipelago. He was accompanied by the *Hertha*, commander Captain Evensen, and the *Castor*, under Captain Pedersen. On the

9th of November the first iceberg was seen in latitude 60° 59′ S. and longitude 57° 12′ W.; then a southerly course was taken, steering close to Elephant Island, constantly surrounded by drift-ice, which towards the east grew more and more like pack, especially in latitude 63½° to 64½° S. On the 16th of November the vessel was near Seymour Island, upon which a landing was made; but Larsen from this point steered east, seeking for seals along the edge of the pack-ice. He continued this course till the 23rd of November as far as longitude 47° 32′ W. in latitude 63° 22′ S., when, discouraged by his ill-success in seal-hunting, he returned to the west as far as longitude 53° W., in order subsequently to steer due south-west. In the face of numerous huge icebergs, the highest latitude attained by Ross in January and February, 1843, was soon crossed, the sea being nearly free from ice. Land was distinctly seen in the west in clear weather, and on the evening of the 29th of November open water was everywhere seen to the south after crossing the 65th parallel of southern latitude. On the 1st of December the ship was near the fixed ice by which the newly-discovered land was surrounded. Larsen named it King Oscar II. Land, and a mountain partly free from ice at its foot was called Jason Mountain; its eastern promontory, three or four miles distant from the ship while in latitude 66° 4′ S. and longitude 59° 40′ W., was named Cape Framnœs. On the days following, the *Jason* continued her southerly course along the ice barrier enclosing the coast line. On the further side the ice-covered land rose gradually and without any inequality of surface towards the interior. After the Antarctic circle had been crossed on the 3rd of December, the vessel, steaming along in sight of land, attained its highest latitude of 68° 10′ S. in longitude 59° 59′ W. on the evening of the 6th of December. Owing to the dense, unbroken ice encountered here, it became impossible to continue the southern course along the coast, or, more correctly, along the ice barrier. The land, however, still extended beyond the horizon to the south, rising gradually from the coast to a good elevation in the interior, and entirely covered with snow.

As the course southwards was stopped by ice, and the open water along the coast through which the *Jason* had made her way was considerably encroached upon by the pack-ice towards the east also, Larsen began his return along the edge of the pack, again approached Cape Framnœs, and now explored the region between King Oscar Land and Louis-Philippe Land. Wetter Island had been previously seen on the return voyage in a bay south of Jason Mountain and Foyn Land to the west of it. Both had been concealed by fog on the voyage south. To the north of King Oscar Land a chain of islands, the Seal Islands, extending from south-east to north-west, was seen, the easternmost, Robertson Island, being the largest. Two outlying islands to the north proved, to Larsen's surprise, to be active volcanoes, which had partly covered the neighbouring ice with their erupted matter. Larsen landed on the eastern one, Christensen Volcano, without, however, reaching the interior, which was free from snow, and was well able to look down upon the western one, the Lindenberg Cone. Beyond this group of islands the sea, always excepting its surface of ice, seemed open and without any more islands, so that Palmer Land and Trinity Land would thus be reduced to an archipelago of comparatively small extent. On the 12th of December he steered farther north, past Snow Land, and on the 14th he met the *Castor* and the *Hertha*. All three vessels now took their course by the South Shetland Islands to Tierra del Fuego and thence to the Falkland Isles, where they landed the proceeds of their expedition, and took in fresh coal in order to go south again and continue their seal-hunting. This second undertaking during the southern summer of 1893-4 only took Larsen into the waters surrounding Joinville Island, and added nothing to his observations as an explorer in these regions. On the 16th of January he had started from Port Stanley in the Falkland Isles, on the 12th of March the 60th parallel of latitude was re-crossed on the return voyage, and on the 15th of March Port Stanley was again reached.

If Larsen thus became the discoverer of the probable east coast of Graham's Land, and verified its great extension to the south, Evensen no less could point to important results achieved by the *Hertha*. He had sighted the South Shetland Isles on the 1st of November and seen his first iceberg on the same day in latitude 61° 56′ S. and longitude 58° 32′ W., while sailing south south-west and south-west and afterwards passing Deception Island and Low Island. Here he steered along the Biscoe Islands, and was surprised by the the unusual circumstance that no ice was seen from the 3rd to the 9th of November. On the 9th of November the Antarctic circle was crossed, on the 10th Adelaide Island was sighted, drift-ice being met at the same time, and on the following day the edge of the pack lying east was encountered. Evensen steered south along this edge as far as latitude 68° 18′ S. and longitude 73° 41′ W., which the vessel reached on the 12th of November. Now he again steered north, and again along the Biscoe Islands, then through the northern portion of the group to the east, and then south on the western side, attaining his highest latitude of 69° 10′ S. in longitude 76° 12′ W. without any hindrance from ice. Alexander Land came in sight on the 22nd November; it was surrounded by pack-ice, but unfortunately we hear nothing of any observations concerning its highly probable connection with Graham's Land. Again Evensen steered to the north-west on the western side of the Biscoe Islands, passed through the Bransfield Straits and the waters to the east of Joinville Island, where, as already stated, he fell in with Pedersen and Larsen, and sailed with them to Ushuaya in Tierra del Fuego and to the Falkland Islands. He, too, made a second voyage to the waters of Joinville Island in the second half of January, returning to the Falkland Islands in March, and to Norway in the beginning of July.

Both voyages, that of the *Hertha* and, more especially, that of the *Jason*, are decidedly the most important since those of Ross for the extended knowledge of Antarctic geography. The most surprising fact in the experience of both vessels is the remarkable absence of obstructing ice in the waters they visited, especially if the time of year be considered. The November of the southern hemisphere corresponds to the June of the northern, a time in which all progress in southern waters is generally stopped by dense pack-ice. And it cannot be argued that the ice in the south was perhaps not detached so early in the season, thus blocking the sea to the north later on, for it does not appear that Larsen and Evensen found any change worth mentioning in the condition of the ice on their second voyage south in January.

In the same year, 1894, in which the vessels of the Hamburg Oceana Company had returned home, a Norwegian ship set out from Melbourne for the south. This was the steam whaler *Antarctic*, belonging to the well-known shipowner, Svend Foyn of Christiania, with a record of twenty-three years' service behind her. A young Norwegian naturalist, C. Egeberg Borchgrevingk, was on board as common sailor, for in his enthusiasm for South Polar exploration he had first resolved to ship as a passenger, only to find his scheme impossible. His description of his voyage, though not contributing much that is new, nevertheless contains some interesting particulars. The *Antarctic* left Melbourne on the 20th of

September, and sailed past Macquarie Island without meeting any whales, to the Campbell Island, where a landing was made. In the beginning of November the first icebergs were seen, and on the 6th a vast mass of ice was sighted in latitude 58° 14′ S. and longitude 162° 35′ E., which extended from east to north-west for a distance of from forty-five to sixty-five miles. It was impossible to determine whether this was a continuous mass or only a chain of closely-wedged icebergs. On the same day it was discovered that the ship's screw was out of order, and it was, therefore, necessary to return to Port Chalmers (Dunedin on the southern island of New Zealand), which was reached on the 18th of November. A fresh start was made south after leaving Stewart Island on the 28th of November, and on the 7th of December the *Antarctic* again reached the edge of the pack-ice. On the next day the vessel was forced into the ice in latitude 62° 45′ S. and longitude 171° 30′ E., and came in sight of the Balleny Isles on the 14th of December, where the pack-ice proved to be impenetrable even for the steamer, which was, indeed, quite closed in. After a thirty-eight days' course through the pack-ice, open water was reached on the 14th of January, 1895, in latitude 69° 55′ S. and longitude 177° 50′ E., and on the 16th Cape Adare was already in sight. On the 18th the *Antarctic* first cruised along the coast to the north-west, then to the south, where it was possible for Borchgrevingk to effect a landing on Possession Island, and to make as accurate an investigation as his short stay allowed. The most interesting find made here was that of a lichen, the southernmost land plant yet known. The voyage was now continued till on the 22nd of January, in latitude 74° S. and longitude 171° 15′ E., the most southern point was reached near the southern extremity of Coulman Island. It would, doubtless, have been possible to penetrate still farther south without difficulty, but as no whales were to be seen, the captain resolved to return, and to make for Cape Adare, which was reached next day. The weather was remarkably clear and glorious, the lofty summits of Victoria Land, radiant in their their icy mantle, shone with magic beauty in the midday and midnight sun, and everywhere gigantic icebergs lay near the coast. During the night of the 23rd January a party landed on a low tongue of land running north from Cape Adare, the first human beings to set foot on the Antarctic continent, or at least the most extensive land mass of the Antarctic regions. Borchgrevingk collected specimens of the stones at hand, found the same lichen as on Possession Island, and then returned to board the *Antarctic.* This was accompanied with some difficulty as the ship was almost entirely out of sight, and the boat was obliged to struggle for several hours through the drift-ice. The *Antarctic* now steered north, ran into the pack again on the 26th of January, in latitude 69° 52′ S. and longitude 169° 56′ E., emerging after cutting her way through for six days, and finally reached Melbourne on the 4th of March, taking a good catch of whales on the way.

This voyage closes the history of Antarctic exploration, as the results anticipated by the Belgian expedition, which left Antwerp under De Gerlache in the *Belgica* on the 16th of August, 1897, are not yet published. This survey indicates what parts of the Antarctic regions have principally been visited, and sums up how much or how little has been achieved by each attempt. It will be the aim of the subsequent pages to gather into a whole the results of all these explorations so far as their fragmentary nature renders such a task possible.

III. CONFORMATION OF THE SURFACE AND GEOLOGICAL STRUCTURE.

It has been seen in our survey of Antarctic exploration how land has been gradually found in South Polar regions, and almost entirely during the present century; also how the conception of a great *Terra australis incognita* has been proved to be equally erroneous with the conjecture that no land whatever, or of only trifling extent, was to be found; so that the whole Antarctic region might be regarded as one vast southern sea, in which the three great oceans of our globe mingle their boundless waters—an opinion defended by Florien in the last century, and by Petermann and Peschel in this. It has been proved, on the contrary, that extensive masses of land exist near the Antarctic circle and to the south of it, and other circumstances, pre-eminently the distribution of the winds and of the drift-ice, point to the probability that continued exploration will lead to extended discovery of land.

If we look at the map of the regions round the South Pole, it is obvious that the land—always excepting the smaller isolated islands lying to the north of the 60th parallel of south latitude—falls into three clearly defined groups. Within these the contiguity of the land seen and discovered at various times leads to the conjecture that it is connected, and that certainly in a wider sense it may in each instance be regarded as forming a geological whole. These three groups, already noticed in the chapters on the situation and limits of Antarctic countries, are:—

1. Peter I. Island, Alexander Land, Graham's Land, the Dirk Gerritz Archipelago, the South Shetland, and the South Orkney Islands.

2. Enderby and Kemp Land.

3. Wilkes Land, the Balleny Isles, and Victoria Land.

Within the limits defined at the outset, the island of South Georgia, the South Sandwich Islands, the Bouvet Islands, and Dougherty Island are also to be found. Beyond the extreme belt of the pack-ice, on the other hand, lie the Marion and Crozet Islands, Kerguelen and Heard Island, as also Macquarie Island and Campbell Island; these latter, therefore, are not taken into account.

If now the situation of the Antarctic groups of land be compared with that of the continents lying partly or entirely to the south of the equator, a striking fact is at once perceived. The two most extensive masses of Antarctic land hitherto discovered lie under almost the same meridians as South America and Australia with New Zealand, in both instances somewhat to the west, and both approaching the opposite continent in peninsular conformation. Moreover, just as South America projects furthest south of all the continents, so the Dirk Gerritz Archipelago and the South Shetland Islands extend farthest north beyond the Antarctic circle, separated from South America only by the comparatively narrow Drake's Straits. In other respects, also, comparisons might be drawn between the masses of land thus lying opposite to each other, as shown in an exceedingly interesting, though merely theoretical, work by Hans Reiter. For instance, just as the coast of Wilkes Land appears to be a duplicate of the Australian coast, not only in horizontal outline, but also in vertical structure, so the gigantic mountain range to which the coast of Victoria Land rises seems to correspond to the mountain chain of New Zealand; while the volcanic southern extremity of the Cordilleras of South America finds its counterpart in the broken and scattered island masses, also bearing active volcanoes, to the south of Drake's Straits. Whether it is reasonable to assume that this external resemblance corresponds to some internal structure, or is even based on some direct connection, later discovery and careful investigation on the spot alone can determine. The subject will again be approached. For the present we turn to consider the conformation of Antarctic lands, and the geological structure with which the surface is so intimately connected.

Before entering upon this quest, it will be well to pause and realise how far it is possible to deal with the subject, and to consider to what extent the observations hitherto made on the spot supply matter for drawing up a summarised account of the countries of the Antarctic regions. The result of such consideration must prove discouraging. All the voyages hitherto made have by their discoveries scarcely added more to our knowledge than the determination of coast outlines, and the statement of the elevations along the coast lines, but neither the one nor the other is even remotely complete or scientifically accurate. The sketch of the history of discovery only too frequently shows that ice prevented all such approach to the shore as would have allowed the details of the coast to be ascertained with any degree of certainty, and, in like manner, frequent dense fogs probably shut out the view of land that might perhaps otherwise have been seen. In the same manner, the value of the measurements made of high land is greatly diminished when regard is paid to the heaving of the vessel and to its distance both from the coast, and the mountain summits of whose height an approximate estimate was made. It must be remembered that even the heights given by Ross, who surpasses all others in accuracy, were calculated from angles taken on board from different positions of the ship, and these very positions could not be determined with perfect accuracy on the heaving sea. An error of a few seconds in the astronomical observation would be productive of an important error in computing distant heights. If the representations of Antarctic countries on our maps and the measurement of their height above sea-level are thus unsatisfactory, and only to be accepted as average or approximate, how much less do we know about their geological structure? It is only necessary to remember that no landing whatever was effected on the whole coast of Wilkes Land, and that Victoria Land offered an opportunity only on one circumscribed spot; Enderby, Kemp, Alexander and Graham's Land have been seen only from afar; portions of the Dirk Gerritz Archipelago have certainly been landed upon in isolated spots, but without any sufficient investigation being possible. We shall see that the South Shetland Isles have been visited and that crews have wintered there, but all this was on the part of wholly uneducated seal-hunters, without a trace of scientific aptitude or knowledge. We have a tolerably satisfactory knowledge only of Deception Island in the above-named group, and of Royal Bay in the island of South Georgia, but for the rest are dependent on the accounts of discoverers who were either entirely uninstructed or conversant only with the meagre outlines of the undeveloped science of petrography during the first half of the century. The specimens from which observations—such as they are—were made, consist of such stones as were found ready to hand, or brought up in the dredging-net, or taken from the stomach of some animal. It is, therefore, no wonder that the following pages will contain but little of an account of the structure of Antarctic lands. Rather will they indicate the chasm which yawns across the collective knowledge we possess of our planet, a void to be ascribed to the neglect of South Polar exploration.

In treating of the several groups of land, we shall purposely start with the entirely isolated group of the Bouvet Islands in the South Atlantic, since they have not the remotest connection with any other Antarctic islands and lands. Next, we shall turn west to South

Georgia and the South Sandwich Islands, then continue the investigation of the land south of Drake's Strait. Turning west again, we shall come upon the regions of Victoria Land and Wilkes Land, and conclude with Kemp Land and Enderby Land.

1. THE BOUVET ISLANDS.

On every map of the southern half of the Atlantic Ocean a narrow submarine ridge runs south beyond 40° S. latitude, almost along the same meridian. On this lie the solitary and lonesome islands of Ascension, Tristan d'Acunha, Gough or Diego Alvarez Island, and a few smaller ones. Continuing a line due south, a greater depth is again indicated, though not in figures based on actual soundings. It is, therefore, not impossible that the submarine elevation is again continued further south, and in its extension serves as base also for the volcanic group of the Bouvet Islands, situated to the south-west of Gough Island.

The peculiar part played by the Bouvet Islands is already known from the history of discovery; their first discoverer, Bouvet, took them to be the promontories of the great southern continent, yet they remained concealed from Cook, Ross, and Moore; meantime they were twice re-discovered by English whalers in 1808 and 1823, and their existence, therefore, proved. All three discoverers of the Bouvet Islands have assigned different positions to them, and it is difficult to reconcile these reports, especially as these reports helped neither Ross nor Moore to find the islands at all. According to Bouvet, the western extremity of the land seen by him lay in longitude 4° 30′ E., according to his colleague Hay the longitude was 4° 15′ E., while Bouvet made the latitude 54° S., and Hay 54° 6′ S. Bouvet described the land as extending from the cape in an E.N.E. direction for a distance of from twenty-four to thirty nautical miles, while the length of the coast to the south-east seemed to be eighteen to twenty-one nautical miles. From north to south the island was about twelve to fifteen nautical miles long. The land was on the whole high, and covered with snow in its more elevated parts, but in the south-east it descended rather low. The coast had many small indentations, but was so steep as to be nearly unapproachable. As it was, Bouvet's ships could not get nearer than twelve to fifteen nautical miles, as the coast was surrounded by dense pack-ice. In consequence of this, and of the dense and frequent fogs, it was impossible for Bouvet to obtain a clearer image of the natural features of his discovery.

Lindsay, who saw land considerably earlier, as far as the season is concerned, places the middle of the island seen by him in latitude 54° 22′ S. and longitude 4° 15′ E., and gives it an extension of about fifteen nautical miles east and west. He, too, found it covered with snow, and, like Bouvet, he describes the eastern end as low and the western as very high and steep. He tried to approach the island, but was prevented by the ice closely surrounding it. This extended three nautical miles on the west side, but on the east (the lee) side the ice had a breadth of twenty-one to thirty-four miles. Bouvet, like Lindsay, thought he noticed trees, or, at least, shrubs, in places free from snow, probably the tussock grass, so widely spread over sub-Antarctic islands.

Finally, Norris, who in 1823 discovered land and landed on it, gives so different a position and description that one must assume that either his predecessors had calculated the position of their discovery most inaccurately, or had found an altogether different island, since Norris declares he saw not only one but two islands, besides several rocks. The middle of the first of these, which he named Liverpool Island, lies according to him in latitude 54° 15′ S. and longitude 5° E., extends nine to twelve nautical miles north and south, is elevated and uneven in the north, low in the south, high and snow-clad in the middle. The coast was steep and, therefore, not fitted for landing upon. At a distance of forty-five nautical miles to the north-east of this island, in latitude 53° 56′ S. and longitude 5° 30′ E., lies Thompson Island, and four to five nautical miles to the south-west of this three isolated rocks, the Chimneys, with a fourth, three nautical miles farther south. As the crew of one of the boats was weather-bound for six days on Thompson Island, some account of it is given, though very short. According to this the island consists of a volcanic mass, the rocks falling perpendicularly to the sea, with the exception of one place in the south-west. The surface shows streams of obsidian with layers of pumice-stone interspersed. Of the vegetation nothing is said, neither is reference made to the extent or the height of the island, or to any other detail that might have been expected.

If these three accounts be compared, the first particular attracting attention is that the latitude of the discovery of Bouvet, as well as that of Lindsay, is not far removed from the latitude that Norris assigns to his Liverpool Island. Bouvet gives 54° to 54° 5′, Lindsay 54° 22′, and Norris 54° 15′ S., therefore midway between the other two explorers. It must be borne in mind that Norris not only evidently had brighter weather than Bouvet or Lindsay, but he was provided with better instruments, and could, therefore, lay down the position more accurately ; it is, therefore, not unreasonable to assume that all three saw the same island. Another argument for this view can be drawn from the fact that both Bouvet's vessels apparently saw land on the 8th and 9th of January, 1739, to the N.N.E. of Cape Circoncision, exactly in the direction, therefore, in which Norris's Thompson Island was seen from his Liverpool Island. Two items remain which apparently tell against the assumption that the three discoveries were identical—the appearance and the size. The latter is greatest in Bouvet's account, while the appearance is described exactly like the appearance by Lindsay, elevated in the west, flat in the east, while Norris describes it as high in the north and low in the south. In a previous work[1] the author has explained the extraordinary circumstance that neither Ross nor Moore succeeded in finding the island group, by the conjecture that it no longer exists. It may have disappeared owing either to a submarine subsidence, or, what is far more probable, to a fresh volcanic eruption, like that of Krakatao. And even if such a conjecture cannot be entirely upheld, a fresh eruption would account for its changed appearance and dimished extent. In the same place it was pointed out that the peculiar ridge of rock resembling the terrace on which surf beats, which Moore saw in latitude 60° 45′ S., longitude 4° E.—therefore near the meridian of Bouvet Island—might be the last vestige of a vanished volcanic island. Be that as it may, in any event it is greatly to be desired, as Ross has already emphasised, that the circumstances should once for all be fully investigated from the Cape, especially in the matter of taking numerous and accurate soundings, and thus to establish either the continued existence of the islands or the existence of a submarine bank in their place.

2. THE ISLAND OF SOUTH GEORGIA.

As early as Bellingshausen's time the idea came into existence that South Georgia, as well as the group of the South Sandwich Isles, is probably intimately connected with South America. Bellingshausen held that all these islands belong to a mountain chain which was supposed to extend by the Aurora rocks—which probably have no existence—right across to the Falkland Islands. Hans Reiter, who has already been referred to, has

[1] Fricker, *Ursprung und Verbreitung des Antarktischen Treibeises.*

latterly taken up another theory, holding that South Georgia and the South Sandwich Islands might be links in a chain extending to the Dirk Gerritz Archipelago from the South American Cordilleras. The conception is so interesting that it is worthy some attention, more especially as many circumstances seem to point to an intimate connection between the two regions.

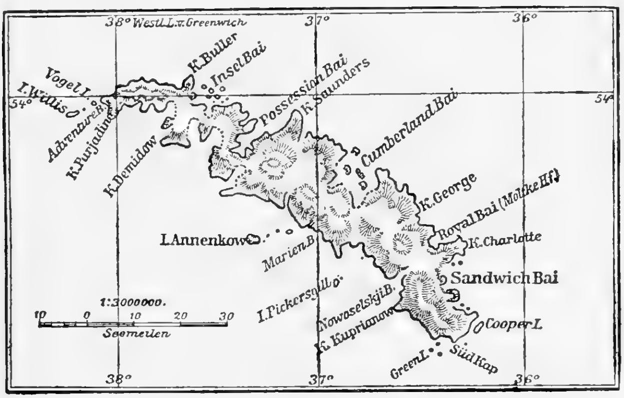
It is well known that the west coast of South America is formed by a gigantic chain of mountains, the Andes or Cordilleras. These are two parallel chains of corrugated, rocky strata, extending from north to south, of which the westernmost, consisting of rock belonging to a later geological period, forms a chain of rocky islets off the Chili coast from Puerto Montt, while the eastern, considerably older and more elevated, forms the true crest or dorsum of the double chain. In the region of the western outlet of the Straits of Magellan, however, the outer chain diverges from its previous direction of north to south, towards the south-east, and terminates, after running due east and E.N.E., in the rocky Cape of St. John at the eastern end of Staaten Island. According to E. Suess the whole range enclosing Tierra del Fuego and forming the belt of islands off its coast, is a continuation of the western mountain range, and not a continuation of the main range of the Cordilleras. It has just been stated that this ends in Staaten Island, but if we examine a more detailed map—best of all, a sea-chart—we find in the extension of the island east and north-east, and at a comparatively small distance from it, a widely extended submarine bank, Burdwood Bank, over which the waters are less than 600 feet deep and diminish to only 140 feet, while half way between Staaten Island and the bank, a depth of 1,250 feet has been sounded. The principal direction of Burdwood Bank is from west to east, and extends perhaps 250 miles, while its breadth at its widest is approximately only forty-five miles. It seems more than probable that this elevation in the bed of the ocean is closely connected with the Cordilleras, since it is not easy to imagine a continental ridge other than a prolongation of these, or a piled-up mass of non-volcanic origin. Proceeding from the Burdwood Bank towards E.N.E. the direction leads to the isolated cliffs of the Shag Rocks, rising above the depths to a height of 140 feet in latitude 53° 49′ S. and longitude 43° 26′ W. Weddel assigns only a height of forty-five to sixty feet to the Shag Rocks, and describes them as three cone-shaped rocks surrounded by a reef. We reach these rocks, however, if the direction of the western extremity of South Georgia is pursued, so that the possibility of this island being causally connected with the Cordilleras is perfectly credible. The eastern extremity of South Georgia turns to the south-east, and its extension is perceived in the Clerkes Rocks, numerous rocky islets which again lie in a continuation of the same line to the Traversey Islands, the north-western members of the volcanic South Sandwich group. The group again does not extend in a line parallel to the meridian, but in a wide curve open to the west, so that the southernmost islands again extend to the south-west.

In regard of its extension the whole group bears a strong resemblance to the Lesser Antilles, and if we continue the comparison South Georgia would correspond to Puerto Rico or to Haiti in regard of situation. It is well known that the Lesser Antilles represent the inner zone of the Central American Cordillera chain, here sunk in the ocean depths with the exception of the summits of its volcanoes, while the Greater Antilles, together with the islands lying east of the volcanoes of the Lesser Antilles, represent the non-volcanic zone. This range of the Cordilleras passes by way of the island of Trinidad, here extending west, and reappears on the continent as the Cordillera of Venezuela. If an equivalent is sought in the volcanic South Sandwich Isles it is found that if a sweep of the range from south-west to due west be presumed, the imaginary continuation would light upon the South Orkneys, and, beyond them, on the South Shetlands, terminating in the Biscoe Islands lying off the coast of Graham's Land. If later investigations should really prove successful eventually in establishing the causal connection which has here been set up as imaginary and hypothetical, then the close relation of at least *one* group of Antarctic countries with the great leading feature of the contintental structure of the globe would be made manifest, the repetition of the great sweep of the Antilles would place these Antarctic countries in direct communication with the gigantic mountain-frame of the Pacific basin. The acceptance of such a theory is not entirely to be rejected, for although very little is known of the geological structure of the South Polar regions, yet what is known of South Georgia points to the inference of an approximation to the rocks of the Cordilleras.

It has been necessary to discuss these points in some detail, so as to throw into relief the importance and significance of South Georgia in any estimate of the probable geology of the whole south-western region of the Atlantic Ocean. We will now turn to a consideration of the island itself.

Although South Georgia belongs to the earliest Antarctic discoveries, even if no regard be paid to its questionable discovery by Amerigo Vespucci, although the north-east coast was laid down as completely as possible by Cook, and the south-west coast by Bellingshausen, and although finally the German South Polar station remained there nearly a year, little is accurately known of even the mere outline of the island. Indeed, on the arrival of the German corvette *Moltke*, it was found impossible to recognise the bays laid down and described by Cook. It is, therefore, necessary to premise that the positions indicated in the map are not even now absolutely correct, those in the neighbourhood of Royal Bay excepted.

South Georgia, as is shown on the map, is a long island, extending on the whole from west north-west to east south-east. The uniform direction is not altered by the few islets off the coast, so that both the eastern and westernmost promontories are found on them. In the west this occurs on Willis Island, situated, according to Bellingshausen, in latitude 54° 4′ S. and longitude 38° 22′ W., and in the east on Cooper Island in longitude 36° 34′ W., according to Cook. The most northern



Map of South Georgia (after Stieler's *Hand Atlas*).

point is Cape North, in latitude 53° 57′ S., near the western extremity, the most southern South Cape, in latitude 54° 57′ S., near the eastern extremity. The greatest extent of the island may be taken to be 105 to 110 miles, the average breadth fifteen miles, the greatest breadth twenty-five miles or more. In many parts, however, the breadth is very considerably less, for bays of fjord-like character make deep indentations on both coasts, more especially in the west where, according to Weddell, two bays approach from opposite sides to within five furlongs of each other. As these indentations are insufficiently known, it is not as yet possible to state the extent of the land area. Including the fjords the total area of the group may be estimated at 1,560 to 1,700 square miles, to which the outlying islets contribute very little. How far the submarine base extends, *i.e.*, the ocean bed at a depth of less than 600 feet all round the island, is not known up to the present time; Cook gives a sounding of only 225 feet at a distance of nearly five miles from shore, near Possession Bay, on the north-east coast, but on the other hand 650 feet were given at the same distance from Cumberland Bay.

Between Willis Island, the extreme western outpost, and the main island, Vogel Island, small and level, interposes in the two and a half miles' wide channel separating the two. From this point the coast runs north-east and east to Cape Buller, to the east of which Possession Bay is found. The bay takes its name from the landing effected there by Cook when possession was taken of the island. Island Bay, Cape Saunders, and Cumberland Bay follow, succeeded by Royal Bay between Cape George and Cape Charlotte. From this point the coast, which extended from Cape Saunders to the south-east, changes its direction to the south, forming Sandwich Bay near to the South East Cape, off which an island, Cooper Island, is situated, and extends to South Cape. From this cape, before which three low level islands, one Green Island, are situated, the coast extends to Cape Kuprianow and forms Novoselskji Bay, before which, at a considerable distance from the shore, Pickersgill Island lies, accompanied by two smaller islands. Next comes St. Mary's Bay, smaller and formerly frequently visited by seal-hunters; then a long straight coast line with Annenkow Island off it, and the last section of the south-west coast appears to be most deeply indented with fjords. Near the western extremity of the island lies

Adventure Bay, followed by the channel between Willis Island and the main island.

Not only the outline, the narrow and extended form, the deep fjords, point to the fact that in South Georgia we have before us a portion of a broken and submerged mountain chain, but the structure of its surface and the meagre details we possess of the geology of the island prove such conjecture a certainty. From one extremity to the other a wild range of mountains fills the island, rising steep and precipitous from the sea to a considerable height, and, so far as is known, nowhere descending to valley or plain of any importance. It appears that a single principal range forms the backbone, from which lateral ranges strike out on both sides, but principally to the north-east; between these the deep fjord-like bays, before referred to, extend far inland. All the highest summits appear to belong to the principal range, and occur especially in the eastern half, where the altitudes were computed at the German South Polar Station in Royal Bay. The highest elevations in the neighbourhood of the station, those of the "Wetterwand," approximate to 7,000 feet at a distance of about seven miles from the coast: much like the Piz Bernina from Pont Resina in the Rhœtian Alps. Summits rise sheer from the sea in Royal Bay to a height of 2,300 to 2,600 feet. From one of these mountains, looking west, still greater elevations were seen in the far distance in the same region where the highest summits had been observed from the south coast also. Between the summits of the range the passes are partly found to be of low elevation, as for instance in the case of the gigantic Ross Glacier, which flows into Royal Bay, where the height of the pass seems to reach only about 1,100 feet. The outlines of the heights are remarkably abrupt and bold, and they occur on ridges with steep descents on both sides. But the circumstance which in addition to its elevations gives the island its peculiar character is its extraordinarily strong glaciation. Wherever it has been possible to penetrate into the bays, numerous glaciers have been observed descending. Cook found five in Possession Bay, from which great masses of ice were constantly detached and hurled into the sea. In Cumberland Bay, and in several intervening bays, glaciers were seen in all directions. Besides the two miles wide Ross Glacier flowing into Royal Bay, the Weddell Glacier also descends into it, while in Little Haven close by, the great Cook's Glacier makes its way down, and two others do not quite reach the shore. The glaciation on the south-west side is even more extensive than that on the north-east side ; the former being on the windward coast of the island is therefore exposed in the first instance to the west winds and their constant precipitation. Klutschak reports that in the south-eastern part of the island, exactly opposite the neighbourhood of Royal Bay, the coast is said to be enclosed by an ice barrier. This without further testimony seems hardly credible, and assumes a very different structure of this part of the island even if the heavier precipitation is taken into account.

In spite of the enormous glaciation of the land, it must not be supposed to be completely covered with ice and snow. During the southern summer of 1882-3 important elevations in the neighbourhood of Royal Bay lost their winter covering; while, on the other hand, in particularly sheltered spots, even near the shore, the snow lay unmelted the whole summer. At the same time moraines pushed far forward in valleys now free from ice point to the fact that South Georgia, too, as compared with its glacial period has undergone a considerable diminution of its glaciation. That the glaciers of South Georgia undergo considerable change within short periods is proved by the Ross Glacier, which in the space of a single year retrograded in the centre of its broad front upwards of half a mile.

With such a decided preponderance of solid precipitation as takes place in South Georgia, it is not surprising that the larger part finds its way to the sea in the form of glaciers. Matters are not quite so bad as Cook thought in respect of the absence of flowing water, and his assumption that there is a complete lack of streams and brooks, nay, even of constantly flowing sources on the island, has been confuted by observations made in Royal Bay. It is true there are but few actual sources; the character of the subsoil and the enormous accumulations of detritus brought down by weather, envelop the slopes to such a height that the water sinks and spreads, appearing at the foot of the deposits without channel or flow. The higher glaciers and snowfields, on the other hand, feed numerous streams that have worn "Klamms" in the rocks, and it is just in the lower portions of these ravines and valleys that the most luxuriant vegetation has developed, so luxuriant that members of the German Station give accounts of pastures that reminded them of the glorious pastures of the Alps.

At the beginning of this section it was stated that the geological structure of South Georgia seemed to point to a close connection with the Cordilleras of South America. According to Suess, the extreme eastern spurs of the Cordilleras of Tierra del Fuego are built up of slatey rocks, clay slate, mica slate and gneiss. So little is definitely known of the geological period to which they belong, that Darwin even designated them changed layers of the chalk formation. Similar conditions are encountered in South Georgia. Forster had remarked that at Cook's landing place in Possession Bay the surrounding rocks consisted of bluish-grey slate in horizontal layers, but no further details were obtained till the time of the German Station there. In the neighbourhood of Royal

Bay there lies on the outside towards the coast, primary clay slate alternating with layers of phyllite gneiss ; upon this follows towards the south clay slate alternating with quartz slate, and in the most southern points, near the Weddell Glacier, huge yard-deep banks of shale or (diabas) tufa and (diabas) breccia, as well as true sandstone, occur. As is shown by the local distribution of these various rocks, the highest parts of the island investigated consist of the latest formations. This in itself is in no way remarkable, but the moment attention is paid to the stratification the whole aspect is changed. A more or less inclined tilt, varying from 20° to 70° of the rocky strata towards the south-west, is everywhere apparent, therefore counter to the major axis of the island ; the more acute angles also are found on the coast, the obtuse ones near the interior. This whole system of stratification is crossed transversely by slate formations, and Hans Thürach, the geologist of the expedition, concluded from this, as well as from the fact that many of the layers showed only semi-crystalline habitus, that the slates of South Georgia are metamorphous, *i.e.*, such as have acquired their character through pressure. Fossils were nowhere found on the island, and the presence of amorphous carbon in microscopic flakes, as they have been found in phyllite, primary clay slate, and quartzite, is no sufficient proof of previous fossil remains.

The structure of the south coast is not as yet understood ; perhaps the island consists of a synclinal fold in which the trough of the faults would represent the highest ridge of the mountain range, and on the other side of the ridge the same rocks would succeed each other in inverted order ; perhaps, however, there is no structure of faults. Whatever the facts may be, the investigations hitherto made have been far too few to allow of even a sketch of the geological origin of South Georgia ; one fact, however, is certain, that important structural disturbances will have to be assumed, and it is possible that this activity has not, as yet, entirely ceased. This conclusion may be drawn from an interesting observation made by Weddell. He had ascended a hill in Adventure Bay for the purpose of taking altitudes of the sun; but, after setting his quicksilver horizon, he noticed that although the atmosphere was perfectly still, and he himself was not conscious of any vibration, the surface of the quicksilver trembled constantly in a lively manner, a phenomenon that can only be accounted for on the supposition that some seismic disturbance imperceptible to Weddell himself was taking place. Whether beside these indications of the structure of the rocks volcanoes also exist on South Georgia must remain doubtful. Klutschak certainly marks some, but these are so vague and uncertain that much caution is required before coming to any conclusion respecting actual volcanic activity.

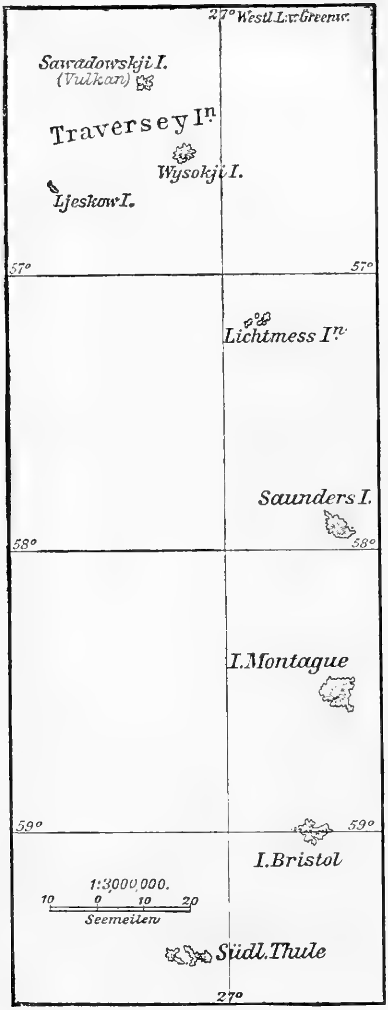
3. THE SOUTH SANDWICH ISLANDS.

The small group of Clerk's Rocks lying south-east of South Georgia in latitude 54° 55′ S. and longitude 34° 46′ W., guide us across to the South Sandwich Isles. This rocky group, consisting, according to Cook, of three or four rocks, seems to be a remnant of a larger island gradually abraded and engulfed by the ceaseless activity of the surf; indeed this inference is suggested by the existence of a submarine plateau at a depth of only 330 feet spreading beyond the rocks a distance of nearly five miles, while the depth between these and South Georgia, according to Cook's soundings, must exceed 1,000 feet.

As the map indicates, the South Sandwich Isles form a curve opening to the west, of which the most northerly, Sowadowskji Island, is situated in latitude 56° 18′ S. and longitude 27° 29′ W., while the position of the most southerly, Southern Thule, latitude 59° 26′ S. and longitude

27° 14′ W., and the most easterly, Saunders Island, is in latitude 57° 51′ S. and longitude 26° 24′ W. The whole group, so far as it is known, consists of sixteen islands and cliffs of greater or less extent, none of them having a superficial area of any size. Generally several of these lie pretty close to one another, separated from the next group by a greater distance. At the extreme north are the three Traversey Islands, consisting of Sowadowskji, Ljeskow and Wysokji Islands. The first of these is a volcano that was in activity at the time of Bellingshausen's visit. It rises abruptly out of the sea, for at one and a half nautical miles from its southern edge no bottom was reached at a depth of 760 feet. The centre of the island is occupied by an elevated summit under 1,140 feet high, according to Bellingshausen's somewhat vague description evidently an extinct crater, the south side of which is remarkably steep and of a red and yellow colour, caused doubtless by sublimated iron chloride and its further product iron oxide. The mouth itself, out of which immense clouds of smoke rose, accompanied by strong gas exhalations, lay at the south-west end of the island, which was nearly devoid of snow. The second of the islands, Ljeskow, lies in latitude 56° 44′ S. and 27° 42′ W. Its length from N.N.E. to S.S.W. is about two and a half miles, with a breadth of half that distance. The southern point bears a blunt cone-shaped mountain, and at the time of Bellingshausen's visit the island was completely covered with ice and snow. The third member of the group, *viz.*, Wysokji, in latitude 56° 41′ S. and longitude 27° 16′ W., is described as circular, steep and rocky. The next group consists of Cook's Candlemas Isles, three in number, of which the first lies in latitude 57° 9′ S. and longitude 26° 48′ W., the second, with a circumference of seven and a half miles, in latitude 57° 10′ S. and longitude 26° 44′ W., and the third, five miles in circumference, in latitude 57° 11′ S. and longitude 26° 51′

W.; they are all high and covered with snow. Fifty miles to the south lies Saunders Island in latitude 57° 51′ S. and longitude 26° 24′ W., attaining a circumference of about eighteen miles, and appearing high and rocky.



Map of the South Sandwich Isles (after Dumont d'Urville).

Both Cook and Bellingshausen describe this island as not completely covered with snow, from which the latter argued that it is probably affected by volcanic action.

Cook observed vegetation at the north end of the island, suggesting a covering of verdure. Next comes the largest member of the group, Montague Island, in latitude 58° 27′ S., and like Saunders Island, also in longitude 26° 24′ W., an elevated island completely covered with ice and snow, and with a circumference of upwards of twenty-eight miles. This island is followed by a small group: Bristol Island, with three outlying islets to the west, of which the outer one, Freezeland Peak, has a high conical summit. The position of Bristol Island is to be found in about latitude 59° S. and longitude 26° 35′ W. Still farther south lies Southern Thule, consisting of four lofty islands and islets, all covered with snow and ice like the preceding group. Nothing has as yet been ascertained concerning the structure of these islands, nor indeed of any of the South Sandwich Islands, with the exception of Sowadowskji, but it seems reasonable to assume that all the members of the group are more or less of volcanic origin, although also containing non-volcanic rocks. The soundings in the region of these isles are so few that it is not possible to come to any conclusion respecting the direction and the breadth of the submarine base, which it is to be presumed these islands have in common.

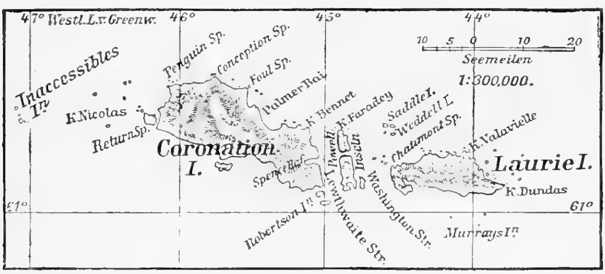
4. THE SOUTH ORKNEY ISLANDS.

Like the South Sandwich Islands, the South Orkneys also belong to the least known of the island groups of the south-west Atlantic, spite of their comparatively low latitude. They have been seen by but few Antarctic travellers, and if an acquaintance with their common coast line is any test, examined by fewer still. With the exception of Powell, their first discoverer, Weddell and Dumont d'Urville, no one, not even their last visitor Larsen, has given a description of the islands; and the accounts of the three former are exceedingly scanty, and

Landing at the Weddell Islands (after Dumont d'Urville).

[*Face page* 152.

contain little beyond a survey of the most important promontories. The group consists of two larger and several smaller islands, and is surrounded by numerous isolated rocks, more or less lofty. The main axis runs from east to west in the smaller, Laurie Island, and somewhat more to the north-west in the larger, Coronation Island. Both are separated from each other by a broad channel, which is itself again divided by two narrow islands lying north and south, Powell Islands, into Washington Straits on the east, and the narrower Lewthwaite Straits on the west. The easternmost and far projecting point of Laurie Island is Cape Dundas, in latitude 60° 57′ S. and longitude 43° 55′ W. (Weddell



Map of the South Orkney Islands (after Dumont d'Urville).

gives 60° 47′ S. and 43° 36′ W.), while the westernmost projection is in longitude 44° 45′ W. with the same latitude. The breadth of the island is from nine to eleven miles, its length from twenty-five to twenty-eight miles, and the area may therefore be calculated at 235 to 312 square miles. The island is lofty, for several summits of from 2,200 to 3,000 feet high are mentioned, but these figures cannot of course be accepted as strictly accurate. Towards the coast the descents are steep, with the exception of Cape Dundas in the east, where it seems lower. All accounts agree as to the nearly complete glaciation of the island; in many parts the glaciers reach the sea, and only the very steepest slopes are free from ice and snow. Only near Cape Dundas was a small amount of vegetation observed on the rocks; Weddell describes it as short turf, while Dumont d'Urville considered it to be lichen. To the north of the northern end of Laurie Island lie several small islands, Saddle Island and Weddell Island, as well as numerous cliffs. The boats sent off by D'Urville succeeded in landing on Weddell Island, and short as their stay was, it was nevertheless of great value to geographical science, since it was ascertained that this small island and probably therefore the two larger ones, is not composed of volcanic rock, but is built up of crystalline slate, that is to say, "calcaire silicieuse," and slates which slope at an angle of 80° from N.N.E. to S.S.W. Quartzite slate is given instead of the former in another place, and this is much more probable than a later fresh-water formation of silicious chalk. Whether this angle indicates an actual fall of strata or possible transverse stratification is not obvious; but it is satisfactory to know that the geological structure of Tierra del Fuego probably reappears so far to the south-east and indeed in undoubted disturbed deposition.

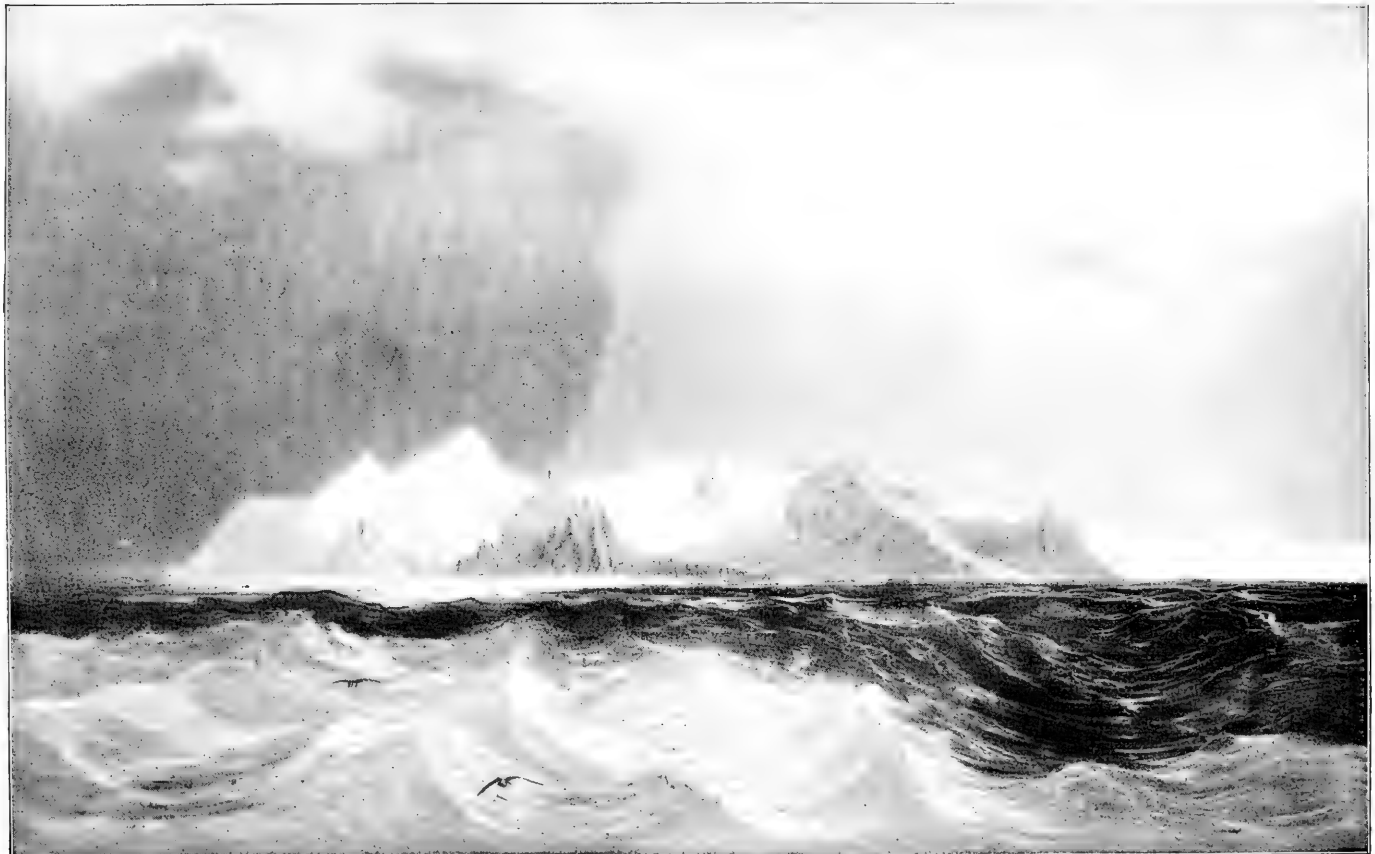
After Laurie Island follows, as already indicated, Washington Straits, separated from Lewthwaite Straits by the extended chain of the Powell Islands which is severed in the middle. Its western shore outlines the largest member of the group of the South Orkneys, Coronation Island, so called in honour of the coronation of George IV. Its easternmost point is situated about latitude 60° 55′ S. and longitude 45° 20′ W., the westernmost, Cape Return, in latitude 60° 43′ S. and longitude 46° 22′ W. Cape Conception projects farthest north, to latitude 60° 32′ S., while the southernmost point is close to the most eastern. What has been said of Laurie Island is equally true of this one, indeed all who have visited it describe it as yet more wild and desolate in its characteristics than the South Shetland Isles. The greatest elevations are found in the east, where a mountain above 5,000 feet high is said to rise above Cape Bennett, the north-eastern point of the island; towards the west they are lower and flatter, all, however, equally buried in ice and snow. On the east coast a small fjord-like bay penetrates into the land, Spence Harbour, and glaciers here descend from all sides. According to Powell's account, they nevertheless do not reach the water, but leave a margin of some feet quite clear, even apparently at high water. It is otherwise in the north-west where the mass of ice, gradually descending from a lower region, forms an abrupt perpendicular ice barrier as coast line. The island is probably from thirty-seven to forty miles in length, and has an extreme breadth of from fifteen to eighteen miles with an area of 560 to 625 square miles.

The island group is surrounded at some considerable distance by single isolated rocks of which the largest and most distant project longitudinally towards the west. These are the Inaccessible Rocks in latitude 60° 42′ S. and longitude 47° 12′ W., three in number, and completely inaccessible islets of diminutive size, probably like the others evidences of a previous extension of the principal islands. The action of the strong surf has here been increased beyond that of the eastern side by the prevalent west winds, the westward current, and the action of the floating ice.

5. THE SOUTH SHETLAND ISLANDS.

Considerably more extensive than the South Orkney Isles is their western continuation, the widely spread group of the South Shetlands, the first Antarctic discovery of the nineteenth century. Situated between the fifty-third and sixty-third meridians of west longitude, and latitude 61′ to $63\frac{1}{2}$′ S., they fall, on closer observation, into three groups. The eastern one, separated by a striking distance from the central group, clearly represents the link with the South Orkneys, while the western subdivision is not widely separated from the middle islands by the much narrower Boyd Straits. In common with the chain formed by the South Orkneys, and corresponding to them, they have a distinct direction: first, in the eastern group, from east to west; and then, in the central group, from east north-east to west south-west. At a trifling distance from these on the south side are three islands with an essentially different structure, while the western subdivision consists of two islands, of which the southern one is a definite continuation of the central group, and the northern one projects to the north.

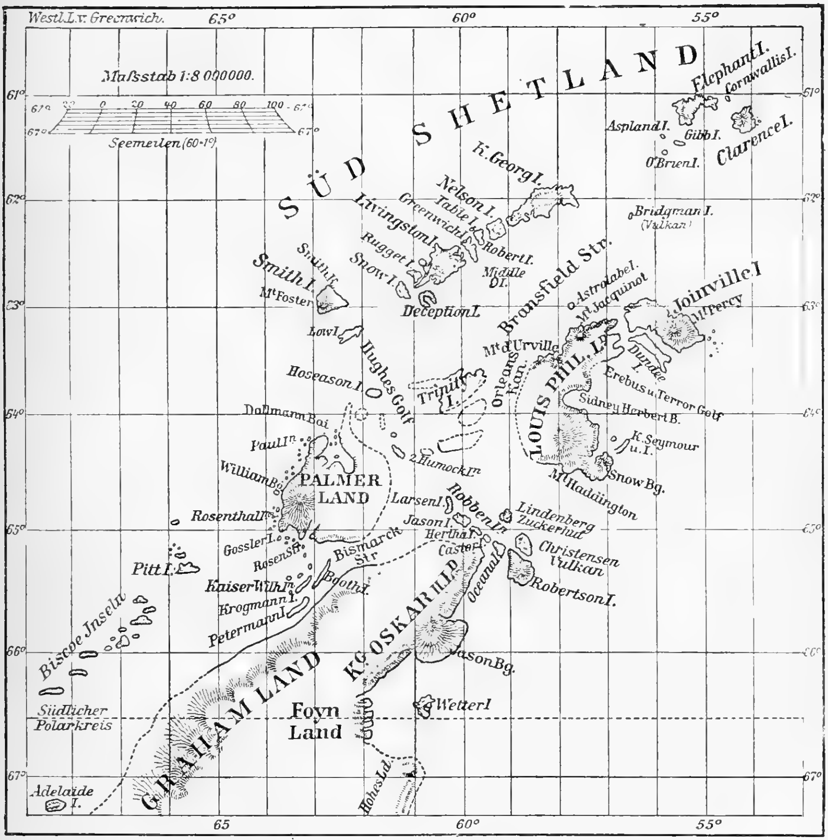
The eastern group consists of two larger islands, Clarence Island and Elephant Island, so called from the great number of sea elephants formerly found there. Between the two lies Cornwallis Island, somewhat to the north, and at the southern end of Elephant Island, though at some distance, lie the four islets Narrow Island, Gibb Island, Aspland Island and O'Brien Island. Clarence Island, which is approximately circular in form, lies on parallel 61° 16′ S. and meridian 54° 10′ W. Though of no great size (30 miles are mentioned as its circumference and about eleven miles as its greatest length) it attains a considerable elevation. This is estimated at 4,300 feet, rising abruptly from the sea and forming several steep summits, of which the most considerable seems to be in the west. The whole island is covered with snow, with the exception of the highest points and the precipitous descent on the coast, where the angle is too great to afford a support to the snow, and glaciers descend on all sides. Nothing is reported of any landing on the island, and for this reason nothing is known of its geological structure; it is possible to conjecture that



Elephant Island (after Dumont d'Urville).

[*Face page* 156.

together with Elephant Island it differs from the structure of the South Orkneys, and belongs to the southern chain of volcanic islands; indeed its anomalous outlines would support such a theory. Of the structure of the tiny island, Cornwallis Island, situated to the north of the strait between the other two, nothing whatever is known.



Map of the Dirk Gerritz Archipelago (after Stieler's *Hand Atlas*).

It appears as though it had been violently detached from the north-east end of Elephant Island. The latter again bears some resemblance in its outline to the South Orkneys, like the members of the central South Shetland group; it stretches lengthways from E.N.E. to W.S.W., broadens out between longitude 54° 40′ and 55° 35′ W., and latitude 61° 1′ and 61° 18′ S., has an extreme length of about thirty miles, with an open, wide bay at its southern end. This island also is covered with numerous abrupt and steep summits of which the highest are said to be upwards of 3,000 feet high, frequently free from snow. The lower and more level land on the contrary is completely snow-covered, and sends numerous glaciers down to the sea. The west side of the island is more especially surrounded by cliffs, which are continued in the four islands before-mentioned—Narrow, Gibb, Aspland and O'Brien Islands—all of small area but comparatively high and covered with snow. Narrow has a lofty conical mountain almost detached from the island; on O'Brien three or four rise—so that, according to D'Urville's comparison, the islet resembles the upturned roots of a molar tooth.

A strait of perhaps seventy-five miles in breadth, and still unnamed, leads across to the central group of the South Shetlands, which extends from Cape South Foreland on King George's Island in longitude 57° 33′ W. to the West Cape of Snow Island in longitude 61° 20′ W., and from the North Foreland of King George's Island in latitude 61° 50′ S. to the southern extremity of Snow Island in latitude 62° 52′ S., in a chain of about 150 miles in length. It is obvious that the whole at one time formed a single island which has been severed by channels crossing the major axis at right angles, into portions closely ranged side by side. One is reminded of Nova Zembla on a small scale, and its division by the Matotschkin Schar: whether, however, the transverse channels are to be regarded as fjord-like passages or as resulting from techtonic action, it is at present quite impossible even remotely to determine. Altogether there are two larger islands, five smaller, and a countless number of the smallest islets and dunes, which are characteristically closely scattered along the entire north-west coast of the chain, while the south coast is almost entirely free from them. The different depths correspond to this diversity, for in the north-west among the cliffs they indicate the existence of an extensive shallow sea, soundings showing a depth of only 500 feet at a distance of ten miles from land.

Proceeding from north-east to south-west the first island is King George's Island, the largest of all, about fifty-five miles long and sixteen miles broad at its widest part. Unfortunately, very little is known of this island, or indeed of any other of the group. The south coast is comparatively high and rocky, but seems to have no elevation of any importance, as 750 to 1,000 feet are given as approximate measurements. Towards the north and east the land gradually descends, and in this direction a few small brooks, already observed by Smith and Bellingshausen, find their way from thawing ice and snow. The greater heights are covered with snow, and probably send down glaciers, but no mention is made of these. Several favourable bays and harbours are found, especially on the south side, while the north coast is rendered insecure by its numerous cliffs. It would lead us too far to name all the harbours and anchoring grounds sought out and named by the seal-hunters of the earlier part of the century, especially as their positions have not all been correctly ascertained and verified.

Field Straits separate this island from Nelson Island, a smaller island of whose structure and characteristics nothing is known. Nelson Straits divide it from the still smaller Robert Island, which rises from north to south like King George's Island and is probably lofty. The same description applies to Greenwich Island lying between English Straits on the east and MacFarlane Straits on the west, with a somewhat uneven surface. All these islands are thickly covered with snow even in summer in spite of their relatively low elevation. Larsen landed in the beginning of December, 1893, on Greenwich Island, and found only the flat centre of the island free from snow, while elsewhere the snow descends to ninety feet above sea-level. It is, however, to be presumed that in January and February larger and more extensive areas are free from snow.

The next island, Livingston Island, is the second in size of the whole group, and also the best known. It is much articulated on the north side, and also on the north-east, nor are deep bays lacking on the southern side. The orographic structure exactly coincides with the other members of the group already described, for the most important elevations occur in the north-east and in the south, with a gentle descent towards the north. Near the southern shore lies Barnard's Peak, with a height said to be 3,400 to 3,800 feet, the most important summit of the central South Shetland group. The glaciation seems very powerful; glaciers everywhere descending into the sea, and of one of these Weddell even states that it extended right across the island. Powell also reports that South Bay or Johnson's Harbour, otherwise very favourably situated on the south-west coast, is rendered positively dangerous by the glaciers descending into it and the masses of ice constantly falling. Bellingshausen found the north-west coast, on the contrary, tolerably free from ice. The remaining islands are unimportant: Rugged Island, as its name indicates, high and abrupt, Snow Island, on the other hand, the western member, low, monotonous, and covered with snow. D'Urville found the snow dirty in appearance—probably the easy approach to it renders it a haunt of the penguins.

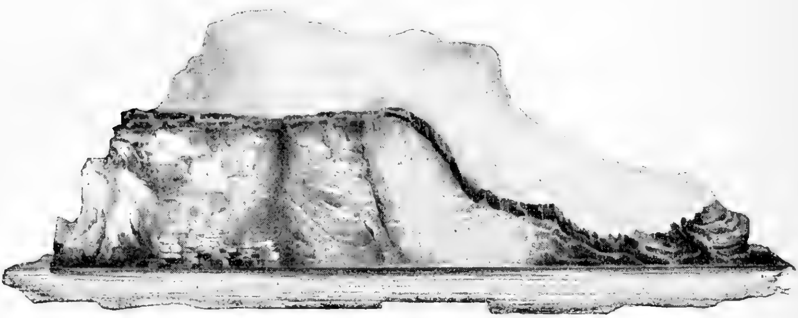
Scanty as are the data for the orographic structure of the chain of islands just described, they are nevertheless fuller than those relating to their geological structure, though fortunately these are not entirely wanting. Though meagre, they are sufficient to confute an opinion that has lately been advanced, according to which the South Shetlands are supposed to be a volcanic range. The very first discoverers who visited the group brought back specimens to their own countries, and though these have been examined only in regard of the minerals visible to the naked eye, while scarcely anything is communicated concerning their matrix, yet various conclusions can be arrived at from them. Moreover, accounts are not entirely lacking of the most important rocks and stones found there. When Smith landed for the first time on King George's Island, not far from the north-east end, he found the ground consisted of blue-grey slate. The writer of the account of the voyage in the Edinburgh *Philosophical Journal* was of opinion, according to the testimony of Smith's steersman, that there might be hornblende slate or chlorite slate; meantime it is not clear whether this applies also to the landing-place. So much is probably correct, that at least the northern flank of the largest island of the group is built up, not of eruptive but of slate rocks, perhaps the same that are found on the South Orkneys. It may also be concluded that the northern coasts of the other islands are of the same structure, as the outlines are identical, a difference in the geology being invariably associated with a difference in the form of the coast outlines. Another statement, which must, however, not be hastily accepted, though a confirmation of it would be welcome, is that coal has been found in superabundance. Details are not given; it therefore remains doubtful whether it is driftwood that has become peat, or actual coal, or anthracitic layers in the shale and slate. In the Chilian Cordilleras on the coast carboniferous strata of the upper chalk formation occur above crystalline slate, and tertiary peat in the neighbourhood of the Straits of Magellan; but it seems scarcely reasonable to assume that therefore the South

Shetland Islands have tertiary coal formations, even though Seymour Island has tertiary formations. Moreover, the statement itself is at best a doubtful one. For the present it is sufficient to determine that the north-west flank of the South Shetlands evidently consists of crystalline slates, that the descent in the north to the level of the sea is very gradual, that *per contra* the greatest elevations are found on the south-east coast, that numerous islets, rocks, and cliffs are scattered along the north-west coasts—perhaps the remaining indications of more extensive land, submerged by the action of the waves—that the south-east flank is entirely devoid of these detached rocks, and that for this reason the depth of the sea on this side probably increases much more rapidly than on the other. If all this be taken into account, and it is borne in mind that the southern flank is accompanied by active volcanoes, the thought arises that the South Shetlands consist of either a contorted or non-contorted mountain chain, the northern portion of which, subsiding to the W.N.W., has remained standing, while the southern has sunk into a chasm on which the volcanic islands we now see arose simultaneously. It would be highly interesting if these conditions could be carefully investigated—an undertaking that might be successfully accomplished by occasionally wintering here, even if there were no actual polar expedition set on foot.

The volcanic islands referred to play an important part in the later geological history of this region; they are situated on the south side of the central group of the South Shetland Isles, to which they form a parallel range. The charts give three: Bridgeman Island, Middle Island, and last, and by far the most interesting of all, Deception Island.

The smallest of these volcanic islands, Bridgeman Island, is also the farthest distant from the non-volcanic members of the group. According to existing surveys it lies in latitude 62° 10′ S. and longitude 56° 30′ W., approximately thirty-five miles from the nearest point of the remaining islands, the South Foreland of King George's Island. The circumference is small, but seems subject to variations brought about by volcanic activity, as neither the estimates of its size nor those of its elevation and outline correspond with one another. While Powell in the early twenties states that he saw a great crater at an altitude of about seventy-five feet above sea-level on the west side of the island, where it is 180 feet high, Dumont d'Urville gives the height of the island as 480 to 500 feet, with a greatest diameter of something over a nautical mile and a circumference of three to four nautical miles. All accounts on the other hand agree in stating that every visit to the island proved it to be in a state of solfatara activity, and also that the several emissions of gases proceeded from fissures mostly near the coast, rising from it, according to D'Urville, to a height of about 300 feet and upwards. All these active manifestations took place on the west side of the island, which, like the northern and western coasts, rises steep and abrupt from the sea; the south side alone is lower and flatter, and thousands of penguins were found on it. The island is described as conical; Wilkes, with whom D'Urville agrees, calls its shape that of a flattened cupola. The sides seemed to be furrowed by the corrugations so characteristic of stratified volcanoes, but this is probably true of only the more loosely constructed parts. Near the summit streams of lava are clearly indicated, and over them glowing red ashes or tufa; the slopes are of the same deep red tint, and have probably been entirely disintegrated by the action of the solfataras. All who have visited the island testify to the suffocating fumes of the gases exhaled. No landing has as yet been effected. The boats of D'Urville's expedition were compelled to content themselves with sailing round it at no great distance; not a trace of snow was anywhere seen, and on the south side even some vegetation was observed. The accompanying view by D'Urville is unfortunately not clear enough to give a good idea of the island.

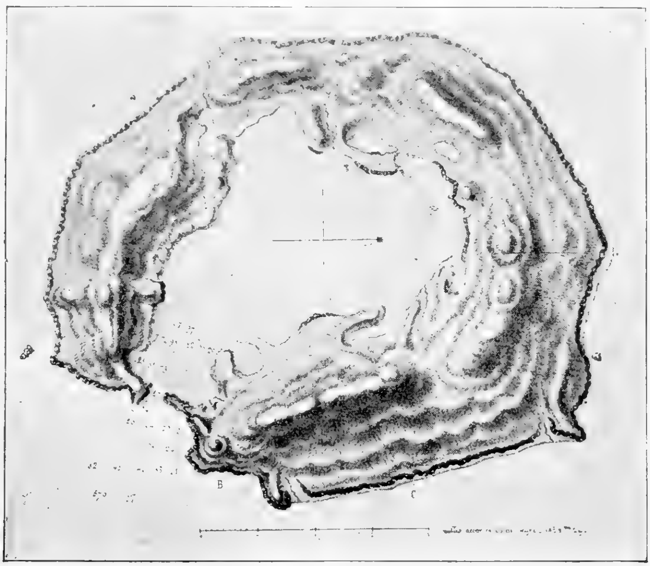
At some distance from Bridgeman Island, nearly ninety miles to the W.S.W., the charts indicate Middle Island, frequently described as elevated, in latitude 62° 50′ S. and longitude 59° 30′ W., some fifteen miles distant from Greenwich Island. Curiously enough, nothing further is anywhere communicated, and of the travellers D'Urville, Wilkes, and last of all even Larsen, not one got a sight of it when in close proximity to the



Bridgeman Island (after Dumont d'Urville).

position laid down. Indeed it is open to conjecture that Middle Island has no actual existence, and is to be explained by an early view of one of the lofty summits of Louis-Philippe Land. Seen perhaps from one of the South Shetland Islands it would have the appearance of being isolated, and might therefore be entered on the chart as an island. On Weddell's chart, which marks both Bridgeman and Deception Islands, Middle Island does not appear at all.

Farthest to the west, and at the same time the nearest neighbour to Livingston Island, nearly four miles off in the northern chain of the South Shetland Isles, lies Deception Island, in many respects one of the most interesting objects to be found in the Antarctic regions. It is one of the most remarkable, and at the same time one of the largest, crater islands on our earth. The circumference of the island, whose centre is in latitude 62° 56′ S. and longitude 60° 40′ W., is about thirty miles according to Webster, to whom we are indebted for an account of Foster's voyages; the diameter from north to south about twelve miles, that from east to west about nine miles. Within this space a considerable portion of



Map of Deception Island (after Dumont d'Urville).

the area is occupied by the inner bay, where the hollow of the crater lies under the surface of the sea. This inner basin, nearly elliptical in outline, has a diameter of five to six miles, and a circumference of thirteen to fourteen miles; it opens towards the sea on the south-west through one very narrow channel of only 550 feet across. The depth of this basin increases rapidly from eighteen feet at the entrance to over 1,140 feet in the centre. (This is Powell's sounding; Kendall gives only 580 feet.) The rim of the basin is on the whole more level than the outer circle of the island, except at the western entrance to this crater bay, where a steep cliff of about 787 feet descends perpendicularly into the water. The shores have many indentations, some being again the ruins of smaller craters, though other spent craters lie apparently close to the shore without visible communication with the great basin. Thus Lieutenant Johnson of Wilkes' squadron found a small crater of 1,400 feet in diameter in the background of the bay; it was separated from the great basin by a rampart 394 feet wide, and rising gradually to a height of eighteen feet, while it fell away steep towards the inside, which was full of water rising to the same level as the surface outside.

According to Webster, the enclosure of the great basin is irregular in form; it is not only broader but more elevated on the eastern side, attaining a height of 1,575 feet (Webster), or even 1,770 feet (Kendall) in Iceberg Hill. The structure of the island is exclusively volcanic, and exhibits many peculiarities. So far as Foster's investigations indicate, the walls of the collapsed crater consist for the greater part of loose eruptive matter, dark ashes, partly solid, as tufas, sands and slack, also pumice stones, all clearly stratified. Basalt, solid and porous, though only very rarely, also obsidian and perlit. These certainly testify against the basaltic nature of the lavas, since perlit is mentioned as occurring in the basalt. An accurate estimate of these rocks could manifestly be made only after thorough chemical and microscopical investigation. Minerals of non-volcanic origin, either as self-existent or enclosed in other substances, are not mentioned. The whole material of which Deception Island is built up is, moreover, exposed to the great changes and the destruction brought about by wind and weather, and by the activity of the solfataras and the fumaroles of the volcanic ruin. At the time of Foster's

View of Deception Island (after Dumont d'Urville).

visit, he had an opportunity of observing both these forms of volcanic manifestation, though no actual eruption producing ashes and lava took place. On the other hand numerous fumaroles, especially on the shores of the basin, were seen, from which hissing jets of steam escaped, breaking through the masses of ash and tufa washed down from the hills; near these were numerous hot springs with a temperature of 190·4° F. It is interesting to find these steam jets and hot-water springs piercing a completely hard-frozen surface, as was discovered by digging down close to the openings. In the neighbourhood of these sources and of the solfataras, a dense layer of milk-white gypsum, partly crystallised, was found, also sulphur and alum; among the gases ejected sulphuretted hydrogen seemed to preponderate. The fumaroles and solfataras were not confined to the shores of the inner basin, they were seen in numbers on the higher summits, which were constantly veiled in clouds of steam. This was especially the case with Iceberg Hill, the cap of which consisted of hot clay containing sulphur and alum efflorescence. The changes wrought in the original substances are not, however, confined to the immediate neighbourhood of the active emission of gas and steam, but everywhere on the island there were wide and often extensive tracts transformed into masses of hard bright red clay through the action of disintegrating processes. This clay is found in a solid and porous state, partly enclosing crystals. In some places a very interesting alternation of layers of undecomposed ashes and snow was found, in others ice and snow alone seemed to cover the summits of the hills, and again hillocks of pure ashes lay between them. Webster does not attribute these conditions to eruptions of ashes of which none were seen, but rather to the activity of the violent tempests of the west winds, which set in motion large masses of light eruptive matter as well as snow. Besides these forces another, that of flowing water, is particularly active, whether as heavy rain during the short summer, or in tremendous masses of melted water descending from the island itself and cleaving the slopes in all directions with ravines forming temporary watercourses.

In its main outlines Webster's account corresponds to the descriptions of Lieutenant Johnson. But although the latter landed as late as the end of March, while Foster had arrived in January, he seems to have seen considerably less snow. This was also the experience of Dumont d'Urville; he certainly did not land, but he remarked that not only the slopes but even the summits were free from snow. Smiley finally reports that the whole south side of the island was in full volcanic activity in February, 1842, "on fire," and that as many as thirteen active centres were seen. This is the last account of Deception Island, and later accounts are entirely wanting.

Boyd Straits, about thirty miles across, separate the last two and westernmost members of the South Shetlands from the middle group. It is a curious coincidence that the northern one, Smith Island, should be the loftiest of the entire group, while Low Island, the southern one, is apparently the lowest. It is equally remarkable that the latter lies exactly on the line of direction of the central main group, while Smith Island, obviously also of entirely different geological structure, seems to be projected north. Low Island, latitude 63° 15′ S. longitude 62° 15′ W., which appears to share the peculiarities of the rest of the island chain in being a slate formation surrounded by numerous rocks, is not described in any of the sources available for information. The name leads to the inference that the island is flat like its neighbour, Snow Island, on the other side of Boyd Straits, which it also resembles in point of size. Smith Island, named after its discoverer, is as already stated very different. Lying in latitude 62° 55′ S. and longitude 62° 35′ W., it rises on all sides abrupt and steep from the sea to considerable heights, the principal, Mount Foster, to the south-west of the island being in round numbers 6,200 feet high, while Mount Pisco, near the south coast, is estimated to be upwards of 4,250 feet high. Only in one place was a small flat shore found, and on this Weddell was able to land. The whole island is completely covered with ice and snow, with the exception of the steepest slopes where no support exists. Doubtless the strong glaciation of this island, as compared with the other members of the South Shetlands, is accounted for by its elevation, and this theory is borne out by the thicker covering being on the southern side. As to its geological structure we are almost in the dark; Bellingshausen alone mentions vertical strata, but whether this fact indicates a powerful upheaval of existing strata, or the columnar severance in a surface of volcanic eruptive rock, it is impossible to determine. The latter appears the more probable, because, as already stated, the mere outlines of the island seem to testify to volcanic origin, which would account both for the tilt in the stratification and for its remarkable height.

We here leave the island chain of the South Shetlands, and turn to the more extensive tracts of land and of island groups lying to their south.

6. THE DIRK GERRITZ ARCHIPELAGO.

Of all the tracts of land hitherto discovered in Antarctic regions none in the course of time has afforded so many surprises, nor undergone such fundamental reconstruction on maps and charts as the islands collectively called in modern times the Dirk Gerritz Archipelago. The oldest charts, those of Powell and Weddell, indicate a vaguely outlined coast to the south of the South Shetland Islands, running in the direction from E.N.E. to W.S.W. in longitude 56° 30′ to 61° 30′ W., and leaving a great gap in the middle. The western portion of this coast bears the name Trinity Land, with Hope Island off the other still unnamed eastern coast. At the present time all this is changed; in place of such a coast extending in one unbroken line to Graham's Land in the south-west, an island group is found, intersected by numerous straits and channels, and entirely separated from Graham's Land, with an area considerably smaller than the imaginary tracts of land of former days, though it must be confessed that even this modern discovery has been insufficiently investigated.

The Dirk Gerritz Archipelago is separated from the South Shetland Isles by Bransfield Straits, the breadth of which varies from twenty-eight to seventy-eight miles. The narrowest part is in the west, where the islets in the north of Hughes Gulf approach Low Island; the widest part lies between Joinville Island—the easternmost member of the Archipelago—and King George's Island. At the western end isolated rocks, the Austin Rocks and the Kendall Rocks, rise in the middle of the channel, the former between Low Island and Trinity Land, the latter between Trinity Land and Deception Island. Unfortunately no information exists concerning the depth of the water in the straits, and therefore it is impossible to draw any inference concerning their structure. The only known sounding, that of Dumont d'Urville to the north-west of Mount Jacquinot, and therefore much nearer to Louis-Philippe Land than to the South Shetland Isles, shows 950 feet; this is a somewhat greater depth than that met with at the same distance north of the South Shetland Isles.

So far as our present knowledge goes, the Dirk Gerritz Archipelago is composed of a number of larger and smaller islands lying approximately, though not completely, parallel to the South Shetland Isles, as may be inferred from the latitude of Bransfield Straits. The names of the larger islands beginning at the east are: Joinville Island, Louis-Philippe Land, Trinity Land—reducible to a group of smaller islands if the latest accounts by Larsen are accepted—and Palmer's Land. Dallmann's discoveries had already established the separation between Palmer's Land and Graham's Land. It is not improbable that later voyages will prove Palmer's Land also to be another group of islands. The whole island chain is separated in the south from Graham's Land by comparatively broad straits, whose western end, Bismarck Straits, fifteen miles wide, was explored by Dallmann in 1874. The apparently far broader eastern end was seen by Larsen, but has hitherto received no name.

It is convenient to begin the examination of the islands of the Dirk Gerritz Archipelago with Joinville Island as the most northerly and easterly. Its length between the eastern point, Cape Moody, longitude about 55° 5′ W., and the western, Cape Kinness, longitude close upon 56° 45′ W., is fifty-five miles in round numbers, while the extreme northern point, Point des Français is in latitude 62° 59′ S., and the southern, not yet named, in latitude 63° 22′ S. From the Point des Français the coast extends E.S.E. as far as Cape Fitzroy, a striking landmark, broken into just before the cape by a deep bay, which impressed Ross as very suitable for a harbour. From Cape Fitzroy the coast takes a south-easterly direction to Cape Moody, and then in a shallow curve sweeps round the foot of Mount Percy, the greatest elevation on the island. From Cape Alexander the trend is to the west, Gibson Bay, which is deep, breaking the coast line. Cape Kinness, as stated previously, forms the western point. It is joined to the main island by a low and narrow isthmus which was not observed by Dumont d'Urville; he consequently set down the cape as an island, which he named Rosamel Island, being confirmed in his error by a deep bay from the north which nearly severs the cape from the peninsula. With the exception of this break the coast line again extends north-east back to Point des Français. The whole island is surrounded by a great number of rocks and rocky islets; a larger one, Dundee Island, lies off the south, separated from the main island by a channel of which the western section, called Active Sound, extends north-east towards Gibson Bay, while the far longer eastern part extends S.S.E. and bears the name of Firth of Tay. The southern point of Dundee Island is Cape Purvis, named by Ross, beyond which Paulet Island and its smaller neighbour Eden Island project. The channel itself is about thirty miles long, two to two and a half miles broad in the western part, and contains somewhat considerable depths, probably over 540 feet; in its eastern portion its breadth is upwards of six miles. Dundee Island is thirty-four miles long with an average breadth of over four miles.

On the east side of Joinville Island, and at some considerable distance from it, are the outlying Danger Islets of which the southernmost, Darwin Islet, lies at a distance of fifteen miles from Cape Moody. Altogether there seems to be seven, of which two, however, are mere cliffs to which other cliffs are added close in shore. The whole north coast, too, is fringed with rocks, and last of all, east of Cape Fitzroy, comes a small, elevated, cone-shaped island, which Ross, from its resemblance to the European volcano, named Etna Islet.

The surface of Joinville Island exhibits a striking difference between the west and the east. While the whole western portion is low and flat, and scarcely above 325 feet high at its greatest elevation—especially on the south side, where, however, one steep hill called D'Urville's Monument by Ross, rises on the coast of Active Sound to a height of 490 to 590 feet—the eastern half of the island is occupied by Mount Percy to which Ross assigns a height in round numbers of 3,600 feet. This mountain is like a flat cupola in form, from which two steep rocky cones rise, and these according to Ross were entirely free from snow. A few officers thought they saw clouds of smoke rising from the summits; Ross, on the contrary, was of opinion that this appearance was caused either by clouds or by snow-drift. Meanwhile there is a probability that careful investigation might prove Mount Percy to be a volcano. The whole island is completely covered with ice and snow. On the south side the inland ice descends into Active Sound, forming deep clefts in coming from the plateau of the island, and these, of course, parallel to the coast line; the mass of ice enters the sea as a rampart upwards of fifty-nine in height. Farther to the east isolated "nunatak"[1] above the ice have been observed from the Sound, and Gibson Bay is equally girt in; only one rocky peninsula, Cape Alexander, about 200 feet high, is free from ice. Here clear geological lines form a profile that might have given some information concerning the geological structure of the island, but unfortunately it has been observed only from a distance, and even then not by an expert. Charles Donald, the medical officer of the *Active* relates that the rocks of which Cape Alexander is composed in general appear black, hard and crystalline. This mass is, however, traversed by two distinct narrow layers of softer, slate-like rock, sloping south at an angle of 45°, and recognisable by their light brown colour. Immediately below them lie—and here the data are somewhat vague—numerous flat, angular stones, which are to be regarded as an accumulation of *débris*, but for the rest correspond to the before-men-

[1] Originally a Greenland expression for rocks appearing in the inland ice.

The *Astrolabe* lying off Louis-Philippe Land (after Dumont d'Urville).

[Face page 174.

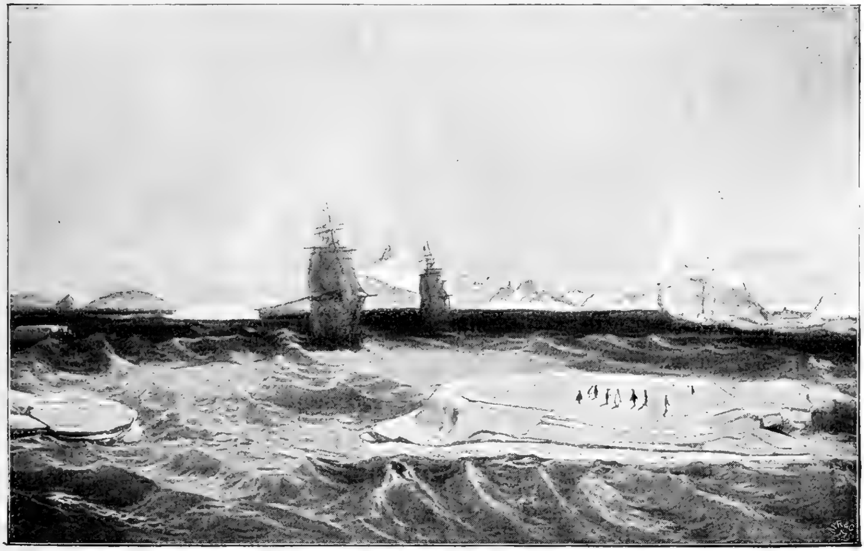
tioned strata. The dark colour of the upper rock, here and there changed to orange, Donald attributes to the presence of oxide of iron; it is quite as probable that it is caused by a lichen which here, as elsewhere in these regions, covers the rocks. On the farther side of Cape Alexander the inland ice rises steep to the double summit of Mount Percy, and the height of the ice wall here, near Cape Alexander, is doubtless upwards of 200 feet. Towards the east it diminishes, and does not appear to border the whole east coast, for Ross tells of a glacier, several nautical miles broad, which descended to the sea from a height of 985 to 1,300 feet, and ended in a barrier 90 to 100 feet high, in front of which Ross observed the largest accumulation of icebergs he had ever seen.

Similar conditions obtain in Dundee Island, although the absence of such lofty elevations brings with it the absence of the deep and universal ice-covering met with in Joinville Island. The ground nowhere rises above 160 feet, and may, therefore, as compared with its extent, be regarded as very flat. The ice covering, broken only by small clefts across the line of fracture, descends very gradually to the sea, forming ice walls of only twenty-seven to forty-eight feet high. In one place on the north-west of the island, Active Sound, Donald found a level beach slightly covered with snow and of a peculiar greenish-brown colour, probably a growth of lichen. The shingle here consisted of red and grey granite, sandstone, conglomerate, and eruptive rock, and further inland bones of whales in a state of decomposition were found. These finds are of the greatest interest, for even if the rocks were found on layers of secondary formation, they nevertheless prove that adjoining sedimentary rocks cannot be far distant, and afford an indication that the tracts south of Drake's Straits are obviously fragments of more extensive country at a previous period. Whether the bones of whales found farther in the interior are to be regarded as an evidence of a recent negative change in the coast (a rise of the land) it is as yet impossible to determine, but it is worthy of note as corresponding to similar finds in the South Shetland Islands. It is to be regretted that Donald had no opportunity of examining the rock near Dundee Island, and that of Cape Alexander, for decided opinions might then have been arrived at concerning the structure of the two islands which seem so closely connected. So much, however, may be affirmed, that the inclined strata observed by Donald on Cape Alexander —provided they are composed of crystalline slate or precipitate rock—decidedly point to structural disturbances such as are very likely to occur in the neighbourhood of volcanoes.

Of the smaller islands surrounding Joinville Island, Paulet Island, some 720 to 750 feet high, the south-eastern continuation of Dundee Island, as also a hitherto unnamed island 300 feet high to the west of Dundee Island, show only a comparatively slight covering of snow. The brownish-green hue noticed in Dundee Island is met with in both. Larsen indeed relates that on his visit the first island, which gave him the impression of being a volcano, was quite free from snow; according to his account it descends almost perpendicularly on the north-east and is brick-red. The Danger Islands seem more deeply covered with snow, except where the descents are too precipitous. Etna Island farther north is also thickly covered with snow.

The accounts of the much larger Louis-Philippe Land are far less complete and satisfactory than those available for an acquaintance with Joinville Island. Louis-Philippe Land is conjectured to be the largest member of the Dirk Gerritz Archipelago, but complete ignorance still reigns as to its western coast. The northernmost point, the point also nearest to Joinville Island, is Mount Bransfield, in about latitude 63° 7′ S. and longitude 56° 55′ W.

From this point the coast descending in terraces extends to the entrance to the broad Orleans Channel in latitude 63° 30′ S. and longitude 58° 35′ W., but beyond this it is entirely unknown. At Cape Foster, latitude 64° 27′ S., longitude 58° 7′ W., the coast returns to the former horizon and extends thence in an easterly direction, on the whole, as far as Cape Lockyer. Here an immense mass of ice, descending from Mount Haddington, reaches from the coast right across to Snow Islan d,and apparently connects



Louis-Philippe Land (after Dumont d'Urville).

the mainland with the island, from which it would otherwise be separated by Admiralty Bay. Seymour Island may be regarded as a prolongation of Snow Land towards the north-east and terminates in Cape Seymour, latitude 64° 13′ S., longitude 56° 32′ W. Towards Admiralty Bay Cockburn Island lies near the northern end of Seymour Island. The circular sweep of the foot of Mount Haddington constitutes the south-eastern as well as the southern boundary of Louis-Philippe Land. North of Mount Haddington, Sydney Herbert Bay, with its deep elliptical curve, ends in Cape Gordon, latitude 63° 50′ S., longitude 57° 20′ W.; it is fifteen miles across and extends the same distance inland. From Cape Gage to Cape Corry, at no great distance, the coast continues in a northerly direction, then E. to E.N.E. as far as opposite Dundee Island, and at length, broken by several small bays, northwards until Mount Bransfield is again reached. The wide bay which is thus framed in by Louis-Philippe Land on the south and west, and by Joinville Island and Dundee Island on the north and north-east, received the name of Erebus and Terror Bay from Ross.

The major axis of Louis-Philippe Land may be taken to run either from north to south, or from N.N.E. to S.S.W., and to have a length of about 100 to 115 miles; so long as the course of the western coast remains unexplored, it is impossible to estimate the extent of the island from east to west.

In contrast with the low and flat north-western portion of Joinville Island, the north coast of Louis-Philippe Land has elevations of some importance. Mount Bransfield, already frequently cited as the most northern point, is a conical mountain of 2,000 feet in round numbers. The land extends uniformly high to the south and west to the point where the coast takes a southern direction, and Mount Jacquinot, also conical in form, rises to a height of 2,000 feet and upwards. The character of the land now changes in so far as a mountain chain, extending south-west, takes the place of the isolated summits previously described, ending with the greatest height on the north coast, Mount d'Urville, 3,000 feet. The land, indistinctly seen, extends farther west to the entrance of the Orleans Channel. With the exception of steep mountain tops and isolated capes projecting into the sea, the whole northern coast of Louis-Philippe Land is completely glaciated, and in nearly every direction the inland ice reaches the sea, standing above the surface in a perpendicular barrier. Unfortunately D'Urville did not approach sufficiently near to the coast to observe the details of the glaciation, which doubtless exhibits many marked disturbances in consequence of the steep descent of the ice. The remarkably numerous dunes by which the coast is surrounded are more or less free from snow; so is Astrolabe Island fourteen miles off. As little is known of the geological structure of this part of Louis-

Mount Haddington and Cape Gage (after Ross).

Philippe Land as of the surface of the inland ice, since D'Urville did not avail himself of the favourable opportunity of landing on Astrolabe Island; neither did he examine the rubble of the icebergs frequently bearing *débris*, nor is the height of the ice rampart indicated, nor the size of the freshly detached icebergs. The dull thundering reports of apparently yielding ice barriers were frequently heard, but no actual detachment was ever observed.

No information whatever exists as to the whole tract between the north coast of Louis-Philippe Land and Mount Haddington, towering above every other object in the south. Towards the east, opposite Dundee Island, it appears rather flat, while there is a continuous rise towards the south. The southern portion of the island is entirely occupied by Mount Haddington, estimated by Ross to be 7,000 to 7,050 feet high, and the loftiest known elevation in this part of the Antarctic regions. It rises towards the interior in three terraces, all beginning with steep descents, and is on the whole deeply glaciated. The dark rocks certainly often appear along the lines of fracture marking the terraces, and in other places "nunataks" rise above the ice; the steep descent of the foot of the mountain is almost entirely free from ice and snow. At a few points, especially to the north of Cape Gage, which commands the western entrance to Admiralty Bay, vast glaciers descend along the deeper valley depressions, extending a considerable distance out to sea. In the same manner a glacier, several nautical miles in breadth, comes down from the south side of the mountain, filling up the inner part of Admiralty Bay and thus attaching the outlying island (Snow Land) to the mainland. Another great glacier lies at the southern foot of the mountain between Capes Foster and Lockyer.

Snow Land, the east coast of Admiralty Bay, on the other hand is completely glaciated, and nowhere shows a spot free from ice or snow. It is of pretty considerable size; its major axis extends nineteen to twenty miles from south-west to north-east, and in the south it rises to about 1,950 feet. Then it descends gradually to the narrow sound separating it from Seymour Island, which is low and narrow and about fourteen miles long. The ice covering of Snow Land everywhere outlines the coast with an ice wall keeping within such modest proportions as forty-eight feet in the higher parts and only twenty feet in the lower. The bed of the sea round this island seems rather irregular, if Ross's soundings to the east of Snow Land and Seymour Island are compared. At a distance of about five miles from the coast they give only 145 feet, while at a distance of three furlongs from the ice wall at the south of Snow Land it was over 325 feet; somewhat to the west and in the line of Admiralty Bay 480 to 590 feet, and fifteen miles south of Snow Land it was already 980 feet. All these irregularities in the structure of the sea bottom might be referred to volcanic phenomena, if indeed they are not attributed to glacial action originating in heavier masses of ice. Ross did not visit the coast at the foot of Mount Haddington, but the dark masses of which it is composed seemed to him to indicate a volcanic origin; this opinion was strengthened by the outlines of the mountain and its superimposed layers of fused stones. The stones taken from the crops of penguins certainly belonged to eruptive matter, and only one specimen of granite is mentioned by McCormick the geologist and superior medical officer of the *Erebus*. Seymour Island, forming the northern continuation of Snow Land from which it is separated by the six to nine feet deep sound, is indisputably of volcanic structure. According to Ross, the island may be assumed to consist entirely of stone and volcanic matter recently ejected; the surface is described as consisting of a deep brown lava with the characteristic corrugated conformation of the smooth mass on the top. Larsen's opinion, which fifty years later coincided with that of Ross, is supported by the circumstance that the island was free from snow; the dark colour of the rocks moreover led him to conclude that the island had recently been in a state of eruption, as the icebergs attached to the island were seen to be discoloured at the top and the side adjacent to land. No centre of eruption, however, has as yet been found. Seymour Island is remarkable as being the only spot in the Antarctic regions in which for the first and only time palæontological remains have been found. Larsen brought away petrifactions on his first visit which were evidently not found in their original resting-place, for they were already partly worn by weather and friction. The English geologists found that of seven shells of molluscs found here five belong to the genus Cucullæa and one Cytherea, both shells. Two pieces of silicated conifers were also found.

Larsen's second visit affords a more detailed account of the configuration of the island which was traversed not only by himself with two companions, but by a second party. He describes the surface as hilly, about 300 feet high—as far as he was able to judge—and intersected by valleys. Of the elevations some are cone-shaped, and appear to be small eruptive cones, built up of ashes and lapilli; no other structure can be assumed since Larsen describes them as consisting of "sand, cement, and small stones". On the other hand it is very puzzling that the petrified wood was found here also, occurring principally on an upper level of about 300 feet above the sea; the trunks, he states, partly stood slanting in the ground. These circumstances recall Tasmania and Kerguelen where fossil conifer wood similarly occurs bedded in basalt lava and tufas, and there may be no great error in assuming that analogous conditions obtain in Seymour Island. This Antarctic discovery might prove to be of great importance, as it goes to support the recent sharply-contested hypothesis that the polar regions enjoyed a far warmer climate during the tertiary period. The fossil plants found in Greenland have been declared to be tertiary drift-wood, but this explanation of the phenomenon in Seymour Island cannot be accepted. The currents could convey a deposit of drift-wood only from the west through Bismarck Straits, and this improbable and unsatisfactory explanation in no way accounts for the slanting position described by Larsen.

The account is interesting of "balls formed of sand and cement" found in other parts of the island "lying on supports of the same"; they presented an appearance as though formed "by the hand of man". Dr. Donald who saw these balls describes them as composed of concentric layers, which leads to the inference that they were columns of basalt which had crumbled into concentric scaled balls, and this is not rare in basalt, and similarly in diabas and

Cockburn Island and Admiralty Bay (after Ross).

trachite. Larsen mentions no vegetation, which is all the more remarkable as Hooker found a comparatively rich flora existing close to Cockburn Island.

Cockburn Island on which Ross landed lies at the entrance to Admiralty Bay, nearer to Seymour Island than to Mount Haddington. As with Seymour Island Ross found it entirely free from snow, as well on the somewhat elevated southern as on the lower northern side. According to his account the island reaches a height of 2,700 feet, while its diameter is said to be only about as much again. The highest summit is crater-like in form, and a rock like a tower rises at the north end. Both stand on a plateau 1,300 feet in height, with a steep descent to a narrow shore, the slope being covered with detritus loosened by frost. The stone of the island is lava, partly solid, partly porous. A yellow lichen mostly covers the rocks, and together with eighteen other lichens, algæ and even mosses, forms a flora that has a scanty subsistence on a surface completely frozen over even in the height of summer.

The last section of the Dirk Gerritz Archipelago, Trinity and Palmer Lands, has experienced important changes in its chartographical representations during the last twenty-five years. After Dallmann's discovery of Bismarck Straits had severed the west coast of Palmer Land from its previously presumed connection with Graham's Land, the discoveries of Larsen showed that there was also no connection either in the east or in the centre, and it was through Larsen's observations that a large portion of the Hinterland attributed to Trinity Land was withdrawn. It may also be mentioned that the present author had assumed a continuation of Bismarck Straits before Larsen's discoveries, basing his opinion on the observation made by Ross of the strong current setting east on the south coast of Louis-Philippe Land.

Great uncertainty still prevails concerning the actual distribution and conformation of the land east of the Orleans Channel and north of Bismarck Straits, although these regions were the earliest visited of the whole archipelago, both by seal-hunters and scientific expeditions (Foster in the *Chanticleer*). Orleans Channel, which bounds Trinity Land in the east, has at its end a breadth of about twenty-two miles. The adjoining coast of Trinity Land, situated in about 63° 30′ S. latitude, extends from about 59° 25′ W. to about 60° 50′ W., and so far as is known it is hilly and almost entirely covered with ice. Foster's statement that the hills of Trinity Land rise to heights of from 5,800 to 6,800 feet may be based on an over-estimate; it is certain that no such heights are given elsewhere.

The entire western half of this coast apparently consists either of islands or a remarkably narrow peninsula, which forms a division between the eastern portion of Hughes Gulf and Bransfield Straits. The coast seems to run south from Hoseason Harbour, latitude 63° 40′ S., longitude 60° 20′ W. According to Dallmann, who unfortunately observed his position rarely and inaccurately, a narrow strait then leads into the Orleans Channel. The land lying to the south of these straits and the southern boundary of Hughes Gulf are only vaguely known; according to Larsen's opinion—not an unassailable one—and the chart based on it by Friedrichsen, the gulf stands in wide and open connection with Bismarck Straits. Up to the present, the south coast of Hughes Gulf is placed in latitude 64° 20′ S., and its west coast is formed by Palmer Land. The gulf or strait, especially in its western portion, has a large number of islands, of which the northernmost, Hoseason Island, was visited by Foster, who landed on Cape Possession in latitude 63° 46′ S. and longitude 61° 45′ W. The ice-covered island proved to be composed of horn-blende syenite, and has therefore no modern eruptive rocks. According to the notes made by Kendall about the view to the south from the neighbourhood of the cape, it seems that the wide gulf becomes an archipelago of numerous small islands farther along, and that their heights are considerable, even if they do not reach the measurements given by Webster. This is particularly true of the remainder of Palmer Land, an island or more probably a collection of islands, which according to present knowledge, extends from Cape Cockburn in the north in latitude 63° 53′ S. and longitude 62° 10′ W. as far as Bismarck Straits in the south, in about 65° 10′ S. latitude, and extends from Hughes Gulf in perhaps 61° 30′ W. longitude to about 63° 40′ W. longitude. The northern half is divided by Dallmann Bay, a deep sweep, into two rather narrow peninsulas or islands, with Cape Cockburn and Mount Parry, apparently of high elevation, on the easternmost. In the south-west of Dallmann's Bay a small strait branches off to the south, and this may probably be connected with Roosen Straits, which are wider, and extend from the end of Bismarck Straits northward. If these circumstances exist, the whole west coast of Palmer Land, with its lofty mountain, Mount Williams, discovered by Biscoe, forms a separate island. Nothing whatever is known of what lies to the east beyond Roosen Straits.

The land which is surrounded by a fringe of dunes on all its coasts is glaciated according to height. Dallmann states that with few exceptions the coast is formed by a wall of ice "several hundred feet in height". On the other hand Biscoe found a shore free from ice and snow at the foot of Mount Williams, close to which no bottom had been reached at a depth of 121 feet, thus indicating a well-marked steep shore, from which the rock, after forming a narrow surf terrace, abruptly rises to considerable height. Unfortunately we have no account from the two explorers who have visited this region of the rocks they met with, so that no conjecture can be made either as to the geological structure of Palmer Land or its interior and its relation to other regions.

7. GRAHAM'S AND ALEXANDER LANDS.

South of the Dirk Gerritz Archipelago lies Graham's Land, the largest land mass hitherto discovered south of Drake Strait. In the "History of Discovery" it was shown that its north-east and east coasts have only lately been made known by Larsen's second voyage, whilst the west coast was seen first by Biscoe, then again by Dallmann, and quite lately by Evensen, who also was the first to see Alexander Land again.

If Larsen's observations are correct, the small island bearing his name must be regarded as the northernmost point of a group of islands situated in front of the northern coast of Graham's Land, which has not yet been sighted. This island lies in latitude 64° 45′ S. and longitude 60° 8′ W., and is the last link of the chain of Seal Islands extending from north-west to south-east. Its nearest neighbour is the Greater Jason Island, then the smaller islets named Hertha, Castor and Oceana Isles, and finally Robertson Island, of very considerable size, whose loftiest summit is situated, according to Larsen's measurements, in latitude 65° 20′ S. and longitude 58° 47′ W. In the immediate neighbourhood of the north-east coast of this island, in latitude 64° 50′ S. and longitude 59° W., lies the volcano Christensen, and to the north-east of it the conical-shaped Lindenberg Mountain, which is also volcanic.

To the south of these islands rises the north-east coast of Graham's Land, named by Larsen, its discoverer, King Oscar II.'s Land. It stretches from the neighbourhood of the eastern Seal Islands in a S.S.W. direction as far as latitude 65° 40′ S., where it forms the base of a considerable elevation, *viz.*, the Jason Mountain, which forms a peninsula projecting far into the sea, and adjoining a bay which penetrates deep into the land. From the middle of it rises the lofty Wetter Island, and in the far background Larsen saw at a great distance Foyn Land, a mountainous country, consisting apparently of four mountain ridges. (These he places in the region of latitude 66° 25′ to 66° 42′ S., and longitude 61° 48′ to 61° 50′ W.) To the south of this region, in latitude

67° S., the coast again projects as far as 60° 40′ W., and stretches in a southerly and south-westerly direction beyond the horizon of the southernmost point reached (latitude 68° 10′ S.) far into unknown distances.

In the west begins the portion of Graham's Land by Bismarck Straits, which has been seen in about latitude 65° 20′ S., and extends from here in a south-westerly direction to beyond latitude 68° S. Unfortunately, neither Biscoe nor Dallmann have given any, even remotely, satisfactory account about these higher latitudes; not even the latitude in which the land was seen has been indicated. We only know that Biscoe saw elevated and extensive land to the east of Adelaide Island, situated in about latitude 67° 15′ S. and longitude 68° 20′ W., and that he believes he has traced it as far as Palmer Land. Evensen does not even inform us if, according to his observation, Alexander Land, which he has seen not merely from the west, like Bellingshausen, but also from the north, is in direct communication with Graham's Land, as one is inclined to conjecture, or if both these countries are divided by a strait parallel to Bismarck Straits. The tract of coast seen by Bellingshausen, and named by him Alexander Land, lies in latitude 68° 43′ S. and longitude 73° 10′ W., and as it gave him the impression of a lofty cape, from which the coast trends to the south-west, it may well be that the other arm of the projection follows an easterly direction, and might accordingly have been seen from the north by Evensen as a coast line. If this be really so, then it is certainly highly probable that Alexander Land is a continuation of Graham's Land.

Just as the Seal Islands lie in front of the north-eastern extremity of Graham's Land, so do the Kaiser Wilhelm's Islands in the west mark the entrance to Bismarck Straits, albeit that their positions as well as their outlines are but faintly indicated in the charts we possess. The chain of Biscoe Islands, which must be regarded as coast islands, is probably in no way connected with the Kaiser Wilhelm's Islands; it begins, according to Biscoe, with Pitt Island in latitude 66° 20′ S. and longitude 66° 38′ W., and extends south-west parallel to the coast, but at a considerable distance from it, averaging about forty-five miles, as far as latitude 66° 20′ S., but it must not be forgotten that the position of the main coast is still very undetermined. Adelaide Island, also situated far to the south, stands in no visible connection with the chain of Biscoe Islands proper, and it seems also to be at a much less distance from the coast, *viz.*, about eighteen miles, according to the indication of the charts.

Our knowledge of the vertical structure of Graham's Land is as scanty as that of its outlines and of its geology; we only know that it possesses near its north-east coast two small active volcanoes. These two volcanic islands are in fact the best known parts of the country, one—Christensen Island—having been visited by Larsen, and the other was seen at no very great distance. The former Larsen describes as mostly free from snow, completely so round the summit, whence a stream of lava was poured out towards the eastern flank of the island. On the unmelted field-ice surrounding the island were found masses of eruptive rocks ejected by a recent eruption, which an examination by Dr. Petersen showed to have consisted of real olivenite felspar basalt. Larsen gives no information about the conjectured elevation of the island, nor about the nature of its volcanic activity, but on the other hand he does tell us that on the slopes of the Lindenberg Cone smoke was seen to rise in heavy masses from numerous parasitic craters; indeed, the intense volcanic activity of this island was made manifest by the fact that the ice was melted for a considerable distance round it. One might almost be inclined to ascribe a volcanic character to Robertson Island as well as to the five Seal Islands lying in a straight line, as they appear strikingly free from snow, in perfect contrast to King Oscar Land, which is wholly enveloped in ice and snow. Robertson Island, the largest of them, is highest in the south, descending towards the north ; this is the case also in the neighbouring Oceana Island ; on the other hand Larsen describes Castor Island as flat, Hertha Island as somewhat higher, and Jason Island finally is described as high, and, according to his estimation, three Norwegian miles (equal to eighteen English miles) in extent. Larsen Island, again, is low.

King Oskar Land is apparently high and wholly glaciated, excepting a few isolated spots where the bare rock stands out from amidst the icy covering. North of Jason Mountain it appears relatively level, or gently ascending, whilst near the Jason Mountain the surface is described as unevenand rugged. To the north of this striking summit the eastern extremity of which has been named Framnœs, lies an ice-clad fjord extending west. From this spot the coast of the country extends to the north, and is enclosed by an ice barrier, the edge of which is distant five to six miles from the land, which gradually ascends, and is here and there of considerable elevation. This icy barrier also extends southwards along the whole extent of coast as far as it is known, and is much higher than to the north of Cape Framnœs. Openings of remarkable depth are noticed in it, which Larsen regards as fjords; they are probably gaps left by icebergs that have drifted away. In many places the icy barrier was overhanging atop, and large masses of ice got detached and fell with a thunderous crash into the sea. From Larsen's account it is to be inferred that the mass of inland ice also fills the large bay situated south of Jason Mountain, in the centre of which lies Wetter Island. The background of the bay seems to have a greatly varied surface, whilst the country south of the bay, as far as is known at present, and even beyond it is possibly elevated, but more uniform in structure. We are wholly uninformed about the geological structure of this newly-discovered country, and even about the varying depths along the coast. We must meanwhile be content with the knowledge of the existence of an extensive tract of land.

Still less do we know about the west coast of Graham's Land. Biscoe only tells us that the country is elevated, continuous, and, in his opinion, extensive. The published narrative of Dallmann's voyage, as well as that of Evensen, leave us wholly in the lurch with respect to Graham's Land. Biscoe gives us scanty information only about the islands he has discovered, but he has made several valuable soundings. Pitt Island, which is the northernmost of the group, abounds in bays, and may well be designated by the epithet, the "Elevated Snow Land," which Evensen applies to the southern members of the group. Adelaide Island, situated at a great distance from the rest of the group, is the highest of them all. It is formed by a mountain chain about four miles in extent, from which a very high summit rises in a steep ascent. Biscoe seems to have found the mountain tops partly free from ice, whilst the lower regions were wholly glaciated, and terminated at the coast in an icy barrier 10 to 12 feet high, the tops of which were rent by large clefts. The soundings off Adelaide Island yielded very peculiar results. At a distance of about three miles from the coast a line of 1,500 feet failed to touch bottom. This isolated, steep and lofty island may possibly also be of volcanic origin.

Alexander Land, finally, which Bellingshausen only sighted from a distance of about forty-five miles, is described as an elevated snow-clad region; nevertheless, he imagined that in places he had noticed the rocky subsoil projecting from amidst the ice.

To Alexander Land are joined in the west, but at a great distance, lands that have been sighted or conjectured, the extreme outposts of our geographical knowledge in the south-east of the Pacific; they are scanty, unreliable points on our charts, which, nevertheless, may at some future time coalesce and form extensive coast lines as the result of later and more favourable times for south polar exploration.

The first of these islands is that discovered by Bellingshausen, and named by him Peter I. Island. It has been referred to in the history of discovery. It is situated in latitude 68° 57′ S. and longitude 90° 46′ W., and appears to be quite isolated, as Bellingshausen saw no land anywhere in its neighbourhood. The dimensions of the island are, on obviously uncertain data, calculated by its discoverer to be about eleven miles in length, five miles in breadth and twenty-six miles in circumference; the mean height, calculated on the basis of three measurements, appears to be 4,200 feet. Excepting several steep slopes, the island was wholly covered with snow and ice. The height and isolated position of the island seem to favour the theory of volcanic origin, although there are no indications whatever of volcanic activity.

Somewhat farther west, in about latitude 70° S. and longitude 100° W., Walker believed in 1839 to have been in sight of land for three hours; this was during an interval of clear weather in the midst of a snowstorm, as has already been mentioned in the "History of Discovery". As he gives no description of this sight of land, it is not impossible that he was the victim of a delusion. However, he sighted, somewhat to the west and at no great distance from this spot, heavy, compact masses of pack-ice, such as occur in the Antarctic seas mostly in the neighbourhood of land, and he also encountered such enormous masses of icebergs that the neighbourhood of land may be inferred, even if his sight of land was deceptive, he having mistaken, as he himself considers possible, a *débris*-laden iceberg for land. But just this latter circumstance would more decisively speak in favour of the proximity of land than the indistinct and delusive appearance of the same. Its existence is finally rendered probable by the description given by Cook in his famous *Ne plus ultra* referred to above. We repeat: In front of of him he saw, in latitude 71° 10′ S. and longitude 106° 54′ W., beyond a zone of pack-ice a nautical mile in width, a firm, compact, mass of ice, which appeared to be rather low and flat. It increased greatly in height towards the south, and supported ninety-seven ice-hills, many of which were very high, and successively overtopped each other till they disappeared in the clouds, giving thus the impression of a complete mountain chain—which it probably was, as may be assumed with considerable certainty. That common icebergs are not to be thought of in this description is shown by the unusual term he employs, and by the fact that the more distant masses tower above the nearer ones; icebergs are in any given region of much the same height, and this would, according to the rules of perspective, exclude the appearance here described. Cook no doubt saw a mountainous country, and the level and firm ice-field in front of it must have been the well-known sheet of inland ice.

It would be extremely desirable that this region too should be taken into consideration in the plans of future south polar explorations. Actual examination alone can definitively settle the question whether Peter I. Island, or some land to the rear of it corresponding to Walker's landsighting, and finally Cook's sights of land, can be combined into one general whole and connected with the coast of Victoria Land. The opponents of the theory of the existence of a south polar land, or even of a south polar continent, ought not to forget that there is absolutely nothing known that militates against the existence of such land, because no land has been seen in regions not yet reached by any ship; in other words, the assumption of the existence of land is logically as justifiable as that of water. In fact the great number of icebergs, met also in the higher latitudes of the south-eastern Pacific, points more distinctly to the presence than to the absence of land, seeing that their origin can be traced only to glaciers or inland ice.

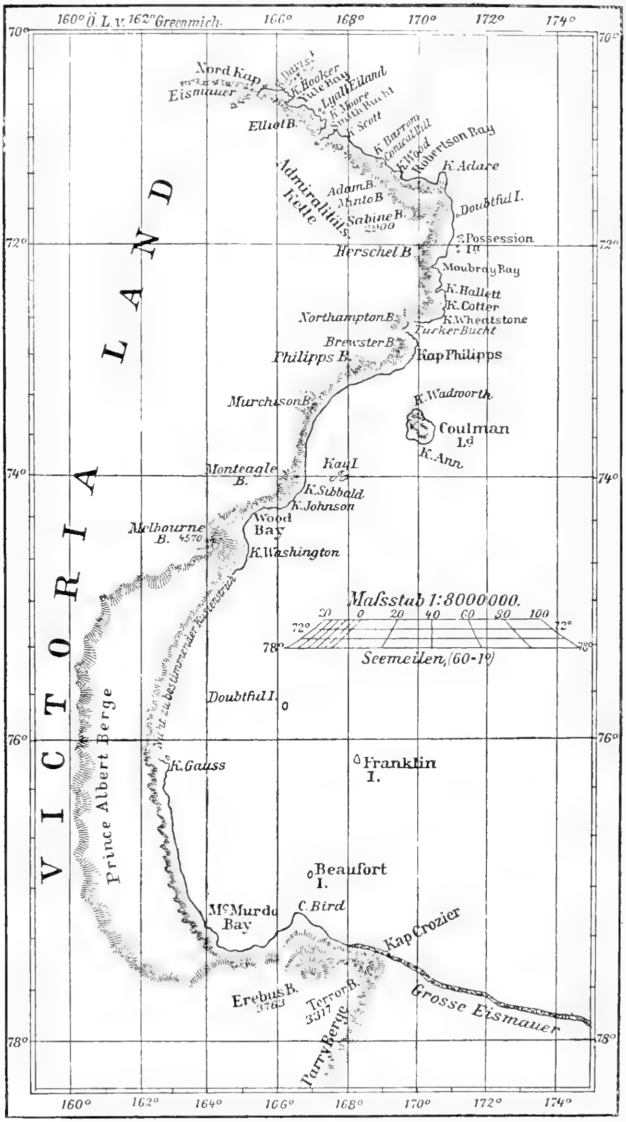
Before passing over to the next large mass of land in the Antarctic regions, we may make short mention of the small, solitary Dougherty Island. It is situated in latitude 59° 20′ S. and longitude 119° 44′ W. (the mean of the only two observations made), and presents the appearance of a rock five to seven miles in length, high in the north-east, flat in the south-west, and the centre covered by a glacier ; its highest elevation might be about 300 feet, which is slight in comparison to its extent. As it has only been seen from a distance, and has never been visited, we know nothing of its character or geology ; possibly it may be of volcanic origin.

8. VICTORIA LAND.

A wide expanse, within which the 68° S. has nowhere yet been crossed, divides the land probably sighted by Cook from the nearest land seen in a westward direction, *viz.*, the extremest eastern point of Victoria Land seen by Ross, or the identical place, where the highest southern latitude has, up to now, been reached ; this is the eastern extremity of the large ice barrier, beyond which its discoverer beheld more land to the south of it. Between this spot and the extreme western land seen by Ross near Cape North, together with the adjoining ice barrier, between 161° 30′ W. and 165° E., extends the wide region of Victoria Land and Ross Sea.

The northernmost point of this considerable mass of land is Cape North, situated in latitude 70° 31′ S. and longitude 165° 28′ E. From it elevated land seems to stretch in a south-west direction, whilst the lofty ice barrier in front of it extends beyond the horizon in a westerly direction. In the other direction the coast line of Victoria Land trends from Cape North to Cape Adare, in latitude 71° 18′ S., for a distance of about 125 miles, showing many a deep fjord, of which Yule Bay and Smith Inlet are the most important, whilst Cape Adare, with its far-projecting, coast forms Robertson Bay. The coast is lined by islets and cliffs in front of it, which are still more numerous and extensive on the eastern coast of the country. This trends due south from Cape Adare to Cape Cotter in latitude 72° 39′ S. and longitude 170° 50′ E. This tract of coast, about ninety miles in length, is also interrupted by numerous bays, of which, according to Ross's chart, Mowbray Bay seems the most important. The coast is fronted by a row of islets, possibly beginning with "Doubtful Island," to which also belong "Possession Island," twice visited by Ross and by the crew of the *Antarctic;* the distance of these islands from the mainland is inconsiderable. Between Cape Cotter and Cape Philipps, which forms an important turning-point of the coast in latitude 73° S. and longitude 169° 55′ E., lies Tucker Bay, which is broad and penetrates deep inland and is overlooked on both sides by lofty summits. From Cape Philipps as far as Cape Sibbald in lat. 74° 6′ S. and long. 166° 47′ E., extends in a wide, but shallow, curve a bay that is still unnamed, with a distance of 100 miles between the two extremities. In front of it lies a large island called Coulman Island, and near Cape Sibbald the small Kay Islets. From Cape Sibbald the coast extends in a gentle curve S.S.W. and S.S.E., assuming an easterly direction at McMurdo Bay. At the very beginning of this stretch of coast line Wood Bay, deep and wide, breaks in between Cape Sibbald at the foot of Mount Monteagle and the foot of the yet loftier

Mount Melbourne. Between Cape Washington at the southern end of Wood Bay and Cape Gauss, latitude



Map of Victoria Land (after Ross).

76° 9′ S., longitude 162° 52′ E., Ross was unable to keep the low coast in view, but the lofty mountains to the back of it were well defined. A small island lies in front of Cape Gauss, and it is possible that there may be at a distance of another sixty miles to E.N.E. "Doubtful Island," but the sighting was uncertain.

McMurdo Bay already mentioned lies at the north-west base of Mount Erebus, and is bounded on the east by Cape Bird which projects far to the north from the volcano in latitude 77° 9′ S., longitude 166° 40′ E. As an elevated prolongation of this promontory Beaufort Island lies sixteen miles to the north. Franklin Island, fourteen miles long and half as wide, lies about fifty-five miles from Beaufort Island in the direction of N.N.E. by N.

From Cape Bird the foot of Mount Terror now forms the coast, extending E.S.E. as far as Cape Crozier in latitude 77° 25′ S. and longitude 169° 10′ E. Here it is attached to the gigantic and uninterrupted mass of the Great Ice Barrier along which Ross sailed a distance of 440 to 500 miles as far as latitude 78° 10′ S. and longitude 161° 36′ W. This is the greatest ice barrier hitherto known on the face of the earth, and in extent corresponds approximately to the straight outlines of the continental coast between Calais and Sylt off Holstein.

The characteristic that distinguishes Victoria Land from all other south polar tracts hitherto seen is its great elevation above sea-level. This and the form of the mountains visible from the sea unfortunately constitute almost all the information we possess about it. For all acquaintance with its geological structure the scanty investigations of Ross, when he landed on Possession Island and Franklin Island, and those of Borchgrevingk on Cape Adare and also on Possession Island or an islet of the same chain, are the only source. Unfortunately, Ross had no real artist on board, and the drawings accompanying his work, which are faithfully copied in the present work, frequently bear the unmistakable stamp of an amateur's impressions. This defect, without the compensation of over-accuracy, prevents that acquaintance with the external aspect of the country which might otherwise have been gained.

Above the whole sweep of the northern coast of Victoria Land, east and west of North Cape, the elevated chain of the Admiralty Range rises in innumerable summits, frequently conical, and many attaining great heights, according to the estimates and measurements of Ross. In the west Mount Elliot above Yule Bay is the highest; in the east near Cape Adare Mount Sabine

Mount Sabine and Possession Island (after Ross).

rises 9,000 to 10,000 feet about thirty miles from the coast. The whole mountain range is completely glaciated, and the ice covering everywhere sinks into the sea, indeed as has already been stated an immense ice barrier extending west from Cape North, which it joins, here reaches a height of 140 to 160 feet. The mass of ice projects several nautical miles beyond the cape into the sea, but of course it is not known how far the edge lies beyond the actual land farther west. To the east of the cape there certainly appears to be no unbroken belt of ice along the coast, but every bay, every indentation carries off the inland ice into the sea, and all these openings are closed in by ice walls 180 to 450 feet in height. The last measurement, never met with in icebergs and ice barriers elsewhere, points to the fact that these masses of ice rest on the sea bottom, and this conjecture is supported by the soundings taken by Ross. These are in so far of great interest that they indicate a comparatively gentle descent of the continental base off the elevated mountain coast. About thirty-seven miles from Cape North the soundings gave only 1,000 feet—no great depth when compared with those off the coast of the Cordilleras. Whether geological or glacial action is accountable for the existence of this submarine terrace is naturally very doubtful.

The only point free from ice hitherto seen or landed upon on the north coast of Victoria Land is Cape Adare, already frequently named as lying in front of the foot of Mount Sabine. It rises as a huge boulder of basalt rock to a height of 3,500 to 4,600 feet above the surface of the sea, to which its foot descends as a long extended peninsula, with a level shore covered with shingle. It is not certain of what rock the cape is composed, as a great block of nephelin-tephrite was found on the shore and not attached to it, although it may belong to the cape. Even in this high latitude sparse vegetation was found to exist in the form of a lichen in particularly sheltered spots.

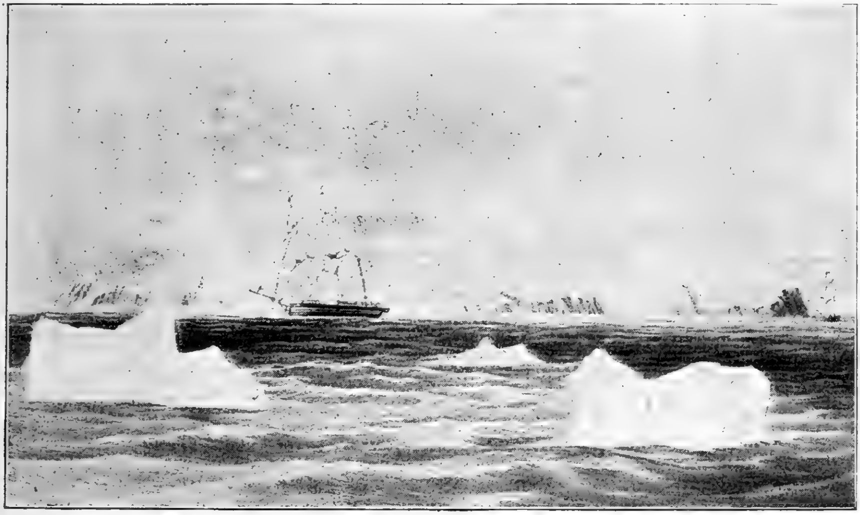
According to the observations of Borchgrevingk the neighbourhood of Cape Adare must still be in a state of volcanic activity. A summit of 7,900 feet, scarcely covered with snow in the midst of the dazzling white mountains, suggested the probability of a recent eruption, and on two out of twenty glaciers counted by Borchgrevingk vast masses of snow seemed to alternate with layers of lava above the ice.

The portion of the coast between Cape Adare and

Cape Cotter exhibits the same characteristics as the north coast, only here the mountain summits seem to rise still higher, 11,800 to 13,800 feet; the highest and most prominent height of this range is Mount Herschell. Here too every coast indentation is completely filled up by vast glaciers again resting on the sea bottom and unable to break away and float. At a distance of two to three miles from the coast Ross sounded depths of only 350 to 550 feet, an insufficient depth for floating Antarctic icebergs of ordinary size. The chain of low islets lying at a short distance from the coast consists entirely of volcanic rocks if an inference may be drawn from one of them, Possession Island, latitude 71° 56′ S., longitude 171° 7′ E., visited both by Ross and the crew of the *Antarctic.* The rocks were partly porous hornblende basalt free from olivin which here and there showed columnar detachment. On the south-west Possession Island bears two pointed heights of 300 feet each, and was pretty nearly free from snow on the occasion of both landings; it had, however, a thick covering of guano deposited by the innumerable penguins that inhabit the island. On a rock at about twenty-eight feet above sea-level Borchgrevingk found the same lichen that appears on Cape Adare.

Cape Wheatstone, the boundary of Tucker Bay on the north, is completely covered with ice at the top, while the steep descent is free from snow; and farther south a cape with two heights, perhaps Cape Jones, is equally steep and free from snow. For the rest this section of the coast is evidently entirely covered with ice, and the same is in the main true of Coulman Island the centre of which lies about latitude 73° 36′ S., longitude 170° 2′ E. According to the chart drawn by Ross it must be of tolerable extent, with a length of at least eighteen miles; with perhaps the exception of Cape Anne, the height of the island appears inconsiderable, otherwise Ross would have made mention of it. According to the view given by him and here reproduced, Coulman Island, with the exception of the steep face of the rocks, is completely enveloped in ice and snow.

Very little is known concerning Capes Philipps and Sibbald, as Ross was unable to approach near enough to gain a good view on account of the heavy land-ice. Cape Sibbald lies at the foot of Mount Monteagle, one of the highest mountains of Victoria Land, looking down with its steep summit on the others, and overtopped



Coulman Island (after Ross).

only by Mount Melbourne, the highest known summit of the south polar regions, said to be nearly 15,000 feet high. The outlines of Mount Melbourne, which bear a striking resemblance to those of Mount Etna, and also its crater at the top, evidently indicate its volcanic nature. At the same time Mount Melbourne marks the boundary of the coast actually seen by Ross, although he saw a lofty mountain chain in the west, the Prince Albert range, which either really is considerably less lofty than the other parts of Victoria Land, or only appears to be so on account of its great distance. It is certain that the coast, which Ross was able to approach as near as twelve and a half to thirteen miles off Cape Gauss, is low and apparently flat.

Although "Doubtful Island," as before stated, may have been only an iceberg heavily laden with *débris*, Franklin Island, where the landing was very dangerous, is undoubtedly a volcanic formation. The north side of the island shows a dark, steep cliff, 500 to 590 feet in height, traversed by a number of light-coloured horizontal layers several feet deep, and with yellowish red colour here and there—these may be layers of pumice stone partly decomposed by gaseous exhalations. On the south and south-west side the island is girt in by a lofty ice barrier. Soundings indicate that Franklin Island is to be regarded as the highest point of a volcanic ridge extending from north to south, for fourteen miles north of the island the measurements gave 1,194 feet, and these gradually decreased to 305 feet six miles to the north-west, and 220 to 250 feet at two and a half to four miles out. On the south a range of cliffs extends above water for upwards of five miles. A continuation of the line of direction leads straight to Beaufort Island, conical and small, but lofty, lying about two miles off Cape Bird and thus also off Mount Erebus.

Mount Erebus, whose base sends out a peninsular projection—Cape Bird—to the north, forms the eastern boundary of MacMurdo Bay, which is broad and deep, and rises from the low land adjacent to it on the west to a height of 12,000 feet in round numbers. It is therefore not only relatively, but absolutely, one of the loftiest volcanoes on the earth, since it may be assumed that the enormous mass consists for the greater part of eruptive and ejected rock from the very level of the sea. The form of the mountain is a regular cone, and during the visit of Ross the centre of eruption was on the summit; although in a state of violent activity the cone was completely covered with snow to about 300 feet from the crater. In January, 1841, the eruptions took place about every half-hour, and on each occasion a cloud of steam and ashes, apparently 150 to 300 feet in diameter, was hurled 1,200 feet to 2,000 feet high into the air. When the cloud had disappeared the reflection of the glowing lava could distinctly be perceived, indeed some of the officers thought they could see streams of lava flowing down till they were lost under the covering of

Volcano of Mt. Erebus and Beaufort Island (after Ross).

snow. Three weeks later the eruptions were more violent, but no lava was seen flowing off.

About twelve miles from the summit of Mount Erebus, its sister mountain, Mount Terror, rises to a height of say 10,000 feet. It was not in a state of eruption, but is also unmistakably a volcano, as could be seen by the remarkable absence of snow on its surface and by its outlines; numerous small parasitic crater cones appeared on the true cone, two especially near the north-eastern foot of the mountain by Cape Crozier stand out very prominently, though this is not apparent in the accompanying reproduction of a sketch taken from the account of his voyages by Ross. Both mountains are the northernmost outposts of a lofty mountain range, the Parry Mountains, extending south to latitude 79° S. and perhaps farther still, as Ross saw their summits rising high above the great ice barrier which joins Mount Terror on the east.

Scarcely any natural feature of the Antarctic world has at any time so stirred the imagination and so roused scientific interest as the discovery of this great ice barrier, *κατ' ἐξοχήν*. It is true that the icy covering of Mount Erebus projects with vertical face several miles into the sea, but this would in no wise astonish the discoverer, as the same phenomenon may be observed everywhere among the glaciers of Victoria Land. The most surprising characteristics of the great ice barrier are its unbroken uniformity, its vast extent, and the entire absence of visible land from its edge. From Cape Crozier, latitude 77° 25′ S., longitude 169° 10′ E., to latitude 78° S. and longitude 169° W., the barrier extended—in January and February, 1841, at least—uniformly, without perceptible indentation, and with very few and slight variations in height. It was highest near Mount Terror, for here, where the mass of ice probably rests on the sea bottom, a height of 180 to 280 feet was observed, while farther east it was, on the whole, nearly 130 to 150 feet. It was only in the last position mentioned that Ross observed the irregularity referred to above in the account of his voyages, with one still more marked to the east of the point he attained. The more broken face of the barrier, as well as the appearance of icebergs covered with detritus, tend to prove that Ross was not mistaken concerning the land seen in latitude 78° 10′ S. and longitude 161° 30′ W., and that it is probable that the great barrier here comes to an end, or at least to the end of its uniform course.

Great ice barrier (after Ross).

It is difficult to gain any more detailed notion of the connection among themselves of isolated portions of Victoria Land, without entering upon over-fantastic speculations. A lofty mountain chain is seen rising steep and abrupt from the sea, extending from north-west to south-east and then on the whole to the south-west, till growing lower, they turn south-east and east in high latitudes with a final curve south. The summits probably consist principally of volcanic matter, like the outlying islands, and the mineral specimens obtained support this conjecture. At the same time it would be absurd to assign a purely volcanic structure to the whole of the extensive country, and non-eruptive minerals brought up from the ocean bed moreover militate against such a theory. The single block of true granite brought up by the dredging net near Coulman Island is sufficient to prove that in the region of Victoria Land also old crystalline rocks must be present, that an early geological formation has to be reckoned with, in which the great outlines of the mountain structures are merely accompanied on the coasts by volcanoes of far later origin. It is worthy of notice that from the only volcano in Victoria Land known to be active, a chain of volcanic islands runs in nearly a direct line northwards—Beaufort Island, Franklin Island, Coulman Island and Possession Island. Hans Reiter, in the work already frequently referred to, gives it as his opinion that the coast of Victoria Land is formed by a contorted range, the continuation of the great Western Pacific curve, of which the last recognisable ranges are those of Stewart Island to the south of New Zealand. He further assumes that the Parry Mountains turn east, and that the contorted island range seen by Ross at the east end of the ice barrier is continued across Graham's Land, thus completing the circle of the Pacific range. Even though it be necessary to guard againt rash or premature conclusions, and though the hypothesis by no means includes the proof, it is nevertheless true that Reiter's conception is worthy of notice, and that it it seems to come near the actual facts. A portion of detritus brought home by Borchgrevingk from Cape Adare proves that the region of Victoria Land has been subject to powerful structural revolutions in its geological past. This specimen, a fragment of granite, showed under the microscope that its crystalline components had been completely pulverised and subsequently cemented by silicious matter, a condition which can be observed in all the heavily compressed crystalline minerals of contorted ranges. It is not to be denied that much may be urged against this view. In the first place, the soundings made of the sea bottom in Ross Sea in no wise bear out the widely accepted coincidence supposed to exist between the greatest depths and the most striking structural features of the contorted coast. So far as is known no really great depth has been found to exist in Ross Sea; the deepest sounding taken by Ross, 2,700 feet without touching the bottom, was in latitude 74° 40′ S. and longitude 166° W., far distant from any known land; in the neighbourhood of land on the contrary the soundings gave much lower, and at the same time extremely variable, measurements. Thus the depth about six miles from Cape Adare was found to be 991 feet, while 135 miles east of Cape Phillips the depth was only 1,082 feet, descending towards the coast to 1,260 feet, no great depth when compared with those off the Cordillera range, Japan, the curve of the Sunda Isles, and other portions of the great contorted system. The greatest depth actually measured descends no farther than 2,450 feet, and this sounding was taken near the edge of the great ice barrier about 105 miles east of Mount Erebus, while the greatest depth measured nearer land was 2,150 feet, between Franklin Island and MacMurdo Bay. Of course it might be urged that the smaller depths may be attributed to the effects of the glacial period in which vast masses of detritus must have been deposited, but if great depths descending thousands of feet had really existed near the coast of Victoria Land, they would certainly never have been so greatly diminished by glacial deposits. All thought of such a possibility must be relinquished, and it must be assumed that the relative shallowness of Ross Sea is due to structural causes. Submarine eruptions may perhaps be responsible for the striking variations, or the lesser depths indicate ridges of glacial deposits as compared with the greater depths. This conclusion, in all probability, applies to a bank near the eastern section of the great ice barrier, where depths of 1,076 to 1,135 feet are found at a distance of thirty to forty-six miles from the barrier. No certain light therefore is thrown on the structure of Victoria Land by the soundings taken, and vague uncertainty must for the present be accepted in this respect, and also in that of its connection with the countries in South America, and with its neighbours, Wilkes Land, and the Balleny Isles, to which we now proceed.

9. THE BALLENY ISLES.

Almost exactly in the same meridian as the westernmost point of Victoria Land, seen by Ross, but nearly 4°, *i.e.*, some 280 miles, farther north, the high volcanic group of the Balleny Isles rises from the deep. As far as is known at present it consists of three larger and two smaller islands, and the middle island of the former, Buckle Island, was in active eruption in two places when Balleny visited them. Accurate measurements, confirmed by Ross also, show that their lofty western extremity is situated in latitude 66° 44′ S. and longitude 163° 11′ E. To the east of it lies Sturge Island, which is also one of the larger ones and is cone-shaped, but does not reach half the height of Young Island, the largest and highest of the group, which contains Mount Freeman, estimated by Balleny at a height of 11,800 to 12,000 feet. Between the two last-named larger islands lies Borrodaile Island, which is smaller and less elevated, and, finally, farthest to the west lies Row Island, which is low and exhibits no special features.

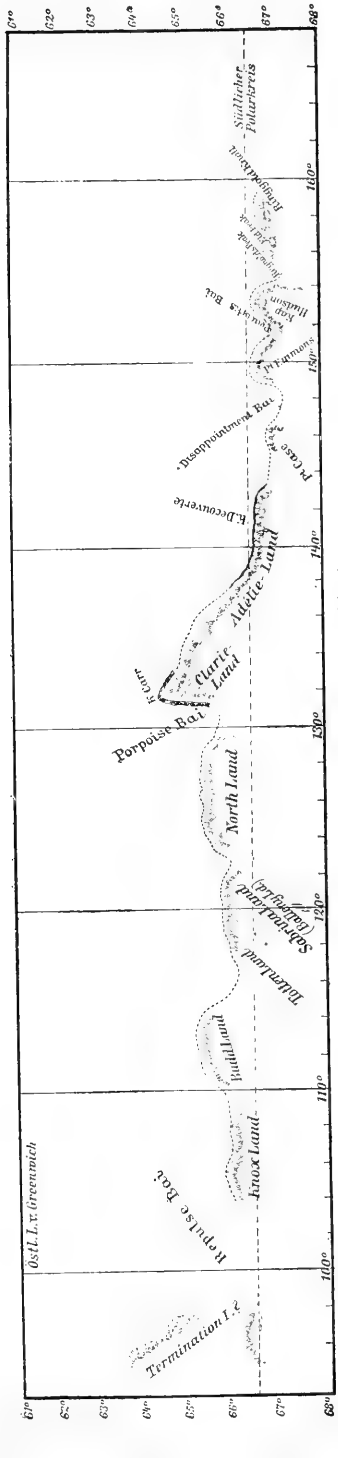
The surface appears completely glaciated, and it is only at the coast that the steep cliffs show the rocky nature of the islands; their petrographic character is shown by the specimens secured by Balleny after having effected a dangerous landing; the rock consists of dense, scoriated, olivine basalt, different from the basalt of the Possession Isles, which contains no olivine. The volcanic character of the islands, together with their inconsiderable distance from the eastern extremity of Wilkes Land, gives them a decisive character in the estimation of the geological structure of these regions; and this becomes still more enhanced by the fact that Ross sighted a second group of islands situated to the south-east of these. In the "History of Discovery" we have pointed out that the three Russell Islands, sighted by Ross, might possibly be identical with the Balleny Isles, and further investigation alone can settle this question. Russell Peak, the highest of these islands, lies, according to Ross's measurements in latitude 67° 28′ S. and longitude 165° 30′ E., which is 1° further S. and 2° further E. than Buckle Island, as measured by Balleny; but as on the one hand Balleny's observations are evidently very accurate, and on the other hand Ross also had seen land due west of the latitude observed by Balleny, it may be inferred that the two groups are not identical. From this assumption would follow the existence of a volcanic range, extending from the south-east to the north-west, and thus repeating the direction of the coast of Victoria Land from

Cape Adare to Cape North. It may further be inferred that in analogy with other volcanic ranges those of the Balleny and Russell Isles indicate a techtonic line of fracture, which being situated farther south and south-west, would constitute the still problematical connecting link between Victoria Land and Wilkes Land. Unfortunately soundings are still wanting which might supply some data for the determination of the submarine south-eastward direction of this hypothetical volcanic ridge; true, Ross has made a few soundings, but these do not lie in the line of the groups of islands ; still they are of interest in so far as they prove the proportionate rapid increase in depth as the distance increases. Thus, at a distance of twenty-eight miles from the northern coast of Victoria Land the depth indicated was only 1,075 feet, whilst at a distance of 125 miles from the same coast the lead failed to touch bottom at a depth of 2,400 feet.

10. WILKES LAND.

The coast of Wilkes Land extends east to west at an almost invariable latitude ; it may be regarded as the longest coast line yet seen in the Antarctic regions, but its unbroken continuity is still a mere hypothesis. In the account we gave of Wilkes' voyage we called attention to the fact that he lost sight of the land for considerable distances, and accordingly it is not impossible that, instead of a continent, Wilkes had sighted a chain of islands. We shall see, however, that the probability of this latter assumption is not greater, but rather less, than that of the theory, that all the separate portions of land sighted are parts of an unbroken whole.

Ringgold's Knoll is the easternmost point of land distinctly seen by Wilkes and his companions. It is



Map of Wilkes Land (after Wilkes).

situated about 67° S. and 158° E.; the westernmost point is Knox's Highland in latitude 66° 30′ S. and longitude 105° 30′ E. "Termination Land," entered on most maps in longitude 95° E., and described by Wilkes himself as an indistinct "appearance" of land, seems, according to the observations of the *Challenger*, to have no real existence. Assuming the coast of Wilkes Land to be continuous, then it would, exclusive of bays and gulfs, have an extent of some 1,750 miles—a long tract. The coast attains its northernmost point at Cape Carr, part of the Clarie coast, situated in round numbers in latitude 65° S. and longitude 132° E. The deepest inlet is "Disappointment Bay," where Wilkes advanced to longitude 147° 30′ E. and latitude 67° 5′ S., without sighting the southern extremity of the bay.

The land sightings from Ringgold's Knoll to the western extremity of Dumont d'Urville's Adélie Land extend, in about latitude 67° S., in a due east and west direction from 158° E. to 137° E.; then the coast projects in a north-west direction as far as Cape Carr, whence it curves almost due south to possibly 65° 45′ S.; next it again pursues a westerly direction to about 66° S., as far the extremity of Knox's Highland. Budd's Highland alone seems, according to Wilkes' account, to project to about latitude 65° S.

Of the general nature of the country we know exceedingly little; since Balleny's visit in 1839, and those of Wilkes and Dumont d'Urville in 1840, not a single ship has approached these regions to confirm and extend the first discoveries. All the knowledge we possess of these regions is based on descriptions of views obtained from greater or less distances, and frequently interrupted by fogs and snowstorms.

Little is known of the eastern extremity of Wilkes Land of the elevations named by Wilkes, Ringgold's Knoll, Eld's Peak, and Reynold's Peak. On the 16th of January, 1840, land was distinctly sighted for the first time. The three vessels, the *Vincennes*, the *Peacock* and the *Porpoise*, lay at no great distance from each other within their several horizons, the *Peacock* being south-east of the *Porpoise*. From the former of these two vessels a chain of mountains was perceived, from which two summits clearly stood out, respectively named Eld's Peak and Reynold's Peak ; between both, several mountain ridges extended in apparently parallel lines, on which other peaks rose whose summits were shrouded in clouds. Ringgold on the *Porpoise* saw only one elevation, which to him appeared to be an island, as it did also to Wilkes on the *Vincennes*. The height of the mountains was estimated by Eld and Reynold at about 1,000 to 2,000 feet, obviously too low an estimate, all the other elevations of Wilkes Land appearing to be considerably higher. It seems to us that the different aspects presented by the land and the low estimates of the elevations may both be due to the fact that the land was situated a good deal further south, and that what the discoverers had perceived was a mountain chain beyond, extending south-east or south-south-east ; from the *Peacock*, lying farther to the south-east, the land presented the appearance of a mountain chain seen from the flank ; the *Porpoise* had more of a front view of it, consequently the whole mass appeared as a single elevation. From the *Vincennes* Wilkes obtained the same view as Ringgold from the *Porpoise ;* he called it "Ringgold's Knoll," erroneously making two sightings of land out of a single one. This view of the matter is, however, to be regarded as a mere hypothetical attempt to clear up a confused account, to be refuted or confirmed by a more accurate survey of the coast. It seems probable that this easternmost sight of land is far more likely to be part of a long connected coast, extending possibly as far as Victoria Land, than a chain of small islands as is assumed in Petermann's otherwise excellent south polar chart, which has been universally copied (*Stieler's Hand Atlas*, No. 7).

The next coast line sighted by Wilkes was in 66° 20′ S. and 154° 30′ E., when he beheld land both in the S.S.E. and in the S.W. The former sighting of land was entered in the English Admiralty chart as Eld's Peak and Reynold's Peak, but according to the above theory in-

Cape Hudson, as seen from U.S.S. *Peacock* on 19th January, 1840 (after Wilkes).

correctly, as these elevations must lie farther east. The cape projecting farther west, approached comparatively near by the *Peacock*, was seen much more distinctly, and was named by Wilkes "Cape Hudson" in honour of the captain of the *Peacock*. Some descriptions of it from various distances may enable us to form some notion of this cape. Like the land previously seen, it consists

Cape Hudson, as seen from U.S.S. *Peacock* on 19th January, 1840 (after Wilkes).

along its whole extent of two parallel chains successively rising like an amphitheatre; they are wholly covered with snow, and attain a height of about 3,000 feet. Since land was also seen in the south, it does not seem improbable that it encircles the deep bay towards the east, and is connected with the elevations seen in the same direction. On the other side Cape Hudson is joined by the broad Peacock Bay, at the back of which land was distinctly seen both to the east and to the west, and its westernmost promontory was named Emmon's Point. Icebergs covered with *débris*, sure harbingers of approaching land, had been observed near this bay by the *Porpoise* before land was actually seen.

View of Adélie Land at Cap de la Découverte (after Dumont d'Urville).

Emmon's Point is succeeded by "Disappointment Bay," bordered in the west by "Case Point". Its southernmost coast, beset by pack-ice, could not be examined, in consequence of which the charts of the coast

Adélie Land (after Dumont d'Urville).

here leave a gap. On the other side of "Case Point" also, no land was seen for a considerable distance in consequence of bad weather, but then we come to a tract of coast of Wilkes Land, *viz.*, Adélie Land, which is the most extensive yet seen, and of which we possess observations and drawings made by Dumont d'Urville, which agree very nearly with those made by Wilkes. The land seems to have a tolerably uniform elevation of 3,000 feet according to Wilkes, or of 3,280 to 3,900 feet according to Dumont d'Urville. Not a single prominent summit rises above these level undulating uplands, whose glaciated declivities descend gradually to the coast, terminating almost everywhere in the familiar, vertical ice barrier ; at one spot only D'Urville saw the bare rock projecting above the icy covering, forming a cape, noticeable more by its colour than by its shape. D'Urville called a certain shallow bay along the coast the "Baie des Ravines"; the

Pointe Géologie (after Dumont d'Urville).

point of the coast first approached by him the "Cap de la Découverte," and another near which it was possible to land, "Pointe Géologie". The illustrations here given are taken from the surveys of D'Urville and of Wilkes. The coast seen here with greater accuracy comprises an extent of 125 to 140 miles, encircled everywhere by an ice barrier. Its monotony forms a perfect contrast to the striking irregularities observed in various places of the snow and ice-clad country. Near the "Cap de la Découverte," which bounds Wilkes' Piners Bay in the east, extensive clefts were observed, and perhaps also gullies filled with water from melted ice ; elsewhere the snow presented an appearance as though it had been furrowed by a plough, and in open unprotected places it lay in ridges like the sand in a wind-lashed desert. It is highly probable that D'Urville saw real snow-dunes, similar to the mighty snow-drifts distinctly observed on the higher levels of the country. The greatest disturbances were noticed on the inland ice at the back of the " Baie des Ravines," where it was so traversed by intersecting systems of clefts that the country appeared to be strewn with isolated gigantic ice-blocks. Characteristically enough the very iceberg bore traces of these convulsions ; their sides were per-

Coast Island at Pointe Géologie (after Dumont d'Urville).

pendicular as usual, but their surfaces were a chaos of ice fragments. In the neighbourhood of " Pointe Géologie " a chain of rocky islets lies fronting the coast, and on one of them D'Urville effected a landing, in consequence of which we possess some geological knowledge of at least this one spot. It is highly interesting to learn that here also crystalline slate was found—gneiss or amphibolite, or probably both ; the summit of the islet visited was broken up into blocks. Of vegetation nothing was seen on this the only spot of Wilkes Land visited by man. The portions of these cliffs nearest to the land or ice barrier were only about two to three furlongs off from these latter, and from them could be clearly seen some summits near the coast free from ice, but all the rest were fully glaciated. This ice barrier is, however, less high than that of Victoria Land; its mean altitude being only 100 to 140 feet, and the icebergs also attain corresponding heights. Farther

Adélie Land, as seen from U.S.S *Vincennes* on 30th January, 1840 (after Wilkes).

west, on the other hand, in longitude 137° E., Wilkes found heights of 150 to 200 feet.

The continuation of Adélie Land towards the north-west was not seen by D'Urville, as he steered too far north, but Wilkes kept it constantly in view, and saw its outlines distinctly beyond the mass of inland ice of the Clarie coast, which projects far to the north. But it seems to be here somewhat lower than it is farther east, or else it is a somewhat larger island in front of the coast, or even a

Adélie Land, as seen from U.S.S *Vincennes* on 1st February, 1840 (after Wilkes).

peninsula wholly glaciated like the rest. This is to be inferred from the circumstance that the *Porpoise* had sailed from the east into a long and rather narrow bay, whose coasts south, west and north are beset by vertical walls of ice. The theory that a gigantic mass of ice had got detached there and drifted north is not tenable—the Clarie coast, that is to say, the northern flank of the supposed peninsula, having been seen by Balleny in the same position a year before D'Urville and Wilkes. Ringgold estimates the height of the ice walls in the interior of the bay to be about 150 feet, whilst D'Urville states it to be in the north 100 to 150 feet, and also notices that the outlines follow a somewhat irregular course. The western coast of the country, which stretches, as has already been pointed out, far to the south, seems not to be different in character from the rest.

The next piece of land that was seen was "North's Highland," separated from the rest by "Porpoise Bay," and also surrounded by a lofty ice barrier, exhibiting, when Wilkes visited it, a very irregular course towards the west. In the same direction the land gradually passes into

View of the coast of Clarie from a distance of six nautical miles (after Dumont d'Urville).

"Sabrina Land," first discovered by Balleny, and designated in its western part by Wilkes as "Totten's Highland". Here is, once more, a large gap on our maps, due to the prevalence of fog and snowstorms, which caused Wilkes to lose sight of both land and ice barrier. On the other hand there is farther to the north "Budd's Highland," a lofty mountain chain, which exhibits a greatly varied configuration, notwithstanding its being wholly enveloped in snow. Here the coast seems to recede somewhat to the south, but soon afterwards it resumes its east to west direction. Wilkes named this section "Knox's Highland". This coast, sighted in 66° S. and 106° 19′ E., probably extends for a distance of ninety miles; the elevations attain, like the others of Wilkes Land, a height of 10,000 to 11,000 feet; they ascend gently to rounded summits, whose ice covering terminates in the usual ice barrier. Ringgold, who describes the elevations of that district as lofty cones, probably fell a victim to the familiar optical delusion of over-estimating the angle of inclination.

Over the whole tract from Cape Carr to Knox's Highland both Wilkes and Ringgold fell in with numerous icebergs, thickly covered with *débris*, which are such sure indications of neighbouring land, that its proximity would be regarded as highly probable, even if it had not been actually seen by both of them as well as by Balleny. Near the last sighting of land Ringgold specially noticed that the ice barrier, as well as the icebergs originating from it, appear quite dark in consequence of the heavy masses of *débris* they held in clearly distinguishable strata. The rocks of this ice-bound conglomerate consisted of red sandstone, granite (perhaps gneiss), red clay and dark mud, as well as sand in great masses. Wilkes mentions basalt; this would be highly interesting, but unfortunately the conformation of the coast, added to the fact, that Wilkes frequently mistook dark rocks for basalt, lead to the suspicion that an error has crept in, and that crystalline slate, or perhaps amphibolite, has been erroneously designated as basalt.

Débris-covered icebergs were seen not merely in the neighbourhood of the land actually sighted, but Wilkes as well as Ringgold have encountered them farther west; Wilkes, indeed, as far as 100° E., which is at no great distance from the spot where in longitude 97° 37′ E. and latitute 64° 1′ S. he believed he had seen the last indication of land called "Termination Land". It has been mentioned above that in 1874 the *Challenger* made a near approach to this spot from the west without noticing any trace of land, whence it may be inferred that Wilkes' supposed sight of land was after all deceptive in spite of the very numerous icebergs he saw, and which led him to believe in the nearness of land. The map certainly does not support Wilkes' testimony, he having himself falsely indicated the existence of land west of the position above described, whilst at the same time he mentions the south-west as the direction in which it was seen, and adds that it seemed to extend to the north. It is, however, not absolutely impossible that "Termination Land" may have been raised by strong refraction high above the horizon, and that it may consequently still exist, but farther south. It is possible that the coast of Wilkes Land, in its conjectured extent, trends to the south and thus forms a west coast, whence the icebergs drift towards the north, and meeting those of the north coast, forming the gigantic accumulation of bergs which blocked Wilkes' progress to the east and that of Nares to the west.

If we take a general survey of Wilkes Land we may be justified in assuming that it consists of a tolerably old mass built up of crystalline slate and sediments, the edge of which follows a due east and west direction, is entirely glaciated, and shows mere moderate elevations. The sub-marine base of the land obviously descends to the sea bottom more steeply than in Victoria Land, in spite of the slight elevations of the country; this is proved by the soundings, albeit few in number, which have here been made. For example, about sixty-five miles north of the supposed position of Ringgold's Knoll or Eld's Peak a depth of 5,105 feet was sounded; in Peacock Bay, about seventeen to twenty miles from the coast, a depth of 4,816 feet was sounded, but a little to the north of it the lead indicated a depth of only 1,923 feet. All other soundings failed to reach the bottom at depths varying from 900 to 1,825 feet. In Piner's Bay, near Pointe Géologie, Wilkes found a rocky bottom at a depth of only 180 feet. The remarkable proximity of a comparatively great depth near the land in Peacock Bay, which does not amount to nearly the half at a greater distance, calls to mind the state of things in Ross Sea near the great ice barrier. From those two soundings it might be inferred that Peacock Bay was shut off in the north by a rise in the sea bottom, whose proximate cause might be the accumulation of glacial *débris;* but it is questionable whether such an enormous terminal moraine may readily be ascribed to such an accumulation.

The position of Wilkes Land, as compared with Victoria Land, is supremely interesting, especially as these two most extensive of all the known coasts of the Antarctic regions exhibit, in consequence of the existence of volcanoes, distinctly different characters, both techtonic, geological and orographic. It will be specially incumbent on future discoverers to fill up the gap in the coast line between Wilkes Land and Victoria Land; indeed an accurate survey of Wilkes Land alone would be of great value in order finally either to justify or remove the doubts entertained about the credibility of Wilkes' communications. It must be admitted that for passing the winter in ships this coast would be hardly more suitable than that of Victoria Land, and for an overland journey to the magnetic pole, such as stands on the programme of future explorers, the coast of Wilkes Land is probably at too great a distance. This theory is based on the supposition, which certainly is not yet proved, that Victoria Land as well as Wilkes Land are not proportionately narrow islands or chains of islands, but the termination of extensive, possibly connected, lands at their rear; in fact this question is intimately connected with the problem of an Antarctic continent, which can be definitively solved only by future explorations. At a subsequent stage we shall show that the prevailing winds, atmospheric pressure, the distribution of the ice, combined with what is known of the geological structure of the Antarctic lands, all tend to support a high probability of the existence of an extensive South Polar Continent, or at least of masses of land connected by ice formations.

11. ENDERBY LAND AND THE NEIGHBOURING DISTRICTS.

The last of the three larger groups of land that have been actually sighted, or were conjectured to exist, are those hastily seen by Kemp, comprising the extensive coast of Enderby Land, besides the frequent views of an ice wall to the west of it, and some indistinct indications of other land ; all these are least known, notwithstanding the fact that they are situated within the region visited by Cook on his first voyage of discovery to the far south. The easternmost point seen, *viz.*, Kemp Land, is situated in latitude 66° 30′ S., almost on the same parallel as the westernmost point of Wilkes Land, the existence of which has been clearly demonstrated in longitude 69° W. The distance intervening between the two districts amounts to forty-four meridians = 1,150 to 1,250 miles.

The *Challenger* penetrated into the centre of this intermediate region, and even beyond it, and it is due to its investigations that the veil has been partially lifted from over this vast tract. Land it is true, was not actually seen, but the soundings that were taken, and the specimens of rock and other substances brought to the surface have thrown some light on this region. The *Challenger* took soundings at three places in the regions of drift ice south of latitude 64° S., *viz.* :—

At 64° 18′ S. and 94° 47′ E. the soundings reached a depth of 7,805 feet.

At 64° 37′ S. and 85° 49′ E. the soundings reached a depth of 10,807 feet.

At 65° 42′ S. and 79° 49′ E. the soundings reached a depth of 10,056 feet.

The substances raised from the sea bottom were mostly blue mud, of which we now know that it is invariably of continental origin; also to a preponderating extent rock-masses, exhibiting distinct traces of glacial action; these were granite, quartz-diorite, diorite-slate (scale-stone), amphibolite, mica-slate, granulous-quarzite, sandstone, small fragments of compact limestone and of decomposed clay-slate, in a word, only such rocks as are produced exclusively by continents or their fragments. Eruptive rocks, or to speak more accurately, eruptive rocks of late origin, have been nowhere met with in high latitudes, but occurred in considerable quantities farther north in the neighbourhood of the Heard Isles, which are volcanic. Every one will agree that Murray is right in the inference he draws from these evidences—that there must be land near 80° E.; for these rock-fragments necessarily are derived from land, and can have reached their subsequent resting place only by being transported by ice. How far off this land may be from the positions reached, whether 120 or 250 miles, or more or less, is, according to Murray, a matter of secondary importance; the main thing being the certainty of its existence, which is proved, not only by the specimens brought up from the bottom of the sea, but is also made probable by the great number of quite new icebergs which the *Challenger* encountered in the higher latitudes between Wilkes Land and Enderby Land.

The first undisputed sight of land in the district of Enderby Land is called Kemp Land—after Kemp, its discoverer. He saw in latitude 66° 25′ S. and 59° E. a perfectly inaccessible coast—and that is the sum total of our knowledge of his discovery. The chart of the British Admiralty, No. 1,240, lays down his whole course, and thus gives the most exact account of this voyage. According to it, this probably conjectural coast line is situated in latitude 66° 35′ S.; it extends from 60° to 58° 30′ E., and is thus about forty miles long.

The *Challenger* in the Ice (after an unpublished water-colour).

[*Face page* 224.

We are somewhat better informed about Enderby Land itself, although it was seen nowhere from a less distance than twenty-five to forty miles; hence it comes that the map we possess is so little reliable and varies in many points from Biscoe's notes. According to this latter the eastern extremity of the land seen would be transferred to 61° E., and scarcely farther north than latitude 66° 25′ S; at least Biscoe's map does not show any position that is more advanced, and the one in question is occupied by a considerable elevation. Farther west is situated, according to Biscoe's observations, a distinctly projecting headland called Cape Anne. From here the land stretches more or less distinctly visible from a great distance as far as longitude 43° 54′ E., where Biscoe came near and himself distinctly saw a perpendicular wall of ice 100 to 110 feet high, a most reliable indication of land. Only a little to the west of it Cook had seen an uniform and level mass of ice extending along the horizon, which, according to his imperfect measurement, he estimated to be 15 to 20 feet high. All the experience so far gained in the Antarctic regions is against the assumption that it was pack-ice or field-ice, for such a thickness of it has nowhere been seen in the frozen seas of the south, and least of all in the open storm-lashed waters at such comparatively low latitudes; it seems safe then to assume that both the ice seen by Cook and that west of Alexander Land was a real ice wall, whose distance and height he may possibly have under-estimated.

This is the extreme point from which the existence of land may be assumed with any degree of certainty, but it is conjectured that it extends thence at ever higher latitudes as far as the zero-meridian. Thus Biscoe believed that he saw land repeatedly about latitude 69° S., and he was confirmed in this belief by observing numerous animals, of whom we know from experience that they keep at no great distance from the land; this seems to have occurred in longitude 31° to 25° E. Similarly Bellingshausen came in latitude 60° to 69° 16′ S. and longitude 16° 30′ to 18° 30′ E. upon fields of floating and of fixed ice, which extended east to west to seemingly endless distances, and this so-called fixed ice may well be regarded as an ice barrier. Near that spot, in latitude 69° 25′ S. and longitude 13° E., Biscoe seems to have sighted something like land, independent of sea birds, who were observed to direct their flight to the south-west. In latitude 69° 22′ S. and longitude 2° 15′ W. he came upon "a dense wall of ice," of which unfortunately we have no detailed account, so that it is impossible to determine whether it is a mass of pack-ice or a genuine ice barrier. About the regions farther west we are still without information about land being sighted distinctly or even indistinctly; but that it must exist at least in higher latitudes is proved by the numerous icebergs met by both Weddell and Ross in their advance southwards between 0° W. and Graham's Land. In latitude 66° 24′ S. and longitude 32° 33′ W. Weddell saw a large iceberg, thickly covered with *débris*, and farther south icebergs were very numerous about the middle of February, and even in latitude 74° 15′ S. he still saw four of the bergs; Ross saw them in great numbers in latitude 70° to 71° 30′ S. and about longitude 15° W.

This exhausts the enumeration of all the land known or conjectured to exist. Of its nature nothing is known beyond the fact that Biscoe describes it as mountainous and covered with snow. No specimens of rock have been obtained from either the sea bottom, or from the matter brought down by icebergs, by which conjectures about the geology of the country might have been possible, and not even soundings have been made in its neighbourhood. Those made by Ross in latitude 68° 34′ S. and longitude 12° 49′ W. are at a great distance from Enderby Land, and no bottom was reached at a depth of about 24,000 feet. If no error has occurred in this measurement then it is the greatest known depth south of latitude 30° S.; it has been distrusted and not entered on any sea charts; Murray, however, strenuously insists on its reliability. Future explorations will show whether Biscoe and Bellingshausen have really seen land, and if it be so, whether it was a continuous coast, as at Enderby Land and Kemp Land, or a succession of separate islands. Then we shall also know whether or not an uninterrupted continental coast extends beyond Enderby Land to the south-west and is joined in high latitudes to the east coast of Graham's Land. There is as little to be said against this theory as for it, or perhaps even less, as will be shown in the next chapter, when the directions of the prevailing winds are discussed.

IV. CLIMATE.

That the Antarctic regions have, till now, remained the least known on the face of the earth is due solely to their inhospitable climate, which precludes the possibility of any human settlements, and compared with which the most northern Arctic regions known to us may be considered as delightful habitations. At first sight it is simply surprising to notice such an enormous difference in the climates of the two Polar regions ; but on considering their external conditions, we speedily arrive at the conclusion that this difference is no more a fortuitous accident than any other phenomenon in nature, but on the contrary is deeply rooted in general circumstances which are still only partially understood.

It is well known that solar heat is the primary source of all climatic phenomena, and the mere mathematical aspect of its distribution shows that the southern hemisphere is placed at a disadvantage when compared with the northern hemisphere. The fact that at about the time of our winter solstice the earth is in her perihelion, where her angular orbital motion is greatest, brings it about that the sun shines only 179 days in the year vertically over places in the southern hemisphere, but 186 days over regions in our northern hemisphere. The southern summer is probably somewhat hotter than the northern summer, in consequence of the greater nearness of the sun ; but, on the other hand, the southern winter is longer, and, because of the greater distance of the sun, colder than the northern winter.

Although the amount of solar heat poured out over the two hemispheres in the course of the year may be absolutely equal, yet *a priori* the climate of the southern hemisphere must theoretically be more extreme than that of the northern hemisphere. It is true that in permanently-inhabited countries of the southern hemisphere, and in latitudes that have been visited at all seasons of the year, less fluctuation in temperature has been observed than in corresponding places of the northern hemisphere; but the cause of this deviation from normal conditions must be looked for in the unequal distribution of land and water, in the huge preponderance of the oceanic over continental areas, and in the existence of the gigantic southern ocean, with its three broad bays penetrating northward deep into the land. The Antarctic region is situated precisely like an island in the middle of this boundless ocean, nowhere approaching any known continent to within 600 miles; and it is thus deprived of the climatic influences of vast continental regions, while, on the contrary, subject to the unmitigated oceanic climate of our globe. The character of an oceanic climate is well known; it is equable, and by diminishing the fluctations in temperature it reduces the summer heat and the winter cold, and produces great precipitation of moisture. This would lead us to expect that the climate of the Antarctic masses of land, or of the problematical south polar continent, must be wholly dominated by the climate of the great southern ocean, and must share its peculiarities. This, however, is counteracted by the peculiar positions of south polar lands. If we imagine all the lands of those regions, as far as they are known to us, united into a single mass, then the coasts would, in accordance with our present knowledge, have an equatorial direction. But in that case the ocean would immediately be deprived of a large part of its influence, because for any given degree of latitude the supply of solar heat is a constant quantity, whilst the radiation of heat into the atmosphere and the aërial currents and climatic influences caused thereby depend on the local distribution of land and water. Accordingly, an interchange of air, such as, for example, takes place between western Europe and the Atlantic, effecting so considerable a rise in the mean annual temperature of north-western Europe, could not possibly take place there. This is clearly exhibited by the charts of the distribution of temperatures and of atmospheric pressure. The isothermal lines and the isobars show but few and slight curves, and instead we observe a pronounced parallelism between both kinds of climatic curves, which, although mainly conjectural, are probably enough in accordance with actual facts. The climate of Antarctic regions proper can consequently either not be inferred at all, or only to a slight extent from that of the surrounding ocean, but it must be based on the thermic condition of the country itself, on the prevailing winds, and finally on the general circulation of the atmosphere over the globe.

The prime and weightiest factor of the south polar climate is the geographical position of those regions. As has just been observed, it is purely oceanic, but this characteristic is not fully distinctive, as it is shared by every island, and even among the continents, primarily by Australia, then by South America, and at bottom by all the continents of the world. But that which distinguishes the Antarctic regions from all other insular masses of land, and the effect of which has already been faintly indicated, is its *circumpolar oceanic position.* This alone prevents the existence of any essential contrast in temperature between the several meridians, which leads to convection-currents of the air, and of the waters that depend on them; it alone conduces to the almost symmetrical distribution of atmospheric heat and pressure which is graphically exhibited by the uniform zones of the isothermal and isobaric lines. If then, in consequence of the situation and conformation of the Antarctic masses of land, no great thermal difference, due to latitude, is to be expected, then the annual difference in temperature must inevitably be all the greater, for, barring a few slight exceptions, all the land masses of the south polar regions lie within the Antarctic circle, and are consequently subject every year to a difference in the length of the day of from 0 to 24 hours on the periphery, and to between 179 × 24 hours' day and 186 × 24 hours' night at the Pole itself. But the supply of heat from the sun depends partly on the inclination of the solar rays, and partly on the duration of daylight, whence it follows that the Antarctic regions must have, in comparison with the ocean to the north of it, an excessive climate independent of its probable continental character. In the winter season, which coincides for the central parts with the long polar night, a supply of heat is wholly excluded, and we are forced to assume a very low degree of temperature, at least for the land. In summer the whole region, and especially the Pole, receives continuously a more abundant supply of heat from the sun, which is all the more intense as the sun is in perigee; but as, according to our present knowledge, those regions are covered by a constant mantle of snow, the summer heat is mainly consumed in melting snow and cannot contribute greatly to a rise of temperature, so that even in summer the air of the ocean must in general be warmer than that of the land, and the sea-breezes can exercise no great influence on the climate of the land.

Our knowledge finally of the relative position of the south polar regions with respect to the universal circulation of the air on the globe and the influence this has on its climate, is as yet purely hypothetical. Hann[1]

[1] An eminent Austrian astronomer and geographer.—The translator.

describes it in the latest edition of his *Allgemeine Erdkunde* somewhat as follows: "The north-west return trade-wind of the southern hemisphere flows in the upper strata of the air from the Equator to the Pole, and according to theory it ought to blow due west to east between the latitudes of 60° and 70° S. To replace the air sucked away from the Equator, air currents ought to be observed on the surface of the earth; these starting from high southern latitudes as west-south-west winds, should in consequence of the earth's rotation gradually assume a south-west and a south direction till at last they became the south-east trade-wind. But instead of this we find on the vast oceanic surfaces of the southern hemisphere, between latitudes 40° and 60° S., very violent and constant west winds, the "Roaring Forties" of English mariners. These owe their existence to the all but total absence of extensive tracts of land, which would create over large expanses of surface, in the southern summer, local minima, and in the southern winter local maxima of atmospheric pressure, and would thereby essentially alter the distribution of the winds. We find, on the contrary, in the southern summer, and still more in the southern winter, a strongly-marked zone of high atmospheric pressure, extending from 40° to 20° S., or even to the Equator; the winds which radiate from the latter towards the south assume an easterly direction in consequence of the rotation of the earth, and circle round a zone of low atmospheric pressure which lies round the South Pole from the fortieth parallel, its maximum of depression coinciding possibly with the Antarctic circle. As the winds must in general tend towards this minimum of depression and towards its cyclones which pursue a west to east direction, any influence exercised by the constant west wind on the south polar lands must be largely reduced, these regions being situated mostly to the south of this belt of minimum of depression. If no extensive south polar lands existed, the west winds would probably whirl round the South Pole and actually reach it, and the south polar zone would then form a large continuous region of low barometric pressure."

Having stated this general theory, we will now turn to the actual facts, or rather to the few isolated and scattered observations, which have been made on the climate and meteorology of the south polar regions. On one point it is indispensably necessary to be perfectly clear, *viz.:* that it is premature to give a truly satisfactory description of the climate of the south polar regions. Modern science requires as basis of such a description a series of careful observations of all the meteorological phenomena extending over a period of thirty-five years, as these alone supply mean values, which are fully reliable. Great, enormously great, is the difference between this ideal and our actual knowledge of the south polar regions. We possess isolated notices scattered over a period of more than a hundred years, or else series of observations of short duration, almost each of which refers to a different locality, but not a single series made on the same spot. The observations at our disposal have been made during circumnavigations of the Pole, or else on rapid advances south, none of which comprised a period of more than a few months. And finally, all have been made during the southern summer, whilst we know absolutely nothing of the long polar winter of the far south, there being no record, at least none of any scientific value, of a winter having been passed there. It follows that our description of the south polar regions can be no more than a circumspect groping in the dark, and a scheduling of the few numerical observations from which further inferences may cautiously be drawn.

The state of the temperature, being the most fundamental element constituting climate, claims our first attention; but unfortunately our knowledge of it is more incomplete than even that of wind and atmospheric pressure. Nevertheless what we know establishes the surprisingly low summer temperatures, which are beyond anything recorded of the Arctic regions. Floeberg Beach, for example, situated in latitude 82° 27′ N. on the edge of a group of islands, and possibly near an extensive polar sea, shows in the warmest month a mean temperature of 38·3° F. The mean summer temperature of the south polar regions is exhibited by the following tables, which are based on the observations so far made; and it must be borne in mind that the temperature of the sea is considerably higher than that of the neighbouring ice-clad lands.[1]

1. Region of Victoria Land (Ross):—

Latitude.	Air.	Sea.
60° to 65° S.	30·38° F.	29·48° F.
65° to 70° S.	29·66° F.	28·76° F.
70° to 74° S.	28·22° F.	28·04° F.
74° to 78° S.	24·98° F.	29·12° F.

2. Region between longitude 77° and 99° E. (*Challenger*):—

60° to 66·30° S.	30·92° F.	32·54° F.

3. Region between longitude 6° and 58° W. (Ross):—

60° to 65° S.	30·92° F.	31·28° F.
65° to 71° S.	29·48° F.	30·74° F.

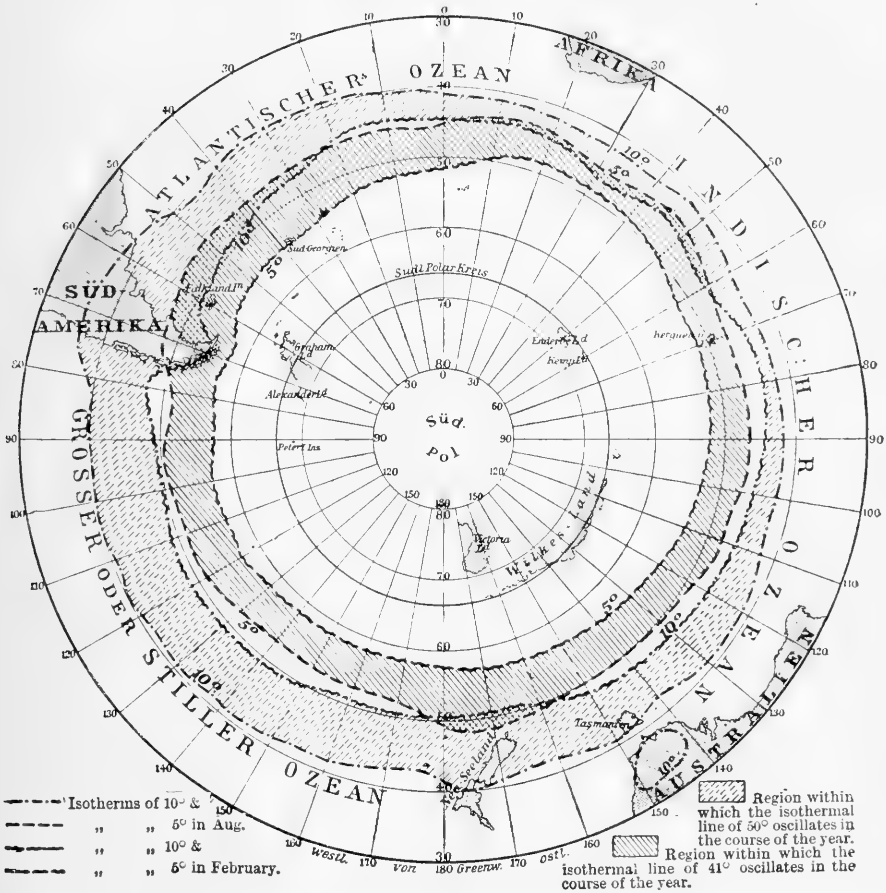
The extremes of temperature observed by Ross in the region of Victoria Land were:—

Maxima: On 31st December, 1841, in latitude 66° 29′ S., longitude 156°29′ E., 43·52° F.
On 11th January, 1841, in latitude 71° 15′ S., longitude 171°15′ E., 40·46° F.

Minima: On 3rd March, 1841, in latitude 67° 45′ S., longitude 167°1′ E., 11·66° F.
On 5th February, 1841, in latitude 77° 11′ S., longitude 157°52′ W., 12·92° F.

[1] From Fricker's *Antarctic Drift-ice*, p. 89 and *seq.*

Wilkes found that the mean temperature for January and February on the coast of Wilkes Land was 30·2° F., and the extremes were 34·52° F. and 23° F. East of Graham's Land, Ross observed south of latitude 64°



Map of the distribution of temperature (after Neumayer—by Haardt).

S. on the 6th of February, 1843, in latitude 64° 12′ S. and longitude 56° 49′ W., a maximum of 44·96° F., but on the 15th of January, 1843, in latitude 64° 32′ S. and longitude 56° 53′ W., a minimum temperature of 23·54° F., that is to say, at a time of year which corresponds to the month of July, at the height of our summer. These numbers are confirmed, at least for the latter region, by the observations made by Bruce on board of the *Balæna* between latitudes 61° and 64° 40′ S. On the 15th of January, 1893, he noted a maximum of 37·22° F. in about latitude 64° S., and on the 17th of February, 1893, in about latitude 62° S., a minimum of 20·84° F. The mean temperature of the second half of December and of the month of January was 31·1° F., and of the first half of February it was 30·56° F., both between the above-named latitudes, which correspond to southern Greenland, where on the narrow strip of coast between the sea and the inland ice, bushes of willows and alders, more than six feet high, are met with along the river banks, and where at Godthaab the mean July temperature is 43·52° F.

The supposition that these unexpectedly low summer temperatures would be accompanied by relatively mild winters may possibly be disproved by future observations, or at best prove to hold good only for the South Shetland and South Orkney Islands, which are at a considerable distance north of the Antarctic circle, and naturally also for all those islands whose latitude is even lower than 60° S. The minimum thermometer left behind by Foster on Deception Island, and discovered in 1842 by Smiley, indicated a minimum temperature of—4° F. Considering the protected position, and the volcanic nature of the insular bay, this record may not supply a standard, nevertheless it is interesting. On the other hand the observations made at the German station in South Georgia in Moltke Haven show a mean annual temperature of 37·52° F.; February was the warmest month, and showed a mean temperature of 41·54° F.; the coldest month was June, with a mean temperature of 26·78° F. On the hottest day, the 11th of February, the thermometer stood at 64·04° F., on the coldest day, the 23rd of July, it stood at 19·86° F

If at the comparatively low latitude of 54° S., in a climate that is purely oceanic, albeit greatly modified by the ice covering of the island, such low winter temperatures are recorded, it is obvious that much lower readings of the thermometer must prevail in the winters of the Antarctic regions proper, *i.e.*, south of the Antarctic circle. In the winter half-year, when no heat comes in at all, radiation from this country, wholly covered as it is with ice and snow, must produce an intense cold of the air resting over the country, and in connection therewith a barometric maximum at least as high as that of eastern Siberia. The winds originating there must contribute their share to the formation both of the more or less complete ice coating covering the bays that penetrate deeply into the land, and of the narrow belt of sea ice along the northern coast. Although the very powerful breakers of the southern ocean may, in numerous places, reduce the ice covering to fragments, yet even such a partially-closed ice covering will prevent the sea from effectually warming the air resting over the land. Thus it happens that the ice mantle has the same climatic effect as land has, and contributes to the increase in space of the thermometric minimum and barometric maximum.

The causes of the extraordinary low summer temperatures even of the sea are naturally, like all the climatic phenomena of the south polar regions, still hidden from us; judging by the scanty observations so far made, three causes might be suggested. Firstly, the complete glaciation of Antarctic lands, which must reduce by air currents the temperature of the surface of the sea and of the atmosphere resting over it; secondly, the enormous ice masses formed in the sea itself, in the shape of sheets, blocks, or most numerous and gigantic icebergs; thirdly, the heavy clouds hovering over the Antarctic waters which often, if not always, absorb the heat of the sun just in summer. During all his three voyages Ross has within

60° S. noted only one single day when seven-eighths of the sky was cloudless; at other times dense masses of clouds commonly filled the upper strata of the air, whilst impenetrable mist and fog lay over the sea, and fully shrouded the ice masses to the great danger of navigation. Reasoning from analogy of the Arctic regions, one is led to assume that the cloud covering is largely reduced in the winter months, so that the heavy clouds of summer obstruct the admission of the sun's rays, and the clearer sky in winter favours excessive radiation, both circumstances thus combining to reduce the temperature.

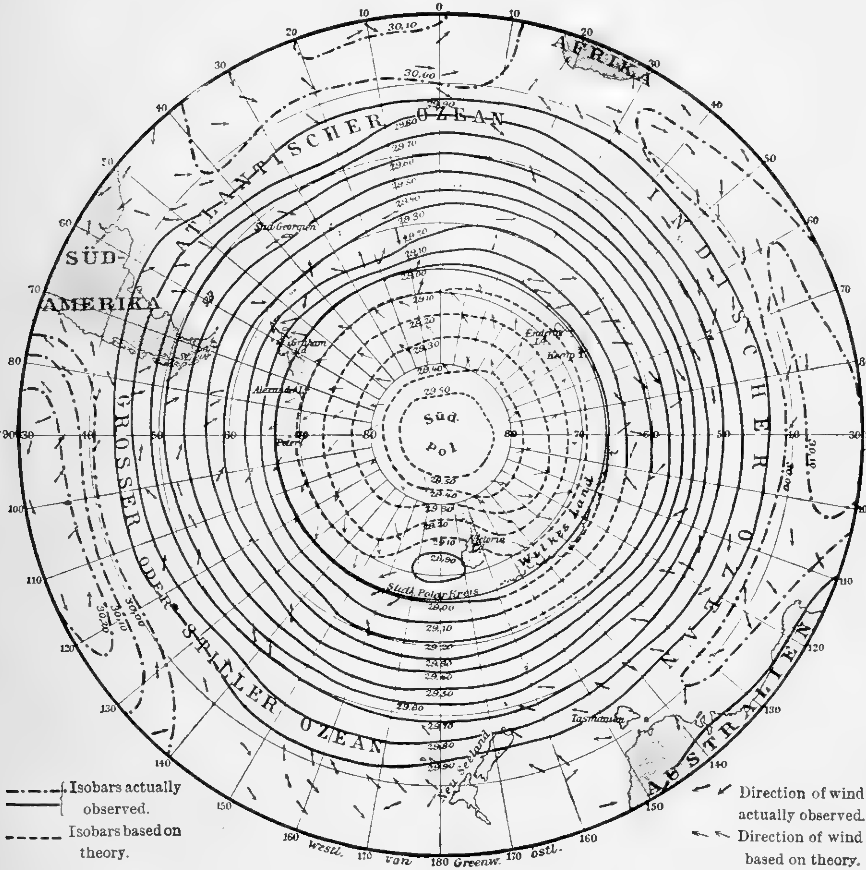
The distribution of *Atmospheric Pressure* presents phenomena as extreme as that of temperature. Assuming the existence of a water surface right to the Pole, atmospheric pressure ought, according to Hann's theory, to diminish as the latitude increases. As a matter of fact the Antarctic regions seem to exhibit permanent depressions of the barometer, such as occur elsewhere only in the centre of progressive cyclones. On the basis of the observations made by Ross, Hann has calculated the mean barometric values of the southern summer in Ross Sea for the years 1840-41 and 1841-42 as follows:—

Latitude S.	60°-67°	65°-71°	70°-75°	75°-78°.
Pressure in Inches	29·122	29·031	28·898	28·968.

According to the observations of Wilkes (who reduced his values to latitude 45°[1]), the mean values for January and February, 1840, for the coast of Wilkes Land (*i.e.*, for about the Antarctic circle) amount to 28·846 inches, consequently to considerably less than even the values recorded by Ross. This is probably due to the fact that along the northern coast of Wilkes Land a main track of cyclones seems to lie. Observations made east of Graham's Land show a somewhat higher pressure.

[1] We are not informed if Wilkes' barometric measures have been corrected according to temperature.

A mean atmospheric pressure of 29·264 inches (reduced to 32° F. and 45° latitude) for the latitudes between 61° and 64° 30′ S., and for the time intervening between the middle of December, 1892, and the middle of February, 1893, may be deduced from the values recorded by Bruce.



Map of the distribution of atmospheric pressure (in inches) and of the winds (after Murray—v. Haardt).

The observations of Ross for the same latitudes, but restricted to the space between 57° 30′ S. and 12° W., indicate the similarly corrected value of 29·193 inches, but for latitudes 65° to 71 S., and between 17° and 7° W., only 28·949 inches.

The observations of Ross show that in the highest latitudes of Ross Sea the atmospheric pressure increases somewhat towards the south, and, to judge by the direction of the *Winds*, the same, no doubt, holds for the masses of Antarctic lands, although we know as little of their barometric as we know of their thermometric phenomena. Nearly all the reports of Antarctic discoverers agree that in the higher latitudes, *i.e.*, in those regions where an advance farther south was no longer possible, the prevailing winds came from the southern or south-eastern quarter of the sky. The districts of the Dirk Gerritz Archipelago and of the northern group of islands seem to be an exception to this rule, as they are under the influence of the permanent west winds owing to the small areas of the land masses; on the other hand the not infrequent south-west winds, which Ross observed on the east coast of Victoria Land, are easily explained by the western position of the country. We are compelled then to assume that over the Antarctic land itself barometric high pressure constantly prevails, corresponding to the unbroken low temperature, and from this region radiate those southern winds, which owing to the axial motion of the earth are diverted to the left and become south-east winds.

How to harmonise the circumpolar anticyclone deduced from these observations with the cyclone demanded by theory, is a question still involved in obscurity, and the solution of this problem must be left to future discoverers, who may possibly pass the winter in those inhospitable regions. The cause of the high pressure is probably due to the powerful radiation of the land and to the consequent chilling of the atmosphere, at least at low elevations. To observe the direction of the winds in the upper strata of the atmosphere, it may prove advisable to send up trial balloons, and to study the cirrhus clouds, and possibly also the clouds of ashes from volcanoes. It is easy to imagine circumstances when reliable conclusions may be drawn from these indications concerning the direction of the winds in the several superimposed strata of air. As the area of the centre of cold over the ice-clad sea may be expected to be enlarged during the winter, it may follow that the anticyclone may also extend radially over the surface of the sea. This conjecture receives support from the fact that in Drake Strait frequent east and south-east winds have been observed in the southern winter, which are almost entirely absent in the southern summer. And finally it is just this general distribution of south and south-east winds which lends support to the assumption that the south polar regions consist principally of masses of land, as these alone are able to give birth to constant anticyclones.

Finally the last of the climatic elements, PRECIPITATION, seems to present great peculiarities, which it would be specially interesting to observe in the summer months. Arguing from analogy with the Arctic regions we infer that in the Antarctic when the whole ice-clad surface, land as well as water, consists of a uniform heat-radiating area, a dryness of the atmosphere must prevail such as accompanies every anticyclone, and this must be extreme here, in consequence of the very low state of the thermometer. This dryness, however, finds expression in the *absolute* moisture of the air; whilst, on the contrary, the *relative* moisture would have to be very high. Over the inland ice of Greenland, Nansen found a relative moisture averaging 94 per cent., but an absolute moisture of only 2 mm. (= ·008 inch) of vapour-tension, and a similar condition may assuredly be assumed to exist in the Antarctic regions. The very scanty absolute moisture is due to the exceedingly low temperature, the large relative moisture to the surface of the ground being covered with snow, which even at low temperature dries up and forms water-vapour. Thus the cold ground alternately deprives the air of its moisture by condensation, and returns it again by evaporation. The rents and gaps in the ice covering of the sea, forming large open spaces, constitute in winter an additional source of moisture, whilst from the open sea beyond, the supply of moisture cannot be of any consequence—at least not that supplied by winds which were blowing polewards at no great height above the ground, as in consequence of the distribution of barometric pressure these winds are of rare occurrence. This does not, however, in our opinion, exclude the possibility of moisture being supplied by the upper air currents, which feed the polar anticyclones. Assuming the temperature of the ascending air in the zone of depression round the Pole to be 32° F., and the heights of ascent to be about 6,000 feet, there would result from it a reduction of the temperature of the air of some 35° to 36° F., that is to say, that by far the greater part of the precipitation must be in a solid form. But now it must be assumed that the precipitation of moisture out of the air must, at least in the higher regions, be in the shape, not of large flakes of snow, but of very minute ice-needles, which are carried mechanically towards the interior of the country by those stormy winds which at a great height flow off to the anticyclone. As the air gradually descends and thus grows warmer, a portion of the condensed moisture brought in may evaporate, only to be immediately again condensed by the colder strata of air resting over the surface of the land, since it is most probable that over the Antarctic land, in winter at least, there exists on the whole the well-known reversed state of the temperature of the atmosphere, which on ascending from the ground first shows an increase to be turned into a decrease at great heights. The purely hypothetically-assumed height of the in-streaming winds is probably not required to produce these phenomena, at least not with land of low elevation, whilst with Victoria Land, for example, it would have to be still more considerable.

The state of things must be different in the southern summer, if not in principle, at least in effect, as the large vapour-supplying water surfaces of the open basins of Ross Sea and Weddell Sea, and possibly also other still unknown bays or gulfs, make their influence felt in the Antarctic regions. Over these regions the air, probably still cold, but in comparison with winter much warmer, may be abundantly charged with water-vapour, which is carried partly perhaps to the coasts by sea-breezes, but mainly to the interior in the manner above indicated. In summer the *relative* moisture in the air over the Antarctic waters is very great; on 30 per cent. to 40 per cent. of the days that Ross passed within 60° S. it amounted to 100 per cent., in other words, the air was saturated with moisture; the number of days when the *relative* moisture was 100 per cent. between 74° and 78° S. was small, amounting only to 25·8 per cent. of the total number of days. On the remaining days it hovered near the point of saturation, whilst low numbers were observed only twice, *viz.:* 62·5 per cent. in the neighbourhood of Mount Erebus, accompanied by a rising temperature and a wind coming from the land, consequently a kind of Föhn, and 52·6 per cent. at the edge of the pack-ice, accompanied by an east wind proceeding from it.

The precipitation in the southern summer corresponds with the state of *relative* moisture prevailing over the sea. As has already been observed, water-vapour rises incessantly from the sea, and if this moisture penetrates cold air, it generates the fogs which are so frequent a phenomenon of the Antarctic waters; and if, in addition, land winds bring this air in contact with the much colder air of their place of origin the fog is succeeded or accompanied by snow. Wilkes expressly says, that the winds from the southern quadrant occasionally bring clear weather interrupted by snowstorms, whilst the northern winds generate dense fogs, and Bruce says the same thing.

Most commonly precipitation takes the form of snow, rain is comparatively rare, and dew and hoar frost make considerable contributions. Ross noticed on 31 per cent. of the days some rainfalls in form of passing showers at a latitude south of 70° S.; persistent rain on the 11th of February, 1842, at 70° 6′ S. and 178° 18′ W., and the last rain altogether on the 29th of January, 1841, in 77° 47′ S. and 176° 43′ E. Wilkes and Dumont d'Urville also experienced heavy rainfalls, but at the considerably lower latitudes of Wilkes Land and Louis-Philippe Land. Hail, on the other hand, occurs but rarely; Wilkes alone reports two instances—he mentions also sleet, and draws special attention to the important part played by the formation of dew. On one occasion he observed that during a fog a crust of ice nearly a quarter of an inch in thickness had been formed within a few hours.

The snowfall is of far more importance in Antarctic regions than all the other forms of precipitation, since it is even in the open sea by no means restricted to the winter season. Ross observed in the southern summer of 1840-41, south of latitude 70° S., that it snowed on 57·6 per cent. of the days of observation; in the summer following on 62 per cent. of the days, and finally in the summer of 1842-43, when he was east of Graham's Land, on 68·8 per cent. of the days. The form of the snow-crystals depends, of course, on the temperature, yet full-shaped large flakes of the familiar crystals apparently occur but rarely; most commonly the snow assumes the shape of small fine ice-needles. These, no doubt, preponderate on land, as seems proved by the occurrence of snow-drifts at Mount Haddington and Wilkes Land, as well as the formation of snow-mounds on Adélie Land, and a glance at the low temperature fully explains this.

About the amount of precipitation it is, of course, as yet impossible to make any positive statement; in summer it is probably very considerable, both at sea and on the coasts; in the interior of the land, and in winter, it is likely to be slight, and, moreover, to gradually diminish as the Pole is approached.

In conclusion, and as an appendix to the description of the climate, short mention may be made of a phenomenon, which is not intelligibly connected with climate, but rather proceeds from the magnetism of the globe, namely the POLAR LIGHT, which corresponds to the Northern Light, and is in contradistinction called the Southern Light, or the AURORA AUSTRALIS. In appearance it does not seem to differ from the AURORA BOREALIS, although the southern display exhibits more rays than bands of light. Like the northern lights so also do those of the south shine forth most frequently and most brilliantly in a zone whose centre does not coincide with the astronomical pole of the globe, but appears to be displaced in the direction of the magnetic pole of the southern hemisphere, which must be looked for in the south-western districts of Victoria Land. This explains the almost total absence of observation of the Aurora Australis from the South Atlantic Ocean; for example: from the polar stations in South Georgia, and from Cape Horn, not a single instance of a polar light is recorded in the year of observation of 1882-83, whilst they were not uncommonly noticed by ships on the way to New Zealand and south-east Australia, and of course also in both these countries themselves.

On the whole much less is known of the southern light than of the northern, its proper domain falling into regions scarcely ever visited by man.

V. THE ICE.

The extremely low temperature of the summer, and still more that of winter, and the consequent precipitation of water in solid form, *i.e.*, of snow, produce the mighty ice covering of land and sea which impress on both the polar regions their characteristic feature, and without which we cannot so much as imagine the high latitudes of our globe. There exists, however, as great a difference in both the sea ice and the glacial or land ice of the northern and southern polar regions as between their two climates, especially their summer temperatures. In the lands of high northern latitudes there are extensive tracts, where, in the warm season, after the snow has melted, not only the bare rocks appear, but there are surfaces covered with a vegetation that under the circumstances might even be called luxuriant. Spitzbergen, situated between 78° and 80° N., supports large herds of reindeer, lemming rats and Alpine hares ; the same holds good both of East and West Greenland—the home of an abundant fauna—and of the true polar regions of Northern Asia and America. The Antarctic regions, on the other hand, exhibit nothing of the kind. Excepting on the island of South Georgia, situated in latitude 54° to 55° S., *i.e.*, at a polar distance corresponding to that of Northern England, and in the South Shetland Isles, we find that only in summer the snow disappears in places, but even there not very extensively, whilst all the rest of these southern lands lie even at midsummer wholly buried under snow and ice. In high northern latitudes gigantic icebergs drift annually into the North Atlantic, and collect off the coast of Newfoundland. They all originate in the island-studded Arctic Ocean, where the intense frosts of winter form huge ice masses over wide, albeit varying, extent; part of which are in summer melted on the spot, part drift farther south to meet the same fate, whilst a not inconsiderable quantity retains its solid form, as happens, for example, over the vast regions north of Behring Strait. In the Antarctic regions, on the other hand, we have shown in our history of discovery that after bursting through a zone of pack-ice, which was not immoderately thick, a sea was reached which was but slightly beset with ice, no matter whether it was water washing the coast, or open, extensive sea surfaces like the Ross Sea and Weddell Sea. From this it follows that in the Arctic regions the sea ice largely preponderates over the land ice, which comes almost exclusively from Greenland, whilst in the Antarctic regions the reverse takes place, that is to say, that the land ice preponderates over the sea ice. This is one more clear indication of the difference in the distribution of land and water in the two hemispheres. This the present author has elsewhere formulated thus: "The northern hemisphere possesses a closed-in polar ocean and a polar edge of the land; the southern hemisphere a closed-in polar continent (or polar archipelago) and a polar edge of the oceans". The effects of this contrast are obvious. The islands sporadically scattered within the north polar basin, and also the northern edges of the continents, are subject to the influence of a continental dry climate; the amount of snow precipitated upon them is mostly too small to produce a glaciation of the land, and consequently the summer warmth is sufficient to liquefy the snow in the lower regions, and to cause the drift-ice of the glaciers (the icebergs) to recede. Conversely, in the Antarctic regions, exceedingly low temperatures prevail even in summer, so low that they hardly anywhere suffice to melt the snow, whilst in the boundless open ocean the formation of an uninterrupted sheet of ice is prevented by its perpetual violent agitation ; and this is so all the more, because the occasional nuclei for ice formations in the shape of scattered larger island groups in those distant southern seas are absent ; hence again the preponderance of icebergs, and the relative insignificance of sea ice.

Land ice or glacier ice is admittedly in its origin snow in a changed form. In our temperate zones, in the Alps for example, the dry powdery snow, falling at a high elevation, is swept by the wind into lower valleys, where it collects in wide hollows—the birthplaces of glaciers. Here the snow masses accumulate and reach down to a certain height, called the Snow Line, below which the temperature of the air is sufficient to liquefy the snow.[1] The thaw of the summer day, succeeded by the frosts of night, causes the ice to assume a granulated shape, and gives it the peculiar character indicated by the terms "Firn-snow" and "Firn-ice".[2] Finally, under the pressure of the snow masses heaped up in the course of years, glacial ice is formed, which flows down at varying rates.

These phenomena do not present themselves in the south polar districts, or, to speak more correctly, they

[1] This definition of the Snow Line is sufficient for the purpose in hand ; for a fuller and more accurate definition, see Tyndall on *The Forms of Water*.—THE TRANSLATOR.

[2] The cognate word of "fern" is "far". Hence "Firnewein" means "far wine," old wine, wine of a distant or old vintage ; similarly "Firnschnee," and "Firneis" mean snow and ice distant both in space (being found at a high elevation), and in time (being the accumulated snow and ice of many winters). We have no corresponding term in English ; possibly the words of our text may prove acceptable.—THE TRANSLATOR.

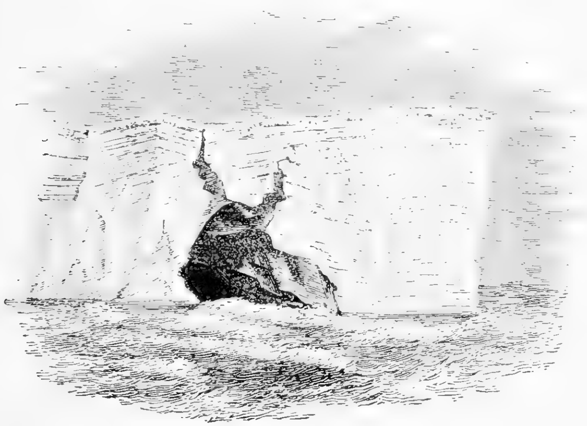
The *Astrolabe* and *La Zelée* in the Ice (after Dumont d'Urville).

[*Face page* 248.

occur only partially and in altered shape. To begin with, true liquefaction to any considerable extent is all but entirely absent in the Antarctic regions. In South Georgia certainly the Snow Line is somewhat high; on the summits of the north coast, which attain a height of 2,500 feet, the snow wholly disappears, and on the Ross glacier the limit of the "Firn," but not of the Snow Line, is at an elevation of 1,150 feet. But only a few degrees farther south, *viz.*, on the northern extremity of the South Shetland Isles, we find a considerable depression of the Snow Line, although the observations needful to determine its position with full accuracy are still wanting; Larsen found on Livingston Island that in the latter half of the month of December the Snow Line was at 100 feet above the level of the sea; no doubt in February it would be somewhat higher. There are also bare places on lofty mountains, and on steep descents farther south, but this is due to orographic, not to climatic causes. As for the Snow Line south of Bransfield Strait, or of Bismarck Strait, and in Enderby Land, Wilkes Land and Victoria Land, it is impossible to say with absolute certainty that it is at the level of the sea, since Cape Adare shows that even flat land or slopes but slightly inclined may wholly lose their snow covering. Where the coast is covered on all sides with inland ice descending from great heights, there may still be some spots protected against that ice, where the summer sun may under circumstances succeed in removing the coat of snow up to a certain height. Such phenomena are, however, exceptional, and cannot affect the total impress of the Antarctic regions. It may be accepted as a general statement, that with the exception of South Georgia, the South Sandwich Isles, the South Orkney Isles, and the South Shetland Isles, the Snow Line in the Antarctic regions seems to coincide with the level of the sea, and that in consequence outside these islands water in a liquid state is entirely absent. In South Georgia water-brooks are common in summer, and near the German station a permanent spring even has been discovered. Similarly there occur in summer on the South Shetland Isles, which alone are somewhat better known to us, brooks formed by the melting of snow and ice.

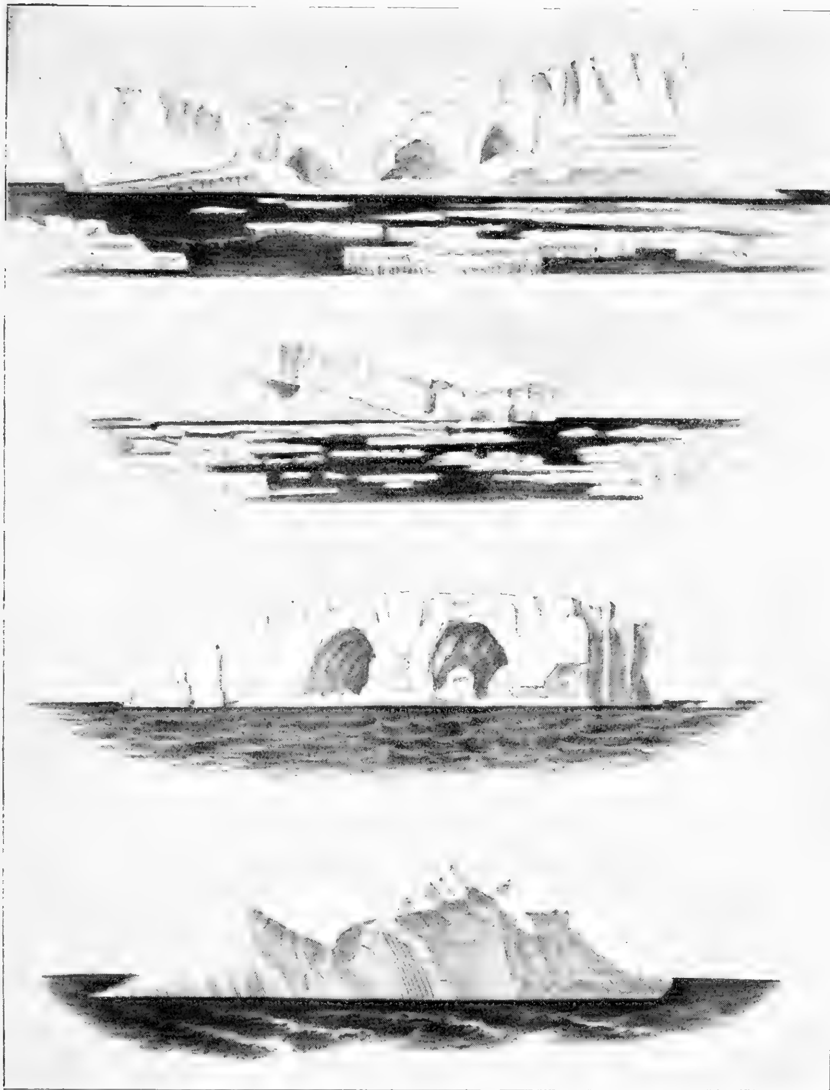
The non-melting of the snow is of necessity accompanied by a change in its transformation. If it does melt near the coast, it is sure to do so somewhat more vigorously at some elevation, leading on the islands, just spoken of, to the formation of the firn-snow with which we are familiar, albeit that the process will be more sluggish owing to the reduced summer temperature and to the much shorter periods. But on the larger tracts of land farther south these circumstances are completely altered. There the dry powdery snow is, even in the height of summer and at no great elevation, driven about by the wind and piled up in huge snow-drifts, and the melting of the snow can be of no great moment. It is certainly very doubtful if active melting of the snow, such as leads to the formation of brooks, and as we witness on the Greenland coast, can take place; the hollowed out forms of the inland ice observed by Dumont d'Urville on Adélie Land may possibly be mere clefts in the ice; nevertheless the big icicles of the great wall of ice prove that even in high southern latitudes vigorous melting does take place. Until minute observations, similar to those made in the north by Peary, Von Drygalski, and others, have been made on the spot, we can rely in our speculations on the formation of Antarctic land ice solely on what has been actually seen, *viz.*, the icebergs, which are not inland ice. It is no longer subject to doubt, that their origin is to be traced to the ice covering of Antarctic lands terminating in the abrupt perpendicular walls along the coast, spoken of in the previous chapter; these icebergs then, frequently and accurately observed, may be accepted at least provisionally, as a substitute for the investigations to be made on land, concerning the transformation of snow into glacier ice.

All Antarctic travellers have been struck by the peculiar stratification of the icebergs, which with newly-formed bergs runs in parallel horizontal lines with the upper surface. These strata, consisting of snow-white and deep cobalt-blue ice, alternate from top to bottom, but they are not of uniform thickness; at a great eleva-



Iceberg seen on 23rd February, 1874 (from the *Challenger's* Reports).

tion above the sea-level, near the surface of the berg, the still undulating white strata are some four feet thick, the blue strata being comparatively very thin; but, as we descend lower down, the white strata diminish and the blue increase in thickness, till, with a berg about eighty feet high at a distance of sixty to seventy feet from the surface, the white strata measure only one foot or so in thickness, and at last disappear altogether, so that the mass below the surface of the water consists almost entirely of ice that is perfectly blue and transparent. An original experiment made by the *Challenger* supplies satisfactory information about the texture of these two kinds of ice. Shots were fired at a berg from a 12-pr. gun, first at the blue ice near the surface of the sea, with the effect that large masses were splintered off and hurled into the water, thus proving that the blue ice was hard and brittle. The second shot entered a broad white stratum near the upper surface of the berg without producing any effect whatever, whence it is inferred that these strata consist of soft, unresisting material, in fact, of snow or firn, that had undergone little alteration. Now, the question arises: How does the snow from the deep hollows change into strata of blue, hard ice, which at first are thin and gradually increase in thickness? The best solution of this problem seems to be supplied by Nansen's observations on the inland ice of central Greenland. Here the climatic conditions of the south polar regions are repeated, apparently aided by the considerable elevation above the sea-level. The snow falls in the shape of a very fine crystallised powder all the year round, but mostly so in summer. Although the conditions are more favourable, still the sun is at that elevation no longer able to do more than slightly melt the snow and moisten its surface; this freezes again at night, so that no part of it filters through and converts the snow into coarsely-granulated firn-ice. Nansen, too, found at the end of August, the first and somewhat thicker, hard crust beneath the thin surface crusts formed in the same summer, at a depth of three to four feet, and sometimes at a less depth. We are led then to assume for the Antarctic regions also that in the height of summer the sun is able to melt the surface of the snow often marked by light undulations produced by the wind. If, then, such a stratum of one year's melting is compressed by the superincumbent strata of many years, the volume of the loose snow between the two hard crusts must be reduced by the contraction of the air-containing pores. I conjecture, however, that the layer of snow placed over



Forms of Icebergs (after the *Challenger* Reports). [*Face page* 252.

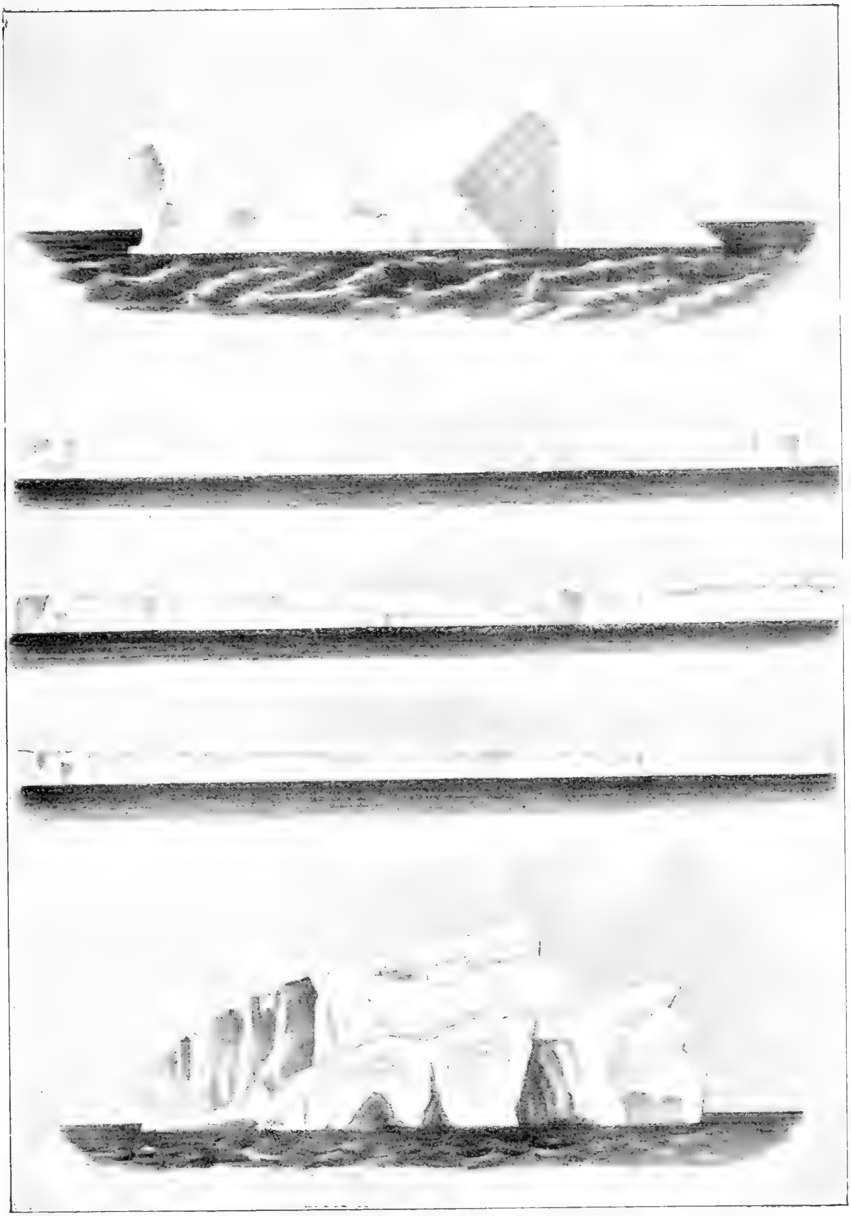
1-3. Seen on 14th February, 1874.
4. Seen on 15th February, 1874.

a thin ice stratum (in Greenland it is ·5 to ·7 inches thick) must be crushed upon it, and thus be brought into close contact with the finely-granulated crystals of this firn-snow or ice, be absorbed by it, and thus added to increase its volume. The same process must be repeated on the lower surface of the stratum of ice, as this also is pressed upon the deeper lying snow beneath it. Thus, these sheets of ice grow in thickness by increasing their volume, but the layers of snow diminish by reduction of their mass and volume, and gradually change into hard, air-enclosing ice; how this air is expelled is still unknown, but the final result of the whole process of transformation is the brilliant pure blue ice of the lowest strata of the whole mass.

In some cases the formation of this pure blue ice will not be completed, not indeed in consequence of some change in the process of transformation, but because of the entry of foreign substances. Mention has been made in former places of *débris*-bearing icebergs, and it was pointed out that sometimes the imbedded masses are also distinctly stratified. In some regions, especially in the more remote neighbourhood of periodically active volcanoes, the ashes are strewn over the snow at every period of eruption, and these are then at the periods of rest covered by snow masses more or less thick. Upon a transverse section such as these icebergs exhibit, these strata are seen as fine brown or blackish stripes. Such kind of bergs, whose upper surface also is occasionally coloured brown by solid substances, have been seen by Bruce and by the members of the *Challenger* expedition. Future investigations may possibly show that the green colour of icebergs occasionally noticed is due to inorganic substances distributed through the whole mass of the berg. In many cases the rubble imbedded in the ice is not stratified, being derived from moraines, which have been uninterruptedly received. Such bergs Wilkes has seen most frequently. Drygalski has collected very instructive instances for such kind of formations in Greenland. We must forbear describing these highly interesting phenomena from want of space, but we may hold fast to the theory that the alternate white and blue sheets of Antarctic ice are due to real stratification, different from the structure of blue foliations of the Alpine glaciers which are mostly traceable to the movements of the glaciers.

With respect to the distribution of the land ice, and its descent to the coast, a marked difference is noticeable between the Arctic and Antarctic regions. As far as it is known, the Greenland ice nowhere reaches the coast in an unbroken mass; only in the valleys of the fjords, which cut deeply into its edge, the ice, rent by mighty clefts, falls sheer into the sea. Numerous rocky summits, the so-called Nunatak, raise their bare heads within the whole circuit of this terminal zone, and not till a long way inland do we find that the ice has a compact surface free from clefts. In the Antarctic regions, on the contrary, we do not meet, as has so often been asserted, an ice cap covering the whole land and hiding all differences of level, but an ice mantle which, no doubt, fully envelops the country, but adapts itself to the large configurations of the ground without obliterating them. This is clearly obvious from all the descriptions, both verbal and pictorial. The information we possess at present does not enable us to account for this, but the nature of the ice in the interior will be one of the problems that future investigators will have to study. It may perhaps be ascribed to the almost universally low summer temperatures in the far south and along the coast, and to the same cause may be due the apparently slow motion of the inland ice in the Antarctic lands, which may be inferred from the regular horizontal stratification exhibited by the icebergs.

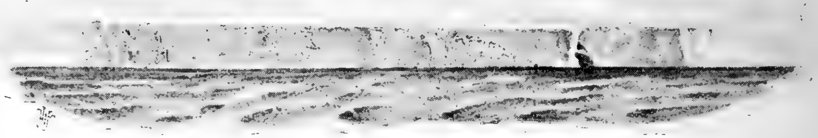
As might have been expected, nothing has as yet



Forms of Icebergs (after the *Challenger* Reports). [*Face page* 254.

1. Seen on 15th February, 1874.
2-4. Seen on 16th February, 1874.
5. Seen on 19th February, 1874.

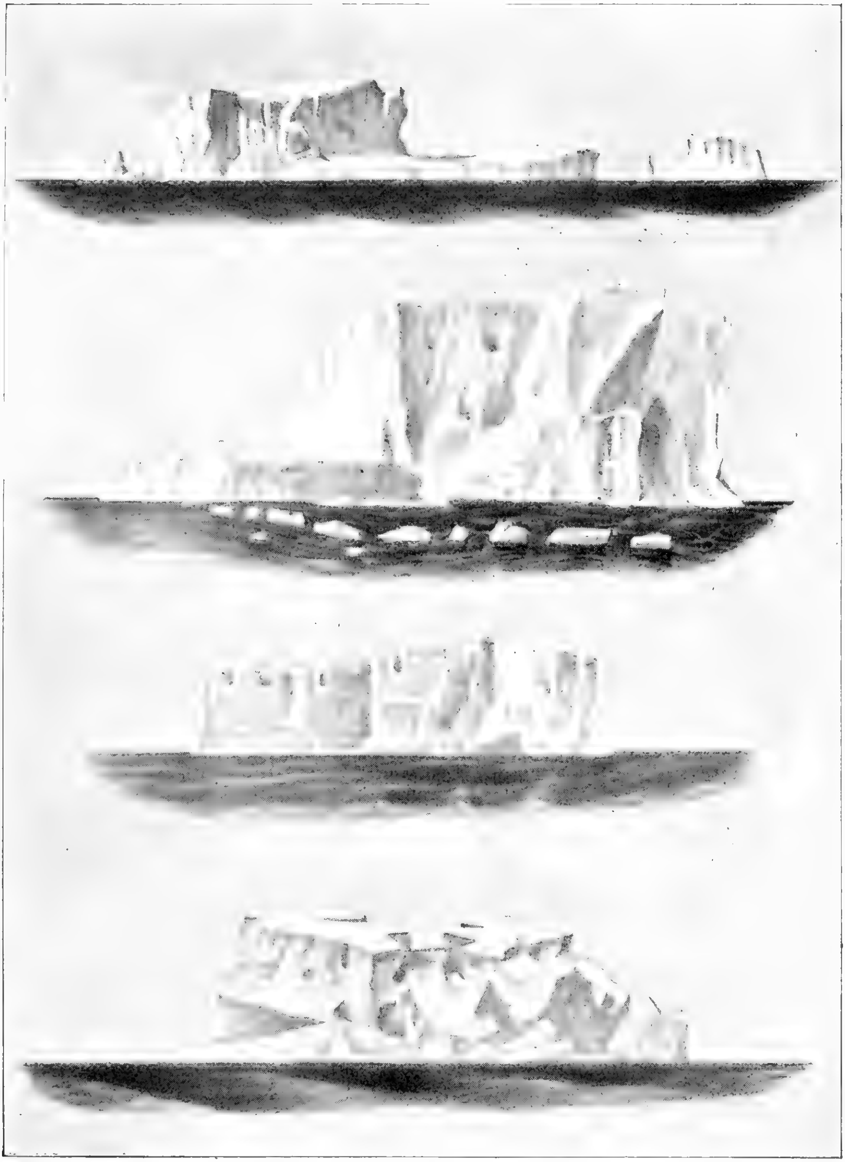
been discovered concerning the mode of movement of the Antarctic inland ice. It is sure to be sluggish and uniform over extensive tracts, as otherwise the inland ice would hardly terminate along the sea in an uninterrupted wall of such extraordinary length—a phenomenon seen in Greenland, only in the rivers of ice that descend into the fjords. This is just the specially characteristic feature of the Antarctic regions that even on small, level isles, such as Dundee Island, the ice, which cannot be very thick, descends to the sea and terminates in a perpendicular wall. In this particular case the thickness of the ice is only 30 feet to 40 feet; at Adelaide Isle it was even less; and quite as low, or only a mere trifle higher, at Snow Land, east of Mount Haddington. On the other hand, the wall of ice at Joinville Island, and in the neighbourhood of Enderby Land, attains a height of about 100 feet, and in the region of Wilkes Land and Victoria Land, heights of 100 feet to 200 feet are of common occurrence. In these very regions we find the most extensive walls of ice, *viz.*, those off the Clarie coast, and one of still greater length east of Mount Terror. Both of these formations used to perplex geographers very greatly; they were regarded as very old formations of sea ice, because with the wall off the Clarie coast the fact was overlooked that Wilkes had seen land behind it, and, with that to the east of Mount Terror, that its gradual transition into a wall of ice at the foot of the great volcanoes made it probable that it was a natural formation of land ice. Wherever up to now land has been distinctly seen behind the large walls of ice, it was observed that its terminal wall was almost regularly some nautical miles off the recognisable beginning of the land, and the same applies to the more isolated ice rivers, which descend from the Admiralty Range in Victoria Land. That in most, if not in all, cases these walls float was proved by soundings made on one occasion, and is, moreover, to be inferred from the height of icebergs near the walls, which are uniform with it, and are undoubtedly floating masses. How far out into the sea this floating ice is swept it is impossible to tell; but, considering the enormous horizontal dimensions of the icebergs, this distance must often be very considerable. This fact throws a brilliant light on the well-known theory of the melting of the icebergs. Sir John Ross's theory that the difference of temperature between the intensely cold upper surface and the much warmer lower surface of the icebergs causes extreme tension, and ultimately in winter the severance of the berg, may turn out to be a true solution of the problem. Another,



Iceberg, after an original water colour of the *Challenger* Expedition.

albeit merely occasional, cause of the severance of especially enormous ice masses may be very violent volcanic eruptions, and the waves generated by them; it is possible that some occurrences of this kind may be responsible for the colossal ice-drifts of the years 1891 to 1896.

The height of these floating walls of ice, and the icebergs newly detached from them, affords the only means at our disposal for an approximate estimate of the thickness of the Antarctic inland ice. Croll, for example, the eminent student of the glacial periods assumed a maximum thickness of 120,000 to 130,000 feet, but sober observation by no means bears out this



Forms of Icebergs (after the *Challenger* Reports). [*Face page* 256.

1, 2. Seen on 21st February, 1874.
3. Seen on 22nd February, 1874.
4. Seen on 25th February, 1874.

estimate. The greatest heights observed of perfectly new bergs with horizontal upper surfaces and vertical flanks do not exceed 200 feet above the water; 250 feet has, in fact, never been observed with any reliable degree of certainty. On the usual basis of calculation, this mass visible above water would correspond to a nine-fold thickness below, *i.e.*, to 1,800 feet under the surface of the sea, and from this it would result that the total thickness of the iceberg would be about 2,000 feet. But even this calculation is an overestimate, because the fact is ignored that the mass above the water is specifically lighter than that below, and is therefore borne by a less volume of the denser mass. The submerged part may possibly be no more than six-sevenths of the total height, which would give to a freshly-formed berg of an average maximum height above water a total thickness of 1,400 to 1,500 feet. If it is further taken into consideration that it is just the submerged part which generally is the chief carrier of the rock and rubble brought away imbedded in the ice from the birthplace of the glacier, one might under circumstances assume a thickness even less than that just named. The theoretical calculation of Sir Wyville Thomson leads to the conclusion that 1,400 feet is the maximum thickness that the inland ice can attain, for a greater superincumbent volume would by its pressure liquefy the lowest stratum; this, however, assumes that the temperature of the lower surface was at 32° F., which according to Drygalski's observations in Greenland need not necessarily be the case.

If Sir W. Thomson's conjecture is correct, then it might further be expected that the Antarctic inland ice is melting underneath—at least slowly—the whole year round: precisely the same as Nansen has shown to be happening with the ice of Greenland. If this be not so, then icebergs would be the only means for removing the Antarctic inland ice—a mode which brings the

Antarctic regions into close relation with the rest of the earth's surface.

The horizontal dimensions of the icebergs vary greatly; in high latitudes a length of 1½ to 3 or 3½ miles is by no means uncommon, and, indeed, some masses are greatly in excess of these measurements. For example, the largest seen by Bruce was more than 30 miles long; and another, seen by several ships in April and May of 1892 in the South Atlantic, in latitude 42° to 46° S. and longitude 30° to 36° W., exceeded 40 miles in length. As these gigantic ice masses are also correspondingly broad, their surface areas must measure some thousands of square miles. The years 1891 to 1896 were remarkable for the appearance of ice masses both numerous and so enormously large that they drifted far into the Atlantic and Indian Oceans.

The drift of the icebergs and their distribution over the great expanse of the southern ocean is a phenomenon of supreme importance, both for the study of physical geography and for the material interests of navigation. After an Antarctic iceberg has been detached from its native wall of ice, it may primarily be subject to the impulse of the winds blowing from the land or from the inland ice, and also to such tidal currents as may occur near them. But, at some distance from the land, it is swept along by the force of the true oceanic currents—a force which must beyond all doubt greatly exceed that of the winds, as the submerged part of the berg is larger than the part above water, not only in volume but also in mass. It is true that the currents of the ocean travel at a slower rate than those of the air, nevertheless the impetus given to the berg by a given volume of water must be much greater than that imparted by a like volume of air; and as, moreover, a considerably greater mass of the berg is set in motion by the water than by the air, it follows that at least in the higher latitudes the path pursued by the berg must depend mainly on the direction of the prevailing oceanic currents. Under favourable circumstances this phenomenon might be utilised to observe the deep-sea currents; for, since an iceberg, like every other floating body, must direct its line of gravity parallel to the impelling current, the longitudinal axis of the berg must indicate the constant currents prevailing beneath the changing currents on the surface.

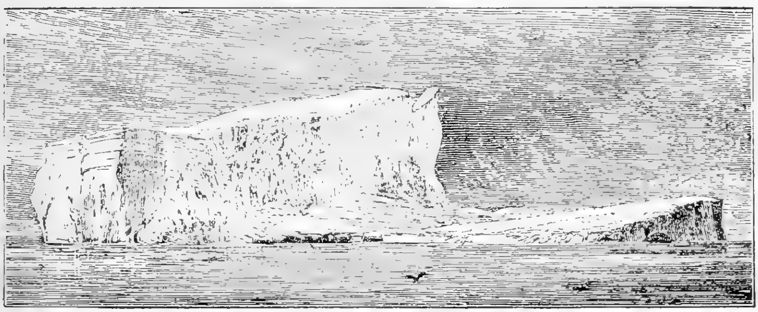
The oceanic currents of the Antarctic regions, on which the distribution of the icebergs mainly depends, are as yet known very little—practically not at all. In the neighbourhood of Graham's Land, and generally between it and Cape Horn, regular and comparatively rapid westward currents have been observed; they are due to the regular west winds, and to their extensive drifts crowded into a proportionately small space and forming a belt round the great southern ocean, which extends up to and beyond 60° S. In the higher latitudes the currents seem naturally to follow the winds in the same manner; they are, therefore, principally pursuing a north-west direction, and gradually become a western drift current.

Near their places of origin the masses of ice, sometimes in huge numbers—witness the voyages of Wilkes, D'Urville and Ross—disperse far and wide over the expanse of ocean as the parallels of latitude increase in size, till at last they disappear in the warmer waters between the latitudes of 50° and 40° S. In the regions visited by trading vessels a certain periodicity has been observed in the frequency of icebergs. Barring exceptions, pre-eminently the giants seen in the years 1891 to 1896, the months of April to July inclusive, are poorest in icebergs. In August their numbers begin to increase, considerably so in September and October, till the maximum is reached in November and December. In January the numbers diminish, still more in February, and in March the state of the ice does not greatly differ from that of April. As has already been observed, these rough statistics apply only to the regions visited by commerce; whilst very little, indeed hardly anything, is known about the state of the ice in higher latitudes—especially in winter.

The gradual drift northwards leads pretty rapidly to considerable changes in the shape of the bergs. Rains and the increased temperature of the air melt portions of the ice towering above the surface of the sea, and as the water that penetrates the rifts in the ice freezes again, it expands and breaks off fragments near the edge with loud reports; along the water-line the breakers hollow out cavities, growing larger and deeper till at last the overhanging roof falls in, and finally the sea water forms cavities all round the berg. The material of the iceberg being ice formed from snow, it follows that the surface water of the sea cannot melt this substance unless its temperature is 32° F. or more; whilst in the water with a temperature lower than the freezing-point, melting cannot take place in the higher latitudes. The breakers, combined with the melting process, form submarine ice terraces, proceeding from and surrounding the berg, which, being hidden, may easily become dangerous to navigation. If the destructive forces have removed a large portion of one side of the berg, then the centre of gravity of the whole mass is changed, and the berg assumes a different position. Thus arise those boldly jagged pinnacles observed in the lower latitudes, whose lofty summits are balanced by a much larger, but far less deep reaching mass beneath the surface of the water. It is seen, then, how unsafe it is to assume, as Dr. Croll for example has done, that the submarine depth of the ice is nine times as great as is the height above the surface of the water.

The numerous illustrations of this work, derived from the *Challenger*, are admirable representations of these wonderful floating masses of ice in the Antarctic regions, whilst those illustrations which are taken from Dumont d'Urville's work exhibit the jagged forms of icebergs that have undergone considerable destruction.

The extreme northern limits reached by the Antarctic icebergs are indicated in the annexed map; they lie about latitudes 40° to 50° S. We possess, however, reliable information only about the regions which are regularly visited. In the Atlantic these limits penetrate farthest north; occasionally the last fragments of icebergs have been met near the Cape of Good Hope.[1] On the



Iceberg seen on 21st February, 1874 (after the *Challenger* Reports).

other hand, this limit is subject to a noticeable interruption near Kerguelen and Heard Islands. It seems that the west wind drift current, being turned aside by the bank connecting the two islands, travels to the south-east over a wide expanse of surface and presses the icebergs backwards. It thus counteracts the current presumably parallel to or setting out from Wilkes Land, and thus brings about the colossal accumulation

[1] Whilst these pages were going through the press I have received the new and surprising intelligence (G. Schott, *D. Ozeanographie i. d. Jahren 1895-96*; Hettner's *Geogr. Zeitschr.*, iv., p. 46) that a piece of ice was seen on the 30th of April, 1894, in lat. 26°30′ S. and long. 25°40′ W.—The Translator.

of icebergs frequently observed in the neighbourhood of Wilkes' problematical termination land. Between June, 1896, and the commencement of 1898, masses of icebergs appeared even north of Kerguelen Land. A similar but less important deviation in the middle portion of the ice limit is observed south of New Zealand, and finally also in Drake Strait, which latter is easily accounted for by the collection of masses of warm water, which are piled up along the Western Coast of Patagonia, and partly encircle Cape Horn.

The sea ice of the Antarctic regions is of small importance in comparison with the icebergs; this is probably due to the action of the high waves of the broad, storm-lashed southern ocean, to which the south polar waters are accessible and exposed. The low temperature of the winter in high southern latitudes must of course tend to form extensive fields of ice; but, on the other hand, they are continually broken up by the restlessness of the sea. In the higher latitudes of Ross Sea, fresh ice begins to form very rapidly—as early as the end of February—whilst Weddell saw not the least trace of fresh ice at the same time of year in Weddell Sea, in latitude 74° 15′ S. In the region west of Peter I. Island, Hudson and Walker found that in latitude 69° to 70° S. fresh ice began to form at the end of March; along the coast of Wilkes Land no observations have as yet been made on the formation of new ice; presumably it will not take place before the end of February, unless we suppose that this month was in 1840 unusually mild. On the other hand, Biscoe noticed that in the first days of March the sea near Enderby Land was in a short time covered with ice an inch thick, when the water was calm.

No direct observations have as yet been made on the thickness which Antarctic sea ice attains in the course of the winter. It has been asserted that clumps of ice a year old were some three feet thick, but this is an isolated observation. On the other hand, all Antarctic travellers have been struck by the fact that the individual fields were of less expanse than they are in the Arctic Seas. Wilkes, for example, never saw one that was more than one and a half miles across; in Ross Sea they are larger, but the largest were observed by Ross to the south-east of Mount Haddington, where they were sometimes five miles in diameter. It seems that the protecting influence of the land makes itself felt here, as the ice finds abundant support and shelter from the waves. In the deep inlets strong coast ice was seen that had lasted all through the summer, by Ross south-west of Mount Haddington, by Larsen between Mount Haddington and King Oscar Land, and again by Ross west of Cape North in Victoria Land, and also west of Mount Erebus.

The surface on which sea ice is formed may probably comprise all the coasts together with the adjacent arms and inlets of the sea that penetrate some way into the land; this can be inferred from the breadth of the zone of pack-ice through which Ross sailed in his second voyage, and the extent of which is nearly equal to that of Ross Sea. It is, however, for reasons previously discussed, highly improbable that this ice covering forms one unbroken mass; on the contrary the ice is first broken up, then crowded together, and the separate blocks piled on the top of each other, till pack-ice is formed. But even this will not bear comparison with the pack-ice of the Arctic regions, as is expressly stated by Ross, notwithstanding that he had met on his second voyage ice masses that had undergone such very heavy pressure, that not a single really level field was to be seen, everything being confusedly piled up, and yet not towering more than ten to fifteen feet above water. A peculiarity very inconvenient to navigation is the circumstance that large hard fragments of icebergs are imbedded in the

Antarctic pack-ice; in some places, indeed, especially near the land, these constitute a very considerable fraction of it. It is equally characteristic of the Antarctic ice-blocks that they are crowned with a thick coat of snow, which not infrequently exceeds three feet in thickness.

Nothing definite can be stated with respect to the time when the ice thaws and begins to drift north; this evidently varies very considerably just as in the north; and even in the most northerly advanced post in the region of the South Orkneys, and especially the South Shetland Isles, it was found that some years they were accessible very early, *viz.*, in October, and at other years not till December. Unlike the icebergs the sea ice depends for its motion mainly on the winds and on surface currents. Travellers have observed that a single storm may completely change the aspect of the sea, or rather of its ice covering. The general tendency of the drift of the pack-ice is towards the north, like that of the icebergs, but it is much less regular, being frequently driven back by northerly winds. In consequence of the circumstance that land lies to the south, which excludes the possibility of more sea ice following in support, an open sea comparatively free from ice is met with in the Antarctic regions almost regularly when the principal zone of pack-ice has been pierced; this is specially the case in the neighbourhood of Ross Sea and Weddell Sea, but it also holds for the coasts of Wilkes Land and Graham's Land. Had the *Challenger* pushed forward farther south, she also would probably have found a more extensive sea surface, or at least an open coast-land.

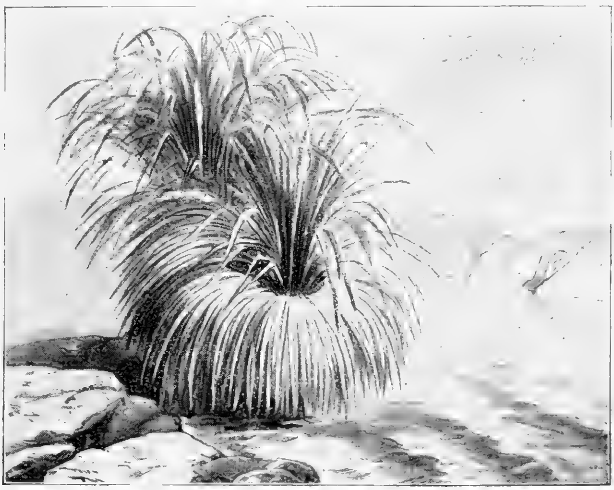
The lower latitudes reached by the pack-ice naturally fall far short of the extreme, and to some extent even of the mean, limit of the icebergs; nevertheless the sea ice reaches fairly low latitudes, and, like the icebergs, mostly so in the Atlantic, where it has been known to arrive at and beyond 48° S. According to some statements it would even appear that in 1892 the drift of the gigantic iceberg brought in its train sea ice as far north as 41° or 42° S.; however, this may have been mere fragments of icebergs, since it can hardly be supposed that in the sea surface, greatly chilled though it was by the melting glacier ice, the salt-water ice could have drifted so far north, seeing that it thaws so much more readily.

Both kinds of ice, icebergs, and sea ice bring to the temperate latitudes of the southern ocean large quantities of cold water; nevertheless these do not suffice to replace the water withdrawn from the tropics by evaporation. The necessary compensation is effected by the exceedingly slow movement of the icy cold waters at the bottom of the sea coming from the south polar regions. This forward movement extends to the Equator and far to the north of it. On the other hand, the melting Antarctic ice causes a great reduction of the surface temperature of the sea in higher latitudes, and also of the lower strata of water in the middle latitudes, in fact, over the whole extent of the drift of the icebergs. The investigations of the *Challenger* have shown that in the neighbourhood of the real pack-ice the surface temperature is uniformly below 32° F., but above 28° F., the freezing-point of sea water. Farther north the temperatures gradually increase, but between the higher temperatures on the surface, and a stratum of equal temperature at a depth of from 500 to 600 feet a body of colder water is wedged in, extending to about 53° S. This is due to the fact that the glacier ice melting in salt water forms with the later a sort of freezing mixture, which reduces the temperature of these mixed waters from 32° F. to 28·9° F. But this mixture cannot sink to the bottom, being partly fresh water, and therefore specifically lighter than the lower stratum which though warmer is more saline. For organic life in the sea this fact is of great importance, as the richest animal life is most abundantly developed in this cold and cool water.

VI. FAUNA AND FLORA.

THE distribution of land and water in the Antarctic regions, and the complete glaciation of the former, at least in the high latitudes, brings it about that in the south polar regions organic life is all but restricted to the sea, and comprises forms which are partly peculiar to those districts, and partly are to be found also more widely distributed in other bio-geographical regions. Both kingdoms of organic life, plants and animals, possess a specially characteristic feature in the Arctic as well as in the Antarctic region, *viz.*, poverty in species, but wealth, sometimes exuberant wealth, in individuals, so long as man, as a destructive agent, does not appear on the scene.

The vegetable world of the Antarctic regions, in our definition of this latter term, is most abundantly represented in the island of South Georgia, which is its most advanced northerly position. Dr. Will, the botanist of the German station in Royal Bay, found that arboreous ligneous plants did not exist, but there were thirteen species of phanerogamous, besides numerous cryptogamous plants, which in summer clothe every spot free from snow with their not over-luxuriant verdure. The only plant with a vivid blossom is a yellow flowering, small ranunculus, *ranunculus biternatus*, which grows in moist localities hidden in the moss. The characteristic plants of the South Georgian landscape are the tussock grass, *poa flabellata* (*dactylis caespitosa*), which is peculiar to the Antarctic flora, a gramineous plant growing on small hillocks raised by the plant itself; its stiff, bristly blades attain a height of $4\frac{1}{2}$ to 5 feet. Next comes a rosaceous plant, *acaena ascendens*, which, rising to a height of one foot, forms bushes that cover extensive tracts of ground. There is also another but rarer grass, *aira antarctica*, which is of some importance, and in the swamps a rush, *rostkovin magellanica*, grows in considerable abundance. As for the rest, large-leaved mosses are predominant; they cover broad plains with a mat-like coating a foot thick; and on the steep, rocky slopes lichens grow, and most prominently the so-called



Tussock Grass (after Hooker).

reindeer moss (*cladonia rangiferina*) and a genus of lichen (*neuropogon melaxanthus, usnea melaxantha*), whose sulphur-coloured leaflets are seen to gleam on high elevations. In the shallows along the coast grow numerous species of algæ, and most commonly the familiar sea-tang (*macrocystis pyrifera*) as well as another species of a gigantic Antarctic sea-weed, the *durvillæa*.

South of Drake Strait the flora is much scantier. Nothing is as yet known with any precision of the vegetation on the South Shetland Isles; we only know from the reports of seal-hunters that a kind of grass is growing there, possibly the *poa flabellata*, and that the ground, where free from snow, is partly covered with moss. The flora on the landing place of Cockburn Island, latitude 64° 12′ S., in Admiralty Sound, has been minutely described by Hooker, the eminent botanist, at that time assistant surgeon on board the *Erebus*. All in all he found nineteen species, four of which were marine algæ, growing on the beach. The rest consist of three fresh-water plants and twelve land plants. Among the latter those of highest organisation are the mosses, represented by five species; next come six species of lichens, among which the *lecanora miniata* is specially noticeable in consequence of its yellow colour, seen from a great distance, and the rest are algæ. Compared with this relatively great wealth of species, Cape Adare and Possession Islands appear to great disadvantage, seeing that only one species of lichen has as yet been noticed in those localities. The appalling poverty of the Antarctic regions stands out in glaring light when compared with the plant-life of the Arctic regions, where, as has already been stated above, nine species of flowering plants are found in much higher latitudes, *e.g.*, in Grinnell Land, at 82° 30′ N., in the midst of a luxuriant vegetation of mosses, supplying rich pasture for terrestrial mammals.

Of pre-eminent importance is a certain microscopic plant which occurs in all the high southern latitudes, and fills the sea with individuals absolutely innumerable, closely following the floating ice masses, being probably attracted by the low temperatures there prevailing. They are diatomaceæ, siliceous algæ, which sometimes fill the sea with a thick rusty-brown pulp of repulsive smell, whose flinty shell, sinking to the bottom, largely contributes to the formation of the deep-sea mud in high latitudes.

On the presence of this minute form of vegetable life is based the existence of the abundant animal life in

Antarctic waters; animals exclusively adapted to life on land do not, and cannot, exist in the Antarctic regions, owing to the absence of all the conditions necessary to their existence. Though Borchgrevingk lately noticed scars of wounds upon some seals, which led him to believe in the existence of some mysterious, powerful beast of prey, it has been most conclusively proved that these wounds were inflicted by the teeth of a ferocious cetacean—the orca gladiator.

The mammals of the south polar regions are represented by whales and seals, that is, by animals that are either entirely or principally adapted to life in the water. A systematic classification of the whales of the Antarctic waters does not yet exist; nor is it known to what extent they resemble their northern congeners. Ross's assertion that the Greenland whale (*balæna mysticetus*), the whale of highest commercial importance, occurs in great numbers in the regions of Ross Sea and of the Dirk Gerritz Archipelago has been confirmed neither by the voyage of the *Antarctic* to Victoria Land, nor by the voyages of Larsen or the Dundee whalers. All the whales so far seen were Rorquals (finners), which do not repay the trouble of catching. In addition to these mention is made of the bottle-nose whale (*hyperoodon bidens*) and the orca gladiator, which are seen in large numbers; but the identity of these animals with northern forms is not satisfactorily established.

This is true in a still higher degree of the seals, which originally existed in few species but in huge multitudes of individuals—they are in fact the only Antarctic mammals that partially visit the land. The sea-elephant (*cystophora proboscidea*) is the largest living representative of the true seals; there are also met with in the Dirk Gerritz Archipelago four species (*stenorhynchus leptonyx*), Weddell's seal (*stenorhynchus Weddelii*), the sea-leopard (*stenorhyncus carcinophaga*), and Ross's seal (*omatophoca Rossii*). On the other hand, the exceedingly important fur-seal, belonging to the Eared Seals, the sea-bear (*otaria jubata*), has of late ceased to be seen.

The sea-elephant is still found in South Georgia, but no longer in such huge shoals as were wont at the beginning of the century to attract seal-hunters. According to Weddell's statistics more than 20,000 tons of sea-elephant oil had been gained at that island from the day of its discovery by Cook up to the twenties of this century, by which time these animals had been well nigh extirpated. The fate that they suffered in South Georgia also overtook them in the South Shetlands, where Weddell reports that he had had 2,000 of them killed in a single visit. In the higher latitudes, on the other hand, in the districts of Wilkes' Land and Victoria Land, the sea-elephant seems to be absent altogether; at least none of the discoverers make mention of it.

Of the other true seals, four in number, v. d. Steinen, a member of the German expedition, proved the existence also of the sea-leopard in South Georgia, but in small numbers only. Larsen and the Dundee whalers have seen it in greater numbers near Louis-Philippe Land and King Oscar Land. In the same district Larsen met a very large school of what appeared to be the sea-leopard or crab-eater, but his accounts are so vague that it is hard to determine what species he refers to. At any rate the four species of seals here named seem to have a circumpolar distribution.

Next to the mammals, the Birds of the Antarctic regions are best known. The true water birds, adapted by their webbed feet to live on both land and water, are most largely represented; and there are, besides, two waders (*chionis*), which belong exclusively to the Antarctic regions. The next species with the largest number of representatives are the stormy petrels (*procellariidæ*) and the penguins (*impennes* or *aptenody-*

tiornithes), of all birds the most peculiar, and most characteristic of the south polar regions. Their anterior extremities have assumed the shape of paddles, fitting them admirably for swimming and diving. Although several varieties of them have spread as far as the coasts of Chili and of South Africa, as well as Australia and New Zealand, yet it is in the Antarctic regions where the greatest number and most important varieties occur. Always sitting, standing, or walking in upright posture, as is shown on a reduced scale in many of our illustrations, they give animation to the ice and more or less accessible rocks, where they form large colonies of breeding places. On rocky ground they waddle awkwardly along, but on the ice and on the snow they lie down flat on their belly, and using their paddles as supports they slide forward with such speed that a man running can hardly keep up with them. In swimming they show greater skill than any other bird, and inexperienced mariners have often mistaken them for small dolphins.

The largest species is the king penguin (*aptenodytes longirostris*), an imposing bird with magnificent plumage. Bruce measured specimens of this species, and found them to be when standing 4 ft. 6 in. high, and upwards of 4 ft. in circumference; they weighed from 55 lb. to 66 lb. or more. The creature possesses great tenacity, and exhibits an unsuspected physical strength. Five men were scarcely able to hold down a king penguin chased by Bruce. The king penguin is, however, not very common, being in this respect far surpassed by the Gentoo penguin (*pygoscelis papua*), the bridled penguin (*pygoscelis antarctica*), and the macaroni (*endyptes chrysolophus*), which are very numerous in South Georgia, and in still higher latitudes.

Farther north the chionis, stormy petrels and penguins are joined by cormorants, and in South Georgia by a species of ducks, Eaton's duck (*querquedula Eatoni*), and a sea-gull identical with, or nearly related to the northern Great Skua (*stercorarius catarrhactes*) is met with in still higher latitudes.

Reptiles and amphibious animals have not been seen in the Antarctic regions, and considering the conditions of life needful for their existence they may safely be regarded as excluded from them. Fishes, however, on which mammals and birds feed, exist in rich abundance, but little progress has as yet been made in their identification and classification; the only zoological observations, of any extent, that have been recorded are those of the short trip far to the south made by the *Challenger*, and even there attention was mainly directed to the deep-sea fauna. In general it may be observed that the animal life in the true Antarctic waters shows near kinship to, if not identity with, that of the Arctic regions.

Of invertebrate animals the information supplied us, especially by the investigations of the *Challenger*, shows the existence of a great number of species and individuals. It would lead us too far to enter into details, but a few facts may be enumerated. Of the species of tunicata large pyrosomidæ, and ascidiæ a foot long have not unfrequently been seen floating on the surface of the sea. Of molluscs we must especially mention those found by Ross called paddling snails, of the species *limacino* and *clio*, which form a chief article of food for the whales, exactly as in the Arctic regions; also a small pretty cephalopod, the *argonauta antarctica*, which frequents the neighbourhood of icebergs, besides great numbers of shells and snails. Brachiopods and worms, and especially crab-like animals, serve as articles of food for higher organisations, showing the high importance to be attached to the crabs of low organisation which often appear in huge multitudes. Among the Cœlenterata large jelly-fish are seen on the surface, and the discovery of live coral at the bottom of Ross Sea excited no small surprise at the time. These southern regions possess also a rich abundance of protozoa, which are present in every quarter, but the forms that have a most important bearing on the general biology and on the sedimentary formations, *viz.*, the globigernia and the radiolaria are more commonly superseded by the above-mentioned vegetable diatomaceæ.

It is obvious now, that whatever products the Antarctic regions yield belong exclusively to the animal kingdom, the existence of useful coal beds in the South Shetland Isles being as yet very problematical. For the economic uses of man only seals and whales seem of importance, and even these do not seem to be offering a promising prospect, seeing that so far the only voyage to Victoria Land to be repeated is that of the *Antarctic*. The main cause of this state of things is the absence of a valuable species of whales and of the fur-bearing seal, which, once abundant enough, have been exterminated. It is said that in the early twenties of the nineteenth century over 300,000 individuals were killed, in addition to about 1,200,000 destroyed between the re-discovery of South Georgia by Cook and the year 1810, *i.e.*, in barely forty-five years. Weddell says that the seal skins of American hunters mostly exported to China fetched $5 a piece; calculated on this basis the above numbers would represent a sum of £1,500,000. At the present time these exceedingly costly skins would naturally fetch much higher prices. As seal-hunters carried on their hideous butcheries without any discrimination and barely left even sucklings unmolested, and these, then, perished from want of care and nurture, it is not surprising that this exceedingly valuable breed of seals should have been all but extirpated within a few years, to the great loss of the shortsighted seal-hunters themselves.

18

VII. THE FUTURE OF ANTARCTIC DISCOVERY.

THE object of the preceding chapters has been to present to the reader a general view of the whole of our present knowledge of the Antarctic regions. We have exhibited the history of the gradual expansion of this knowledge, the distribution of land and of water as far as it is known. We have discussed the results of the scanty observations made on the climatic elements, and on the sequence of phenomena due to them, as well as the predominance of the ice, and in short outlines the most important forms of organic life, both animals and plants, and yet all this merely shows that for the geographer the south polar regions are little more than an emphatic point of interrogation, a frank confession that on every branch of geographical knowledge we stand before a riddle, the solution of which belongs to the future. It is not merely because the number of unknown regions on our earth has been largely reduced, but mainly because all branches of geography have gained in depth, that the necessity is more and more forced upon science of energetically attacking the long-neglected study of the south polar regions, since it is impossible to conceive a complete system of geographical theories so long as such knowledge is wanting.

In the last sections of the "History of Discovery" mention has been made of the stimulus given and the efforts made to reanimate Antarctic research by its most eminent living advocate and representative. Georg

Neumayer, the present director of the famous German Observatory in Hamburg, the most eminent institution for hydrography and maritime meteorology, has not ceased in his efforts to promote an expedition to the south polar regions for purely scientific purposes ever since 1856, when he went to Australia for the second time to fit up and direct the Flagstaff Observatory at

Georg Neumayer.

Melbourne, which was erected for the study of terrestrial magnetism, hydrography and meteorology. He had early become aware of the fact that it was practically impossible to prosecute the study of terrestrial magnetism and of atmospheric phenomena so long as the Antarctic regions remained a *terra incognita*, principally because the observations made by Ross had become too antiquated to be useful to the first named of these two sciences. But

Neumayer's endeavours to promote such an expedition proved unavailing, and he had to rest content with pressing home the necessity of south polar investigations in lectures, delivered first at Melbourne, and then after his return home, in Germany; unfortunately to no purpose, owing to a want of intelligent interest in these problems, even amongst the educated classes; unless, indeed, the fact that the southward advance of the *Challenger* followed the lines laid down by him be regarded as a result of his labours. At last, in 1882 and 1883, a considerable step forward was made in polar studies both North and South, when, thanks to Neumayer's unwearied efforts, Weyprecht's proposal was adopted, *viz.*, to encircle both the Poles with a system of permanent stations, at which, during at least a year, the elements of terrestrial magnetism and of meteorology should be synoptically and thoroughly investigated. It is true that, as has already been mentioned before, the South Pole, in which Neumayer was specially interested, had been treated very step-motherly. The North Pole was surrounded by ten stations, all within the Arctic circle, in addition to two stations north of the sixtieth parallel, and six meteorological stations of the second rank placed by Germany in Labrador. On the other hand, in the Antarctic regions there were but two stations erected, *viz.*, the German in South Georgia and the French in Tierra del Fuego, and even these were the one 10° and the other 12° north of the Antarctic circle; and, moreover, the utility of these two stations was diminished by their being but 36° of longitude asunder, when it would naturally have been desirable that 180° should have intervened between them. Nevertheless the station in South Georgia has become specially important in geographical science, independent of the results in the domains of meteorology and terrestrial magnetism; so important, that Royal

Bay on that island, and the surrounding district may be regarded as that spot in the Antarctic regions which is best known in every respect.

The meteorological results secured in the south polar stations were so interesting and startling, that they once more emphasised the supreme importance of Antarctic investigations, not only for the science of meteorology, but also for the theory of the structure of the surface of the whole globe and its organic life, as is made evident by what has been said about the structure of the surface of the island. This matter was discussed at three meetings of the German Geographical Congress, and this assembly of eminent savants publicly and emphatically declared Antarctic investigations to be both necessary and feasible; however, this resolution led to no practical effect, the needful means not being forthcoming from either public or private sources.

The urgent appeal of German geographers found an echo on the other side of the German Ocean. John Murray, the distinguished member of the *Challenger* expedition, who after the decease of its scientific head was charged with the publication of its results, published in 1886 a detailed and very weighty treatise on the exploration of the south polar regions. Now at last it seemed that the persistent endeavours were to be crowned with a successful result; Nordenskiöld, the famous circumnavigator of Asia, expressed his intention of adding to his northern voyage a voyage to the south polar regions; governments and private supporters in Australia were reported to be willing to find the needful means, but all these hopeful prospects were once more doomed to disappointment and came to nothing.

Nevertheless, Murray's work had the small practical result that seal catching and whale fishery in the Antarctic regions was resumed by the Dundee whalers and by the Hamburg Society *Oceana*. Although the enterprise did not prove a commercial success, yet it not only added somewhat to our geographical knowledge, but it once more demonstrated that the ice of the south polar waters opposed no insurmountable obstacle to scientific exploration. At the same time these voyages had to some extent roused a widespread interest in

John Murray.

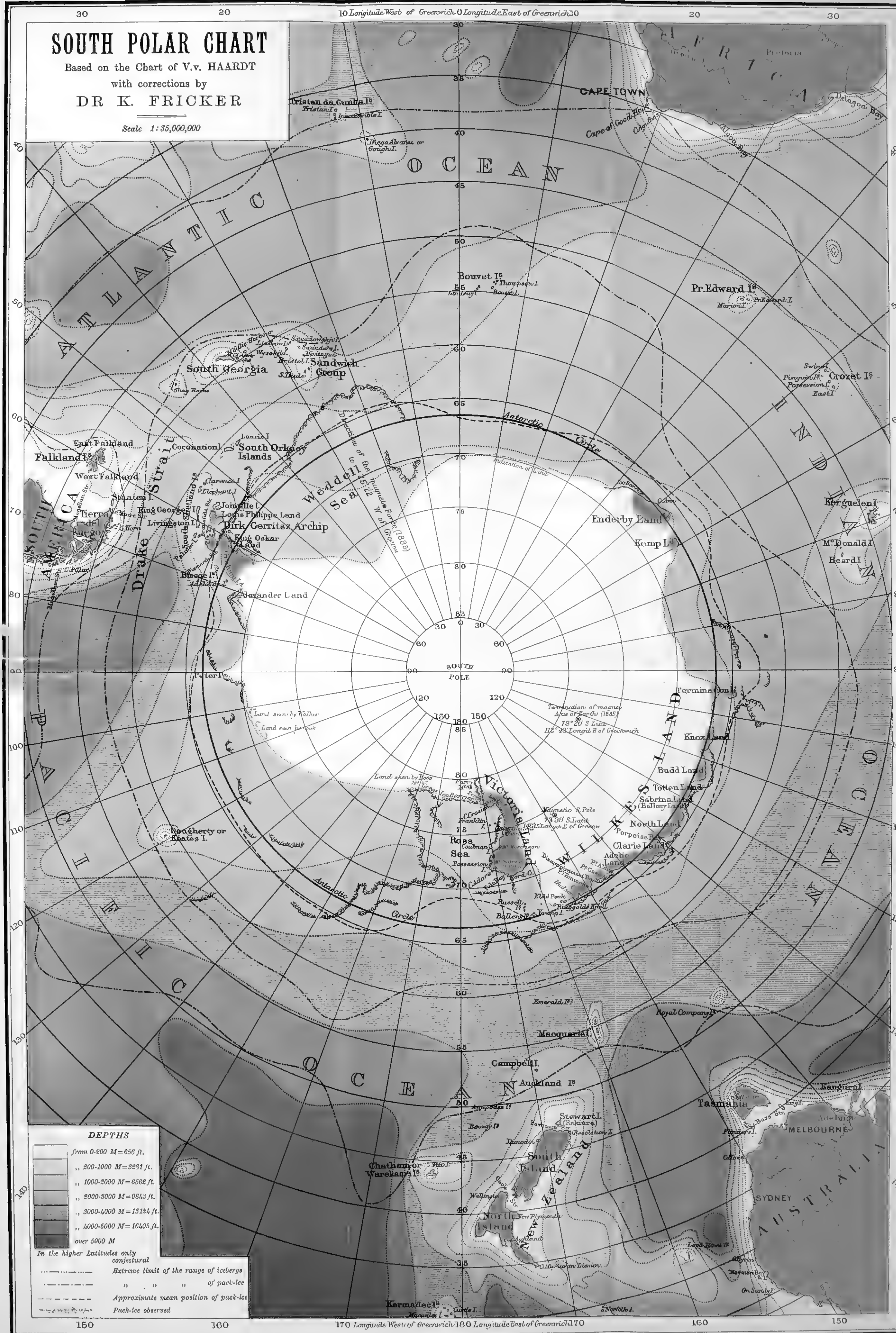
Antarctic discovery. Relying on this, the indefatigable advocate of Antarctic exploration in Germany once more brought the subject forward at the Geographical Congress of Bremen, and demonstrated its necessity for the domains of meteorology and terrestrial magnetism. He was supported by E. von Drygalski and E. Vanhöffen, the excellent investigators into the nature of the inland ice of

Greenland; the former pointed out the necessity of studying the nature of Antarctic ice, and the latter the problem of the origin of organic life in those regions. These appeals proved highly successful; the Geographical Congress appointed a committee under the chairmanship of G. Neumayer, instructing them "to consult on the possibility of speedily despatching to the Antarctic regions a German scientific expedition, and if the report should be favourable to initiate the first steps for its execution". This committee in its turn elected a Board consisting of a great number of eminent scientists and students of geography, and presided over by Neumayer. They elaborated a plan, determining the scientific and practical direction of the enterprise. They pointed out that its range should not be restricted to a mere extension of Antarctic topography, but that the study of meteorology, of terrestrial magnetism, of the shape of the globe, of zoology, botany and geology, and finally of the investigation of Antarctic ice, urgently required a winter sojourn in the Antarctic zone. This entailed the necessity of settling on a suitable place for winter quarters on land, and in order to keep up communication with the rest of the world the expedition must have a special ship at its disposal, in addition to another vessel engaged in studying the local geography, the distribution of land and water, and hydrography. If the operations are to have a permanent scientific value, they must extend over a period of not less than three years, which means a sojourn of two winters in those regions.

With respect to the quarter whence the expedition is to penetrate into the south polar regions, the Commission selected the route advocated by G. Neumayer for nearly fifty years, *viz.*, the meridian of Kerguelen, or thereabouts (70° to 85° E.), as, with the exception of the flying visit paid by the *Challenger*, this region has not yet been searchingly examined, and new results cannot fail to be secured—no matter whether land is met with or not. Moreover, this region is excellently fitted for the establishment of a station, because being nearly equidistant from the observatories of the Cape and of the south point of Australia, combined work could be undertaken. The district of Ross Sea and the neighbourhood of Graham's Land are disregarded, as they receive sufficient attention from English and Belgian explorers.

As for the practical arrangements : both the vessels of the expedition are to be steamers, of about 400 tons measurement, strengthened for ice navigation ; each is to be manned by a crew of thirty men, inclusive of four officers and four men of science. The cost of the whole undertaking would in round numbers be about £47,500 (950,000 Marks), which is to be raised by private subscriptions, and if possible by government subsidy.

All this was agreed upon more than two years ago, and meanwhile the elaboration of the scheme has been vigorously pushed forward. Will it ever be carried out? Will the German nation be mindful of what it still owes to science if it would retain its designation of the "Nation of Thinkers and Investigators?" Or will it once more allow itself to be outstripped even by smaller European nations? In this very southern summer a Belgian expedition, under De Gerlache has gone in search of the waters east of Graham's Land; a new whaling expedition, having E. Borchgrevingk on board, is reported to have started from Australia; it is intended that they should pass the winter at Cape Adare, and thence advance polewards on snow-shoes ; in England also and in the United States South Polar Expeditions, planned by Fridtjof Nansen, the greatest polar traveller of our day, are being taken in hand. Will Germany and German science again commit the oft-repeated mistake of being too late, and be content to accept the leavings of others? The prize is great, and independent of the inestimable results for geophysical science, the German scheme can contribute to prove the existence or non-existence of an Antarctic continent, as well as the connection of Wilkes Land and Enderby Land. We Germans should never forget what has been done for the advancement of science by the governments and private individuals of small and mostly poor nations, such as Sweden, Norway, Denmark, Holland and Belgium. German prosperity is advancing on all sides; it is assuredly much greater than it was when the *Germania* and the *Hansa* set out for East Greenland, *not* at the charge of any government, but supported by the contributions of private individuals of all classes, who were enthusiastic in the cause of science. Oh that Germany would find a Dickson and a Gamel, a Wilezek and a Sibirjakoff, not to mention hosts of others, so that German science may also have her share in the solution of this last and greatest problem of geography! Not merely the rich, but everybody who possesses knowledge of, and interest in, this undertaking can contribute his mite and aid in the realisation of this aspiration. The author of this present work will consider himself abundantly rewarded if he has been able by his labour to awaken a lively interest in German South Polar Exploration.



Swan Sonnenschein & Co., Lim., London.

LIST OF IMPORTANT BOOKS, ARTICLES AND MAPS.

(*a*) HISTORY OF EARLY DISCOVERY.

v. Wieser, Magalhaesstraße und Australkontinent a. d. Globen des Joh. Schöner. (On Amerigo Vespucci.) 1881.

S. Ruge, Das unbekannte Südland. Deutsche Geogr. Blätter. 1895. 3. P. 147. (Earliest conjectures down to Le Maire.)

De Brosses, *Histoire des Navigations aux Terres Australes.* 1756. (Specially important for Bouvet.)

Capt. Jas. Cook, *Voyage towards the South Pole and round the World.* 1777. 2 vols.

Burney, *A Chronological History of the Discoveries in the South Sea or Pacific Ocean.* 5 vols. 1803 *sqq.*

(*b*) HISTORY OF LATER DISCOVERY.

Edinburgh Philosophical Journal, iii., iv., v. 1820-22. ("Discovery and Exploration of the South Shetland Islands.")

Neue allgemeine geographische Ephemeriden; 7, 8, 9, 10, 14, 15, 16. 1820-22, 24-25. (The same.)

v. Bellingshausen, Zweimalige Untersuchungen im südlichen Eismeer und Reise um die Welt in den Jahren 1819-21. 1831 (in Russian). Short abstract:—

F. Lowe, Bellingshausens Reise nach der Südsee u. Entdeckungen im südl. Eismeer. Ermans Archiv für wissenschaftl. Kde. v. Rußland. II., 1842.

J. Weddell, *A Voyage towards the South Pole,* 1822-24. 1825.

Webster, *Narrative of a Voyage to the Southern Atlantic.* 2 vols. 1834. (Voyage of the *Chanticleer* under Captain Foster.)

Kendall, "An Account of the Island of Deception". *Journ. of the Roy. Geogr. Soc.* 1833. Pp. 62-66. (Foster's voyage.)

J. Biscoe, "Recent Discoveries in the Antarctic Ocean". *Journ. of the Roy. Geogr. Soc.* 1833. Pp. 105-12.

Nautical Magazine. 1835. Pp. 265-75. (Foster's voyage.)

J. Balleny, "Discoveries in the Antarctic Ocean, 1839". *Journ. of the Roy. Geogr. Soc.* 1839. (Notices of the same also in Ross, *inf.*)

J. S. C. Dumont d'Urville, *Voyage au Pôle Sud et dans l'Océanie,* 1841-54. (Vols. ii. and viii.; also Atlas Pittoresque.)

Chas. Wilkes, *United States Exploring Expedition.* 5 vols., and Atlas. 1845 *sqq.* (Vols. i. and ii.)

J. C. Ross, *Voyage of Discovery and Research to the Southern and Antarctic Regions.* 2 vols. 1846.

R. McCormick, *Voyages of Discovery in the Antarctic and the Arctic Seas.* 2 vols. 1884. (Vol. i. treats of the voyage of J. C. Roß.)

Moore, "Magnetic Voyage of the *Pagoda*". *Nautical Magazine.* 1846.

On Dallmanns Discoveries: essays by A. Schück in the Verhandlungen d. Vereins für naturw. Unterhaltung, V., Hamburg 1882, and Zeitschrift für wissensch. Geogr., VI., Weimar 1888.

W. Klutschak, Ein Besuch auf Süd-Georgien. Deutsche Rundschau für Geogr. u. Statistik. 1881.

H.M.S. Challenger: Report on the Scientific Results, etc. Narrative. Vol. i. London, 1885.

Die internationale Polarforschung. Die deutschen Expeditionen und ihre Ergebnisse. Herausgegeben v. G. Neumayer. 2 vols. Berlin 1891.

C. Mosthaff and H. Will, Die Insel Süd-Georgien. Deutsche Geogr. Blätter. 1884. VII., pt. 2.

Vogel, Über die Schnee- und Gletscherverhältnisse auf Süd- Georgien. Jahresbericht d. Geogr. Gesellsch. in München für 1885. Pt. 10.

Burn-Murdoch, *From Edinburgh to the Antarctic.* London, 1894.

(Larsen), Dr. J. Petersen, Die Reisen des „Jason" und der „Hertha" in das Antarktische Meer 1893/94. Reprint from the Mitteilungen d. Geogr. Gesellsch. in Hamburg 1895.

C. E. Borchgrevingk, "The *Antarctic's* Voyage to the Antarctic". *Geogr. Journ.* 1895. Vol. v. No. 6.

—— Über die Reise des Antarctic nach Viktoria-Land. Verhandlungen der Gesellsch. f. Erdkunde zu Berlin. 1895. Nos. 8 and 9.

H. J. Bull, *The Cruise of the "Antarctic" to the South Polar Regions.* London, 1896.

"Cruise of the *Balæna* and the *Active* in the Antarctic Seas, 1892-93." I. The *Balæna*, by W. S. Bruce. *Geogr. Journ.* 1896. Vol. vii. No. 5—II. The *Active*, by Charles W. Donald. *Geogr. Journ.* 1896. Vol. vii. No. 6.

(*c*) MOST IMPORTANT MODERN GEOGRAPHICAL WORKS ON THE ANTARCTIC.

A. Petermann, Petermanns neue Karte der Südpolar-Regionen. Petermanns Geogr. Mitteilungen. 1863.

G. Neumayer: A selection of the most important of his numerous works:—

(*a*) Die Erforschung des Süd-Polar-Gebietes. Berlin 1872. Zeitschr. der Gesellsch. f. Erdkunde (also as a „Sonderabdruck").

(*b*) Notwendigkeit und Durchführbarkeit d. antarkt. Forschung. Verhandlungen d. V. deutschen Geographentages zu Hamburg. Berlin 1885.

(*c*) Bericht über den Fortgang der Bestrebungen zu Gunsten der antarktischen Forschung. Verhandlungen d. VII. deutschen Geographentages zu Karlsruhe. Berlin 1887.

(*d*) Die neuesten Fortschritte zu Gunsten einer wissenschaftlichen Erforschung der antarktischen Region. Annalen der Hydrographie u. marit. Meteorologie. 21. Jahrg. 1893. XII.

(*e*) Über Südpolarforschung. Bericht des VI. Internationalen Geographenkongresses. London 1895.

F. Ratzel, Betrachtungen über Natur und Erforschung der Polarregionen. „Ausland" 1883 u. 1884. (Also as a separate impression.)

—— Aufgaben der geographischen Forschung in der Antarktis. Verhandlungen des V. Deutschen Geographentages in Hamburg. Berlin 1885.

A. Penck, Die erdgeschichtliche Bedeutung der Südpolarforschung. *Ibid.*

C. F. W. Peters, Die Bedeutung der antarktischen Forschung für die Geodäsie. *Ibid.*

H. Reiter, Die Südpolarfrage und ihre Bedeutung für die genetische Gliederung der Erdoberfläche. Zeitschrift für wissenschaftliche Geographie. Weimar 1887. Vol. vi. Pt. 1.

J. Murray, "The Exploration of the Antarctic Regions". 1886. *Scot. Geogr. Mag.* Vol. ii.

—— "The Renewal of Antarctic Exploration". 1894. *Geogr. Journ.* Vol. iii. No. 1.

K. Fricker, die Entstehung und Verbreitung des antarktischen Treibeises. 1893.

E. v. Drygalski, Die Südpolarforschung und die Probleme des Eises. Verhandlungen d. XI. deutschen Geographentages zu Bremen. Berlin 1895.

E. Vanhöffen, Welches Interesse haben Zoologie und Botanik an d. Erforschung des Südpolargebietes? *Ibid.*

(*d*) CHARTS AND MAPS.

Many of the above works contain maps, more especially those of Weddell, Dumont d'Urville, Wilkes and Ross. The more important recent maps are :—

1. General Maps of the whole South Polar Region.

G. Neumayer, Südpolarkarte nach dem gegenwärtigen Stand des geographischen und physikalischen Wissens. 1 : 40,000,000. Berlin 1872. Zeitschr. der Gesellsch. für Erdkunde.

J. Murray, "Exploration of the Antarctic Regions". *Scot. Geogr. Mag.* 1886. With map in the scale of about 1 : 45,000,000.

—— "Renewal of Antarctic Explorations". *Geogr. Journ.* 1894. Appended is a map of the South Polar Region in the same scale, as well as nine smaller maps representing marine sediments, ice, climate and terrestro-magnetism.

H. Reiter, Die Antarktis, 1 : 20,000,000. Zeitschrift für wissenschaftliche Geographie. 1887.

The most important maps in modern Atlases are :—

A. Petermann, Süd-Polar-Karte, 1 : 40,000,000. Stielers Handatlas, No. 7; and that in the *Atlas Universel* of Vivien de St. Martin and Schrader.

An excellent map on a large scale is the Südpolarkarte of—

Vincenz v. Haardt, 1 : 10,000,000, Vienna, 1895, with numerous insets exhibiting the physical conditions.

Two maps by the British Admiralty should finally be mentioned :—

Ice Chart of the Southern Hemisphere, No. 1241, and also

South Polar Chart, No. 1240.

The most valuable special map of recent times is :—

Friedrichsen, Originalkarte des Dirck-Gherrits-Archipels, mit Begleitworten. Hamburg, 1895.

INDEX.

THE ABERDEEN UNIVERSITY PRESS LIMITED.