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THE RENEWAL OF ANTARCTIC EXPLORATION.*

By JOHN MURRAY, Ph.D., LL.D., of the "Challenger" Expedition.

When we cast a retrospective glance at the history of knowledge concerning our planet, we find that nearly all the great advances in geography took place among commercial—and in a very special manner among maritime—peoples. Whenever primitive races commenced to look upon the ocean, not as a terrible barrier separating lands, but rather as a means of communication between distant countries, they soon acquired increased wealth and power, and beheld the dawn of new ideas and great discoveries. Down even to our own day the power and progress of nations may, in a sense, be measured by the extent to which their seamen have been able to brave the many perils, and their learned men have been able to unravel the many riddles, of the great ocean. The history of civilisation runs parallel with the history of navigation in all its wider aspects.

Horace and many other poets have sung the praises of the sailor who "first put forth on cruel ocean, in the frail rude bark." But in navigation, as in all other branches of human activity, there has been a slow, gradual, and laborious development from the construction and management of the simple raft by the river-side up to the ironclad and Atlantic greyhound of our own day. Many active and original minds, many stout and brave hearts, have contributed to these final results. The tempest-tossed sea is now no obstacle and no terror for the instructed mariner with a well-found ship. The "severance of the sea" has disappeared along with the ideas associated with the expression.

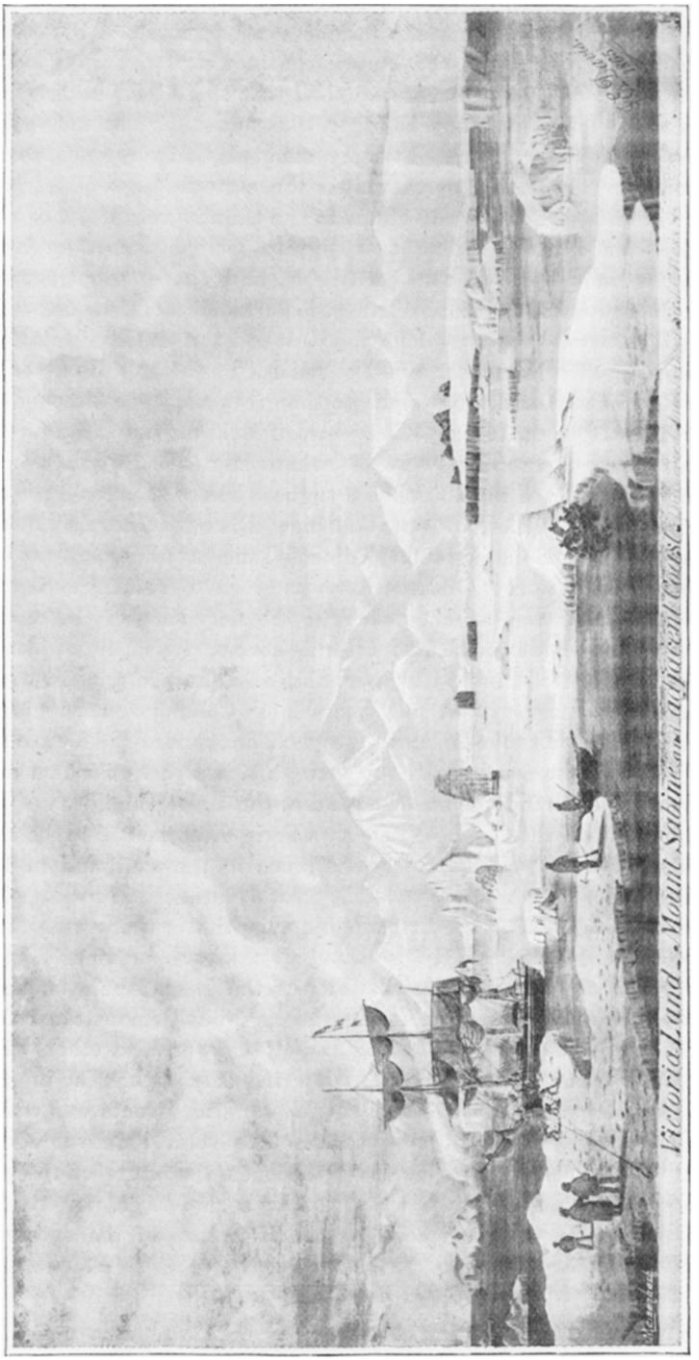
* Paper read at the Meeting of the Royal Geographical Society, November 27th, 1893. Map, p. 80.

Not only so, but the most profound depths of the wide mysterious ocean have in our own time been forced to yield up their hidden treasures to the persistent efforts of the modern investigator.

Is the last great piece of maritime exploration on the surface of our Earth to be undertaken by Britons, or is it to be left to those who may be destined to succeed or supplant us on the ocean? That is a question which this generation must answer.

The civilised nations at the birth of navigation were most probably in the same phase of development as the Pacific Islanders of the present day. Yet it is a most remarkable fact that at the very dawn of history we find a commercial people who were able to conduct voyages which rival those of the fifteenth century. Long before the oldest Hebrew and Greek records, the Phœnicians had settled all over the Mediterranean; they were in the Ægean fourteen, and at Gades on the Atlantic eleven, centuries before the Christian era; they made long voyages in the Erythræan Sea or Indian Ocean, as well as on the Atlantic beyond the Pillars of Hercules. Herodotus tells us that, about six hundred years before Christ, Phœnician sailors reported that, in rounding Africa to the south, they had the sun on their right hand. "This, for my part," says Herodotus, "I do not believe; but others may." This observation as to the position of the sun is, however, good evidence that the expedition of Necho really took place. At all events this is the first hint to be found in literature of a visit to the Southern Hemisphere, and we do not meet with any more definite and satisfactory information till the time of the Renaissance.

For all practical purposes, the views of the later Greek philosophers, with reference to the figure and position of the Earth did not differ from those of the modern geographer, except in the difference between the geocentric and heliocentric standpoints. Eratosthenes estimated the circumference of the Earth at 25,000 miles, a very remarkable approximation to the truth, and we find him speculating, eighteen centuries before Columbus and Magellan, on the possibility of circumnavigating the globe. The ancients divided the surface of the Earth into five zones. The torrid zone was uninhabitable from heat; the two frigid zones towards the poles were uninhabitable from cold, and in the Southern Hemisphere there was a temperate zone similar to that of the Northern Hemisphere in which the known world was situated. Aristotle does not say that the southern temperate zone is inhabited, but Strabo admits that there may be other worlds inhabited by a different race of men. Pomponius Mela, who lived in the first century of our era, speaks as an undoubted fact of the existence of the autochthones inhabiting continental land in the Southern Hemisphere, although this land was inaccessible owing to the heat of the intervening torrid zone. Mela held, like most of his predecessors, that the habitable world of Europe, Asia and Africa, formed a single island surrounded by the all-



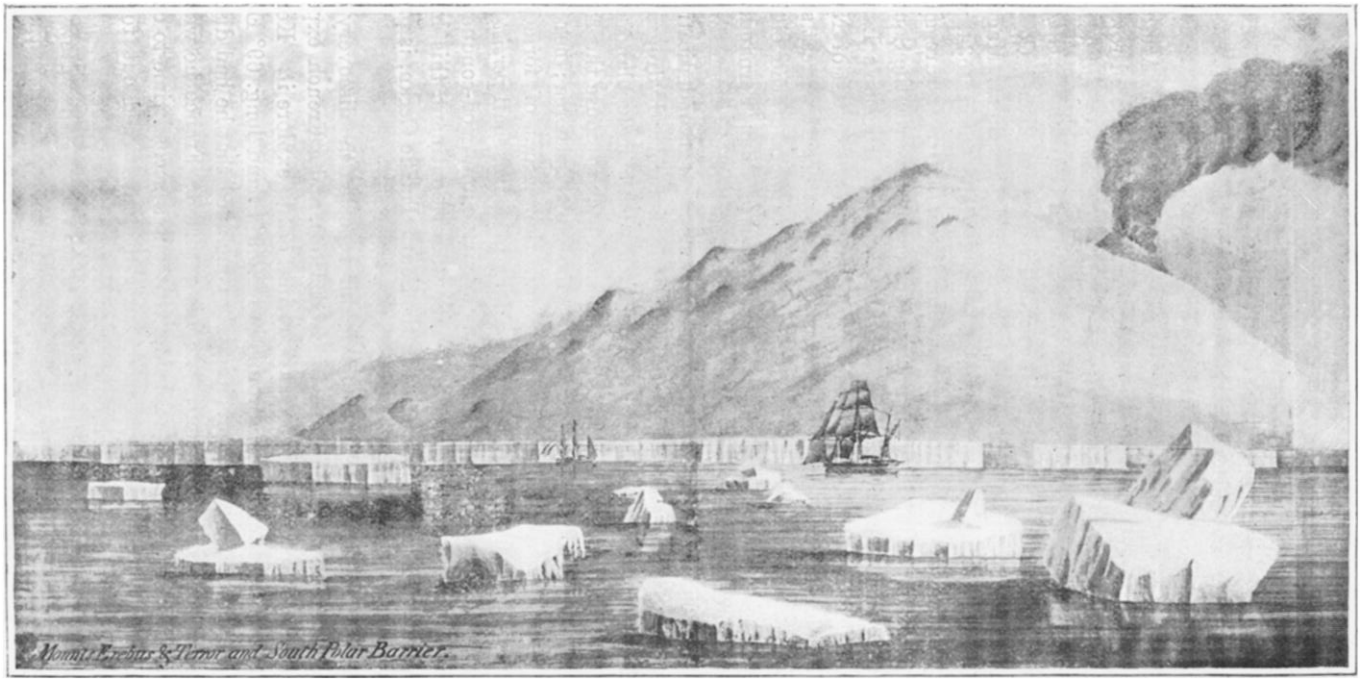
VICTORIA LAND: MOUNT SABINE AND ADJACENT COAST.

encircling sea. Marinus of Tyre, who lived in the second century, rejected this view, and returned to the less correct notion of Hipparchus, who had maintained that the known continents were united to other similar masses of land still unknown, and that the Atlantic and Indian Oceans were separated from each other, thus forming great enclosed seas such as the Mediterranean. Ptolemy adopted the views of Marinus, and consequently in his maps united the eastern coast of Africa by unknown lands or Southern Ethiopia to the Chinese coast.*

The science and learning of antiquity were swept away by the destructive incursions of the barbarians, and there is retrogression rather than progress to record during the dark and middle ages.

The Portuguese voyages along the west coast of Africa, initiated by Prince Henry, the Navigator, must be regarded as among the first fruits of the Renaissance, and the prelude to the great maritime discoveries of the 15th and 16th centuries. The views of Mela prevailed in Portugal, whereas those of Ptolemy were elsewhere supreme. By the time of Prince Henry's death in 1460, the Portuguese had reconnoitred the coast of Africa for 1700 miles, and Bartholomew Diaz reached and doubled the Cape of Good Hope in 1486. This most successful voyage produced an immense sensation. A death-blow was given to Ptolemy's view that the Indian Ocean was an enclosed sea; the fiery zone of the ancients had been crossed; the southern temperate zone of Aristotle, Strabo, and Mela had been reached, and it was inhabited. The air was filled with the noise of discovery. A few years later Columbus made his ever famous voyage across the Atlantic, Vespucci announced the discovery of a new world in the Southern Hemisphere, *a fourth part* unknown to the ancients. The Portuguese sailed to India, the Spice Islands, and even China by way of the Cape. From a peak in Darien, Balboa beheld a boundless ocean beyond the new found lands in the west, and in 1520, Magellan passed into and crossed this great ocean, which he called the Pacific, thus completing the first circumnavigation of the world. These great voyages doubled at a single bound all that was previously known of the Earth's surface. The sphericity of the Earth, the existence of antipodes, were no longer scientific theories, but demonstrated facts. The loss or gain of a day in sailing round the world, together with a multitude of other unfamiliar and bewildering facts, struck the imagination, and altogether the effect of these startling events was without parallel in the history of the world. The solid immovable earth beneath men's feet was replaced by the mental picture of the great floating globe swung in space, supported by some unseen power. This grand conception can be traced in the literature of the succeeding

* See Murray, "The Discovery of America by Columbus," *Scot. Geogr. Mag.*, vol. ix. p. 561. 1893.



MOUNTS EREBUS AND TERROR AND SOUTH POLAR BARRIER.

century. Bacon and Milton had the image of the huge spinning globe continually before them, and Shakespeare's spirit seemed

> "To reside
> In thrilling region of thick-ribbed ice;
> To be imprison'd in the viewless winds
> And blown with restless violence round about
> The pendent world."

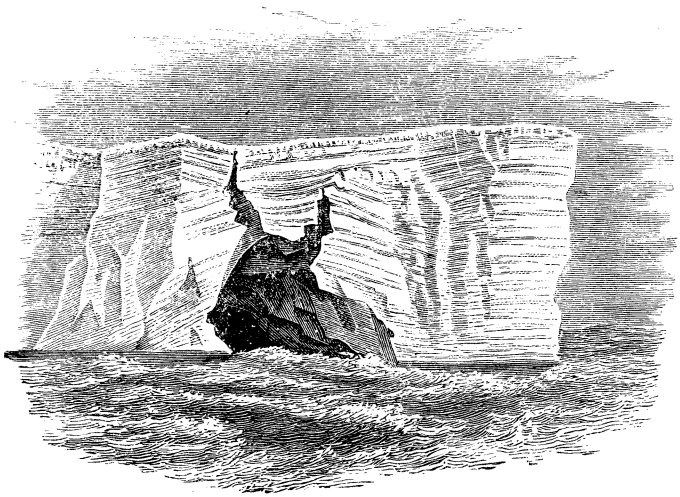
Although many voyages were soon undertaken to the Arctic, centuries passed away before maritime exploration was directed towards the Antarctic regions. The unknown lands of Ptolemy and other geographers, though now cut off from the northern continents, still retained their place on charts down to the second voyage of James Cook, under the names of Southern Ethiopia, the Austral Continent, Magellanica, Regio Brasilio, and Regio Patalis. On a globe dated 1534, which I lately examined at Weimar, mountains, lakes, and rivers are shown on a large extent of land in the Pacific, stretching towards the South Pole. In 1642 Tasman showed that Australia and Van Diemen's Land were surrounded by the ocean to the south, but the west coast of New Zealand, which he visited, was believed to be a part of the great southern continent, and this was held by some geographers of the eighteenth century to extend as far east as the island of Juan Fernandez, to be greater in extent than the whole civilised part of Asia, and to contain fifty millions of inhabitants. Here is a part of the dedication of a collection of voyages, published in 1770, by a former hydrographer of the Navy: "Not to him—who infatuated with female blandishments, forgot for *what* he went *abroad* and hastened back to amuse the European world with stories of *enchantment* in the New-Cytherea; BUT to—the man—who *emulous* of Magalhanes, and the heroes of former times, *undeterr'd* by difficulties, and *unseduc'd* by pleasure, shall *persist* through *every* obstacle, and not by chance, but by virtue and good-conduct *succeed in establishing an intercourse with* a Southern Continent, this historical collection of former discoveries in the South Pacific Ocean, is presented by Alexander Dalrymple."

About this time a French navigator reported the discovery of land to the south-east of the Cape of Good Hope, and a French expedition, under M. de Kerguelen, was sent out in 1772 to explore it. Kerguelen sighted land with high mountains in lat. 49° S. and long. 69° E., sent a boat on shore, and rather precipitately concluded that he had discovered the great southern continent. On his return to France he was hailed as a second Columbus, but on being sent out a second time to complete his discovery, the supposed southern continent turned out to be the almost barren island which now bears Kerguelen's name.

During his first expedition James Cook showed that New Zealand was an island, and that there was no southern continent in the Pacific north of the parallel of 40° S. Cook's second expedition, in 1772, was

undertaken with the express purpose of settling once for all this question of a southern continent; and he crossed the whole southern ocean in such a manner as to leave no room for doubt that, if such a continent did exist, it must be situated within the Antarctic Circle, and must be covered with perpetual snow and ice.

Cook reached latitude 71° 10′ S., in longitude 106° 54′ W., and here he probably saw the ice-barrier and mountains beyond. He believed there was a tract of land towards the South Pole extending further north in the Atlantic and Indian Oceans than elsewhere, and says—"It is true, however, that the greatest part of this southern continent (supposing there is one) must lie within the Polar circle, where the sea is so pestered with ice that the land is thereby inaccessible. The risque one runs in exploring a coast in these unknown and icy seas is so very great



ICEBERG AS SEEN FROM H.M.S. "CHALLENGER," FEBRUARY 23RD, 1874.

that I can be bold enough to say that no man will ever venture farther than I have done, and that the lands which may lie to the south will never be explored. Thick fogs, snow-storms, intense cold, and every other thing that can render navigation dangerous, must be encountered, and these difficulties are greatly heightened by the inexpressibly horrid aspect of the country, a country doomed by nature never once to feel the warmth of the sun's rays, but to lie buried in everlasting snow and ice. The ports which may be on the coast are, in a manner, wholly filled up with frozen snow of vast thickness; but if any should be so far open as to invite a ship into it, she would run a risque of being fixed there for ever, or of coming out in an ice island. The islands and floats on the coast, the great falls from the ice-cliffs in the port, or a heavy snow-storm attended with a sharp frost, would be equally fatal."

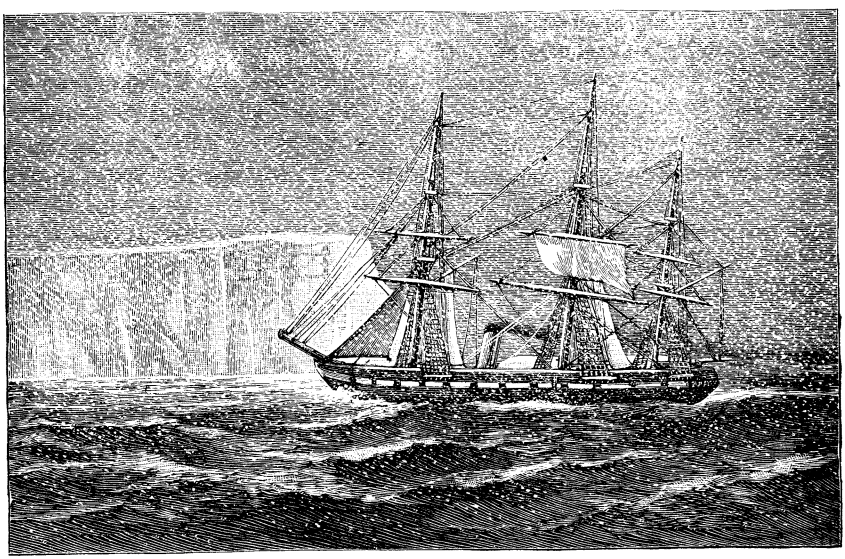
Two navigators have, however, ventured further than Cook. Weddell in 1823 penetrated to 74° S., but saw no land. Sir James Clark Ross in 1841 and 1842 reached the 78th parallel, and discovered Victoria Land. These three explorers, Cook, Weddell and Ross, are the only ones who have passed beyond the 70th parallel of south latitude.

A great many expeditions have sailed between the 60th and 70th parallels, and nearly all of them have discovered land in these southern latitudes. In 1819 Smith discovered the South Shetlands to the south of Cape Horn, and soon afterwards a brisk seal fishery among English and American sealers sprang up in these waters, the seal-skins bringing a high price in China. Bellingshausen discovered the islands of Alexander and Peter the Great; D'Urville discovered Adélie Land; the United States exploring expedition discovered Wilkes' Land; Powell discovered the South Orkneys; Biscoe discovered Enderby's Land; Balleny discovered the Balleny Islands and Sabine Land, and Dallman more recently discovered Kaiser Wilhelm Islands and Bismarck Strait to the north of Graham's Land.

The greatest, the most successful and most important expedition to the Antarctic was, however, that of Sir James Clark Ross, just referred to, between the years of 1839 and 1843. He has furnished more trustworthy information than all the preceding and succeeding expeditions put together. The chief object of the expedition was to make magnetic observations, and these were carried out with marked success. Ross, who had previously planted the flag of his country on the north magnetic pole, even sailed within 160 miles of the south magnetic pole. During the expedition Ross threw a flood of new light on the physical and biological conditions of the Antarctic. He discussed his meteorological observations, and pointed out the permanently low atmospheric pressure of the Southern Hemisphere; he took surface and deep-sea temperatures with much regularity; he became a pioneer in accurate deep-sea sounding and deep-sea dredging; he recognised that the animals from deep water were almost identical with those found at similar depths by his uncle in the Arctic, and he prophesied that a nearly uniform low temperature would ultimately be found everywhere in deep water, and that living animals would be found at the greater depths all over the floor of the ocean. In the account of his voyage we find the best expression of all the anxieties, the dangers, the sufferings, the charms and fascination, which accompany work in these bitter, appalling, and magnificent realms of ice, where snow-storms, fogs and gales alternate with brilliant sunshine.

In January 1841, after passing heavy pack-ice far to the south of New Zealand, Ross discovered Victoria Land, consisting of mountain ranges from 7000 to 12,000 and 15,000 feet in height. To the east he found open navigable water with off-lying islands, on two of which —Possession and Franklin Islands—he landed. This bold coast was

traced for 500 miles to the south, where it terminated, in latitude 78° S., in the volcanic cones of Mounts Erebus and Terror, Mount Erebus at the time vomiting forth flame and lava from an elevation of 12,000 feet. Glaciers descending from the mountain summits filled the valleys and bays of the coast, and projected several miles into the sea. It was impossible to enter any of the indentations or breaks on the coast, where, in other lands, harbours usually occur. On some days the sun shone forth with great brilliancy from a perfectly serene and clear sky of a most intense indigo blue, and the members of the expedition gazed with feelings of indescribable delight upon a scene of grandeur and



H.M.S. "CHALLENGER" AFTER COLLISION WITH AN ICEBERG, FEBRUARY 24TH, 1874.
(*From a sketch by Lieut. Aldrich, R.N.*)

magnificence beyond anything they had before seen or could have conceived.

From the eastern foot of Mount Terror, Ross found a perpendicular wall of ice from 150 to 200 feet in height, extending away to the east, through which, as he says, there was no more chance of sailing than through the cliffs of Dover. He traced this ice-barrier in an east and west direction for 300 miles: and within a mile of it he obtained a depth of 260 fathoms, with a fine soft mud at the bottom. In the following season Ross was not so successful; for weeks he was a prisoner in the pack-ice. Still, he reached the ice-barrier again in latitude 78° 10′ S., a little to the east of his position in the previous year, but no new land was discovered. In the third season Ross made explorations among the islands to the south of Cape Horn, landing on Cockburn Island, but his attempts to follow in the track of Weddell

were unsuccessful, owing to the heavy pack-ice encountered throughout the season.

It must be remembered that Ross was the only Antarctic explorer provided with ships properly strengthened and fortified, and this probably accounts for his remarkable performances in the pack-ice. The oftener I read the account of this magnificent expedition, the more do I wish that another such commander, and another such expedition, might be sent out from this country, provided with steam-power and all the appliances for investigation which the experience of the past fifty years would be able to suggest. With the same amount of good luck, priceless additions would certainly be made to human knowledge.

The *Challenger* was the first, and up to the present time the only steam-vessel which has crossed the Antarctic circle. She was wholly unprotected for ice-work. Her contributions towards the solution of Antarctic problems belong for the most part to the deeper regions of the Antarctic Ocean. During last year, some interesting observations have been furnished by the Scotch and Norwegian whalers, who visited the seas and islands immediately to the south of Cape Horn.

After this brief review of Antarctic exploration we may ask: What is the nature of the snow- and ice-covered land observed at so many points towards the South Pole? Is there a sixth continent within the Antarctic circle, or is the land nucleus, on which the massive ice-cap rests, merely a group of lofty volcanic hills? This is a question still asked and answered differently by naturalists and physical geographers. To my mind there seems to be abundant evidence that there exists in this region a vast extent of true continental land, the area of which is greater than that of Australia, or nearly 4,000,000 square miles. Of all the bold southern explorers Ross and D'Urville are the only two who have set foot on land within the Antarctic circle. I can find no record of any ship having come to anchor within the Antarctic area, or indeed south of the latitude of 60° S., although Ross met with shallow enough soundings off Possession Island, and Wilkes found 19 fathoms in Piner's Bay, Adélie Land.

Ross reports the rocks of Possession, Franklin and Cockburn Islands, on which he landed, to be of volcanic origin, and in his dredgings to the east of Victoria Land in depths from 200 to 400 fathoms, he likewise procured many volcanic rocks along with some fragments of a grey granite.* All explorers report the islands to the south of Cape Horn to be composed of volcanic rocks, but the recent soundings in this vicinity by Mr. Bruce indicate the presence of metamorphic and even sedimentary rocks, and Dr. Donald has brought home some interesting

* McCormick compares the mountains of Victoria Land to those of Auvergne in France. His sketches are very different from those of Davis, in showing much more geological structure and much less snow and ice. See R. McCormick, 'Voyages of Discovery in Arctic and Antarctic Seas;' Vol. I., London, 1884.

tertiary fossils collected last year on Seymour Island by a Norwegian whaler.* We have thus very good reasons for assuming that in the Antarctic, facing the great Pacific Ocean, there is a chain of active and extinct volcanic cones, rising in Mounts Erebus and Melbourne to 12,000 and 15,000 feet, similar to, or rather a continuation of, that vast chain of volcanoes which more or less completely surrounds the whole Pacific, facing, so to speak, the circle of continental land looking out on that great ocean basin.

When we remember that their ships were wholly unprotected for ice, the voyages of D'Urville and Wilkes to the Antarctic circle south of Australia must be regarded as plucky in the extreme. At Adélie Land D'Urville passed through the vast tabular icebergs and reached open water within a few miles of the land, which at that point rose to a height of 2000 and 3000 feet. Here the members of the expedition landed on a small island about 600 yards from the mainland. The rocks are described as granite and gneiss, and from the description of their hardness there can be little doubt that the fundamental gneiss so characteristic of continental land was here exposed. Wilkes was unable to reach land, but in the same locality he found very shallow water, and landed on an iceberg covered with clay, mud, gravel, stones, and large boulders of red sandstone and basalt, 5 or 6 feet in diameter.

There is another way in which a great deal may be learnt concerning the nature of Antarctic land. During the *Challenger* expedition transported fragments of continental rocks were never found towards the central portions of the great ocean basins in tropical and subtropical regions. The only rocks dredged from these areas were fragments of pumice or angular rock-fragments of volcanic origin. In the Central Pacific, however, as the fortieth parallel of south latitude was approached—therefore just beyond the limit to which Antarctic icebergs have been observed to drift—a few rounded fragments of granite and quartz were dredged from the bottom of the sea; similar fragments were obtained in the South Atlantic in high latitudes, and as the *Challenger* proceeded towards the Antarctic circle in the South Indian Ocean these fragments of continental rocks increased in number till, at the most southerly points reached, they, along with the mineral

* Messrs. G. Sharman and E. T. Newton, F.R.S., palæontologists to the Geological Survey, state that the nine fossils from Seymour Island are of much interest from a geological point of view. They are weathered and somewhat denuded, indicating, probably, a long exposure upon a seashore. They belong to the following well-known forms: Five to *Cucullæa*, one to *Cytherea*, one to *Natica*, and two are pieces of coniferous wood. All these genera have a wide distribution in time, and consequently tell little as to the age of the fossils; but some of the shells present so close a resemblance to species known to occur in lower tertiary beds in Britain, and to others of about the same age, recorded by Darwin and Baker, from Patagonia, as to make it highly probable that these Antarctic fossils are likewise of lower tertiary age.

particles and muddy matter derived from continental land, made up by far the larger part of the deposit. These fragments consisted of granites, quartziferous diorites, schistoid diorites, amphibolites, mica schists, grained quartzites, sandstone, a few fragments of compact limestone, and partially decomposed earthy shales. These lithological types are distinctly indicative of continental land, and, remembering what has just been said as to their distribution, it seems wholly unnecessary to refute the suggestion that these fragments may have been transported from the northern continents.

Glauconite is another mineral which was procured in the blue muds near Antarctic land. This mineral fills the shells of foraminifera and other calcareous organisms, and has been found in the muds along nearly all continental shores where the *débris* of continental rocks makes up the greater part of the deposit. Glauconite is now in process of formation in all these positions, but it is apparently wholly absent from the pelagic deposits of the great ocean basins far from continental land, as well as from the deposits around volcanic islands. Its presence in the blue muds of the far south is therefore most suggestive of an Antarctic continent.

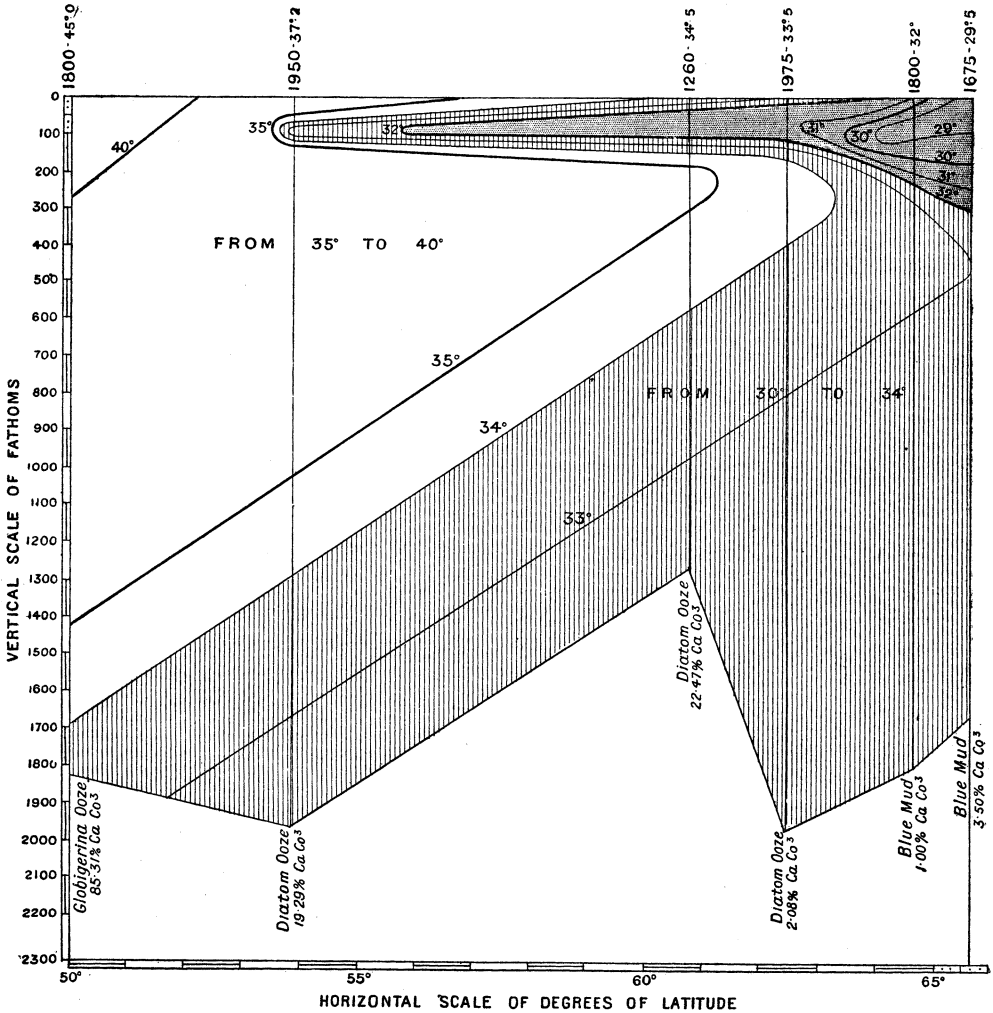
When we come to estimate the extent of this sixth continental area, greater difficulties are presented. A knowledge of the depths of the surrounding ocean would enable the outlines to be drawn with great exactitude, but unfortunately the positions where accurate soundings have been taken are few and far between. In the South Pacific, South Atlantic, and South Indian Oceans, between the latitudes of 30° and 50° south, we have most excellent lines of soundings right round the world, and in these latitudes the average depth of the ocean is over 2300 fathoms, or about $2\frac{1}{2}$ miles.* Between the latitudes of 50° and 65° south, the indications we possess appear to show a gradual shoaling, with an average depth of about 1700 fathoms, or nearly 2 miles. I have been criticised for showing on bathymetrical charts a great depth in the Southern Ocean to the south-west of South Georgia. This has been done because of a sounding by Ross, who paid out 4000 fathoms of line at this spot without finding bottom. Ross knew perfectly well how to take deep-sea soundings, and his observation seems to show that the ocean is here deeper than 4000 fathoms, and this may well be accepted till disproved by more trustworthy results; besides the temperature of the deep-water to the east of South America points to a great depth in this region. The depths obtained by the *Challenger* in the neighbourhood of the Antarctic circle were 1675, 1800, and 1300 fathoms, and judging from the nature of the deposits I think all these were within 100 or 200 miles from land. Wilkes obtained depths of 500 and 800 fathoms about 20 or 30 miles from the

* See accompanying map of South Polar area.

shore of Adélie Land, and Ross obtained many soundings of from 100 to 500 fathoms all over a great bank extending 200 miles to the east of Victoria Land; similar depths have been found to extend to some

MERIDIONAL TEMPERATURE SECTION

Between the Parallels of 50° and 65° South Lat.



distance to the east of Joinville Land to the south of Cape Horn. We have no trustworthy indications of ridges, barriers, or banks extending far northwards from Antarctica. It is therefore most probable that the

northern continents are everywhere cut off from the Antarctic land-mass by a depth approaching to, if not exceeding, 2 miles. Taking all these indications into consideration I have shown on the map what I believe to be the probable position and extent of Antarctica. Like other continents it would appear to have mountain ranges with volcanoes facing one ocean, and lower hills and great lowland plains stretching towards the other ocean basins. In order to account for the distribution of terrestrial organisms in the Southern Hemisphere, some naturalists believe that there must have been in recent geological times a great extension of Antarctica towards the tropics. However this may be, all will agree that a very necessary preliminary to any profitable discussion of so difficult a subject must be a fuller knowledge of the present conditions that prevail throughout the Southern Hemisphere, such as a new expedition alone can be expected to supply.

All observers agree in representing the great Antarctic land-mass to be buried beneath a heavy capping of perpetual ice and snow. The nucleus of rock is only revealed in off-lying islands, or on the face of high and bold escarpments. The outlines and larger features of the mountain ranges are not obliterated in the high land near the coasts at all events, for peak after peak with varied contours are seen to rise, one behind the other, towards the interior.

The snow and ice which descend from the steep seaward face of the Admiralty and Prince Albert Ranges of Victoria Land, while filling up the valleys and bays, do not present an inaccessible face of ice at all parts of the coast, although this is often stated to be the case. Ross himself says: "Had it been possible to have found a place of security (for the ships) upon any part of this coast, where we might have wintered in sight of the brilliant burning mountain, and so short a distance from the magnetic pole, both of these interesting spots might easily have been reached by travelling-parties in the following spring." McCormick, a member of Ross's expedition, recommends Macmurdo Bay, at the foot of Mount Erebus, as a place where winter quarters might be found, and hints that there would be no difficulty in ascending and travelling over the land.

The ice and snow, however, which form on the slopes of the mountain ranges facing the interior of Victoria Land, descend to the lower reaches of the continent, where they accumulate in vast undulating fields and plains, hundreds of feet in thickness, and ultimately this great glacier or ice-cap is pushed out over all the low lands into the ocean, forming there the true ice-barrier, a solid perpendicular wall of ice, probably from 1200 to 1500 feet in thickness, rising from 150 to 200 feet above, and sinking 1100 to 1400 feet below, the level of the sea. When the forefronts of this great creeping glacier are pushed into depths of about 300 or 400 fathoms, large stretches are broken off, and float away as the oft-described, perpendicular-faced, horizontally-stratified, table-topped

icebergs of the Antarctic and Southern Oceans, which may be miles in length, and usually float from 150 to 200 feet in height above the sea-surface.*

No sooner do these great ice-islands—these majestic and sublime sentinel outposts—of Antarctica sail forth on their new career, than they collide the one with the other; the fragments of impact are scattered over the surface of the ocean, and, with similar fragments derived from the steeper land slopes, with salt-water ice, and accumulations of snow, they form what is known as the *pack*. This pack, when heavy and closely-set, has been erroneously called by Wilkes and other writers the ice-barrier—a name which should only be used to designate the solid continuous ice-wall that is pushed into the sea from the central regions of the continent, such as that along which Ross sailed for 300 miles.

Waves dash against the vertical faces of the floating ice-islands as against a rocky shore, so that at the sea-level they are first cut into ledges and gullies, and then into caves and caverns of the most heavenly blue,† from out of which comes the resounding roar of the ocean, and into which the snow-white and other petrels may be seen to wing their way through guards of soldier-like penguins stationed at the entrances. As these ice-islands are slowly drifted by wind and current to the north, they tilt, turn, and sometimes capsize, and then submerged prongs and spits are thrown high into the air, producing irregular pinnacled bergs higher possibly than the original table-shaped mass. As decay proceeds, the imprisoned boulders, stones, and earth are deposited over the ocean's floor as far as sub-tropical regions.

The late Mr. Croll used to speak of an accumulation of ice and snow at the South Pole 10 and even 20 miles in thickness; but from all we know of the properties of ice, and the relation of its melting- or freezing-point to temperature and pressure, it is highly improbable that such a thickness of ice will be found on any part of the Antarctic continent. If the snow-cap rests on rock of a temperature half a degree below the

* A floating iceberg will have 89·6 per cent. of its volume immersed if it have the same temperature and consistency throughout. The upper layers of these ice-islands are, however, much less dense than the deep-blue lower layers, and therefore it is most probable that the height above water is about one-seventh of the total thickness of the berg.—See Murray, "The Exploration of the Antarctic Regions," *Scot. Geogr. Mag.*, vol. ii. p. 553. 1886.

† The deep-blue colour is due to the fact that all the air has been expelled from the deeper parts of the ice-cap by the constant melting and regelation which takes place throughout the whole mass as it moves over the land. When a cannon-ball was fired into this azure-blue ice the ball did not penetrate, but large masses of ice fell away, the fractures having a conchoidal appearance like glass. When a ball was fired into the upper areolar white layers of a table-berg it penetrated without producing any visible effect. Fragments of the white areolar layers were subjected to pressure and impact on board ship, and it was observed that these fragments could be easily deformed, while fragments of the transparent azure-blue ice behaved quite differently under the same tests, resembling a purely crystalline substance.

freezing-point, then the greatest thickness of ice formed on the continent would not likely exceed 1600 or 1800 feet, and this appears to be just a little more than the greatest thickness of the great ice-barrier when it is floated off into the ocean as ice-islands. This may possibly represent the greatest thickness that can be formed under existing conditions.* A party of well-equipped observers—who should spend a winter on the Antarctic continent—would doubtless bring back valuable information for the discussion of this interesting problem—such as serial temperatures from borings in the ice-cap, both vertically and horizontally, the temperature of the Earth's surface beneath the ice, whether or not water runs away from under the glaciers, as well as observations concerning the appearance of the upper surface of the ice-fields and the motion of the ice over the land.

Our knowledge of the meteorology of the Antarctic regions is limited to a few observations during the summer months in very restricted localities, and is therefore most imperfect. One of the most remarkable features in the meteorology of the globe is the low atmospheric pressure, maintained in all seasons, in the Southern Hemisphere south of latitude 40° S., with its inevitable attendant of strong westerly winds, large rain and snowfall, all round the globe in these latitudes. The observations hitherto made point to the existence over certain parts of these latitudes of a mean pressure of 29·000 inches and under—as, for example, to the south-east of the Falkland Islands, and to the south-east of New Zealand.

On the other hand, in the Arctic regions there is in the winter months no such system of low pressure in similar latitudes, but instead there are two systems of low pressure, having a mean of 29·500 inches, which are absolutely restricted to the northern portions of the Atlantic and Pacific Oceans. Over the rest of the Arctic regions proper, the mean atmospheric pressure exceeds 30·000 inches, being, roughly speaking, about the same as the mean pressure of London. In accordance with this distribution of pressure, observations show that northerly

* See Murray, *op. cit.*, p. 535: 1886. The motion of glaciers is often compared to that of rivers and of viscous bodies; but these comparisons are not strictly correct, and may sometimes be misleading. The peculiarity of ice motion and its erosive power appear to be largely due to the fact that its melting or freezing-point varies with temperature and pressure. The pressure being unequally distributed throughout the glacier, minute crystals of ice are melted where the pressure is greatest; the resulting water occupying less space, regelation at once takes place, and where the ice is wholly compact and crystalline pressure is exerted in all directions, motion taking place in the path of least resistance. The immense thickness of ice sometimes invoked does not seem necessary to account for the erosive effects produced by glaciers. The stratified appearance of the southern icebergs is evidently due to the constant melting and regelation which go on throughout the ice-cap; in the deeper parts of the bergs these layers are not thicker than wafers, and where the ice is wholly crystalline the layers disappear altogether.

winds immensely preponderate over Arctic and sub-Arctic regions. The large number of meteorological observations made during the present century in the high latitudes of the Northern Hemisphere place these facts in the clearest light, and they are admirably represented by Dr. Buchan in his new isobaric charts which accompany the *Challenger* Report.

In the Northern Hemisphere the land almost completely surrounds the Arctic Ocean; in the Southern Hemisphere the open ocean completely surrounds the Antarctic continent, and this open ocean carries with it the low barometric pressure all round. Now if the low pressure still further deepened with increase of latitude towards the South Pole, it is certain that the prevailing winds over all these high latitudes would be north-westerly and northerly. But the observations made by Ross, the *Challenger*, and more recently in latitudes higher than 60° S., by the Dundee whalers and others, quite unanimously tell us that, in these high southern latitudes, the predominating winds are southerly and south-easterly. Thus during the winter of 1892–93, in latitudes higher than 60° S., half of the whole winds recorded by the *Diana* were south, south-east and east, being directions opposite to the winds which would certainly prevail if pressure diminished steadily to the South Pole. Such surface currents as have been observed in the Antarctic Ocean come also from south and south-east.

All the teaching of meteorology therefore indicates that a large anticyclone with a higher pressure than prevails over the open ocean to northwards overspreads the Antarctic continent. While this anticyclonic region may not be characterised by an absolutely high pressure at all seasons, it must be high relatively to the very low pressure which prevails to the northward. The southerly out-flowing winds which accompany this anticyclone will be dry winds and attended by a small precipitation. It is probable that about 74° S. the belt of excessive precipitation has been passed, and it is even conceivable that at the pole precipitation might be very little in excess of, or indeed not more than equal to, the evaporation. Even one year's observations at two points on the Antarctic continent might settle this point, and enable us to form a tolerably complete idea of the annual snowfall and evaporation over the whole continent. An approximate estimate might then be given of the annual discharge from the solid glacier rivers into the surrounding ocean. Indeed it is impossible to over-estimate the value of Antarctic observations for the right understanding of the general meteorology of the globe.

Not less interesting than the meteorology of the land-area is that of the ocean in southern latitudes. In the neighbourhood of the Antarctic circle the temperature of the air and sea-surface is even in summer at or below the freezing-point of fresh water. A sensible rise takes place about the sixtieth parallel, and a temperature of 38° Fahr. has been recorded in that latitude in March for both the air and sea-surface.

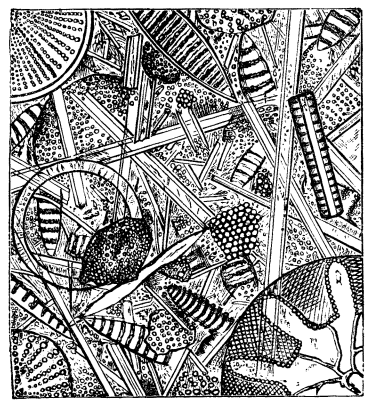
The general result of all the sea-temperatures observed by Cook, Wilkes, Ross, and the *Challenger*, in the Antarctic Ocean shows that a layer of cold water underlies in summer a thin warm surface stratum and overlies another warm but deeper stratum towards the bottom. The cold stratum extends like a wedge northwards for about 12°. At depths between 50 and 300 fathoms at the southern thick end of the wedge the temperature is 28° Fahr., and at the northern thin end of the wedge it increases to about 32·5° at 80 fathoms. The surface layer ranges from 29° in the south to 38° in the north, and the deeper bottom layers range from 32° to 35°. See diagram on p. 13.

Mr. Buchanan found that the density of the cold layer, and indeed, of all the deeper waters, was higher than that of the surface, and his admirable researches on the effects produced by freezing sea water appear to give a satisfactory explanation of the effect of these phenomena on the distribution of temperature in this ocean. It has been found that sea water on freezing is divided into two saliniferous parts, one solid, which is richer in sulphates, and one liquid, which contains proportionally more chlorides than the parent sea water.* The liquid brine thus produced is denser, and sinks into the underlying water, thus rendering the deeper water more saline and at the same time lowering its temperature. In a basin isolated from general oceanic circulation, like the Norwegian basin of the Arctic regions, there is produced in this way an uniform temperature of about 29° F. in all the deeper waters, but no trace of this state of matters is found in the Antarctic. On the contrary, at the greater depths a temperature is found somewhere between 32° and 34° F. as far south as the Antarctic circle, and not therefore very different from the temperature of the deepest bottom water of the tropical regions of the ocean.

The presence of this relatively warm water in the deeper parts of the Antarctic Ocean may be explained by a consideration of general oceanic circulation. The warm tropical waters which are driven southwards along the eastern coasts of South America, Africa, and Australia, into the great all-encircling Southern Ocean, there become cooled as they are driven to the east by the strong westerly winds. These waters on account of their high salinity can suffer much dilution with Antarctic water, and still be denser than water from these higher latitudes at the same temperature. Here, again, the density observations indicate that the cold water found at the greater depths of the ocean probably leaves the surface and sinks toward the bottom in the

* Pettersson has shown that sea-ice expands irregularly with heat, and that the latent heat is abnormal, being less than that of pure ice. He also found that the chemical composition of the brines formed in Arctic Seas by the freezing of ice out of a limited quantity of water is different from that of sea-water itself. There is, however, no certainty that this behaviour of the ice and free sea-water is due to the formation of the hypothetical cryohydrates of Guthrie.

Southern Ocean between the latitudes of 45° and 56° S. These deeper, but not necessarily bottom, layers are then drawn slowly northwards towards the tropics to supply the deficiencies there produced by evaporation and southward-flowing surface-currents, and these deeper layers of relatively warm water appear likewise to be slowly drawn southwards to the Antarctic area to supply the place of the ice-cold currents of surface-water drifted to the north. This warm underlying water is evidently a potent factor in the melting and destruction of the huge table-topped icebergs of the Southern Hemisphere. While these views as to circulation appear to be well-established, still a fuller examination of these waters is most desirable at different seasons of the year, with improved thermometers and other instruments. Here, again, a new Antarctic expedition would supply the knowledge essential to a correct solution of many problems in Oceanography. Ross describes a strong tidal current and rip between Possession Island and the mainland of Victoria, but, on the whole, we have very little information concerning the tides and surface-currents in the Antarctic.



DIATOM OOZE FROM 1950 FATHOMS IN THE SOUTHERN OCEAN. MAGNIFIED 300 DIAMETERS.

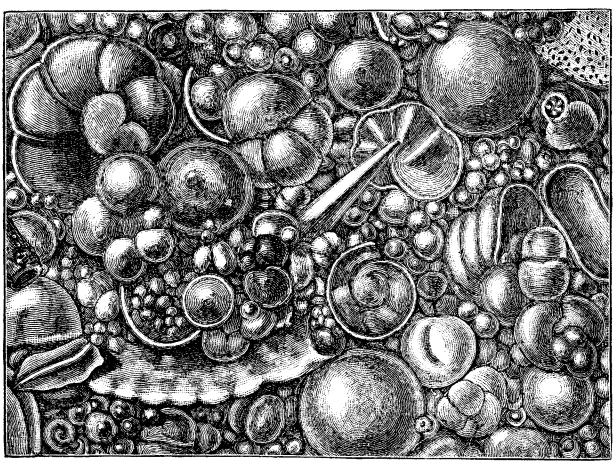
No land animal, and no trace of vegetation—not even a lichen or a piece of seaweed—has been found on land within the Antarctic circle. On Cockburn Island, in latitude 64° S., Hooker collected twenty cryptogamic species, three of them seaweeds, and this may be regarded as not far from the southern limit of terrestrial vegetation. The fossils and fossiliferous beds above referred to distinctly indicate the existence of more genial conditions within the Antarctic in past geological times, and should befully explored.

When we turn to the waters of the Antarctic Ocean, we find at the present time a great profusion of life, both animal and vegetable. During the *Challenger* expedition, myriads of minute spherical tetrasporæ were observed to give the sea a peculiar green colour over large areas. Diatoms were frequently in such enormous abundance, that the tow-nets were filled to the brim with a yellow-brown slimy mass, with a distressing odour, through which various crustaceans, annelids, and other animals wriggled.

As these marine algæ are the primary source of food in the sea, their great development in the Antarctic Ocean leads to a corresponding abundance of animals. Occasionally vast quantities of Copepods Amphipods, and Schizopods were observed to give the ocean a dull red

colour, and the more delicate tow-nets were at such times so filled with these animals, that they occasionally burst on being hauled on board ship. These small crustaceans are in turn the chief food of the fishes, penguins, seals, and whales, which abound in the waters of the Great Southern Ocean.

Organisms such as the Diatoms and Radiolaria, which secrete silica, and the Foraminifera and Pteropods, which secrete carbonate of lime, are, on account of their distribution, the most interesting of all the pelagic creatures captured in the surface and sub-surface waters of the ocean. Near Antarctic land the deposits at the bottom of the sea are, as already stated, mostly made up of rock-fragments and detritus from the snow-clad Antarctic continent. A little to the north the number of these particles decreases, and they are largely replaced by the dead



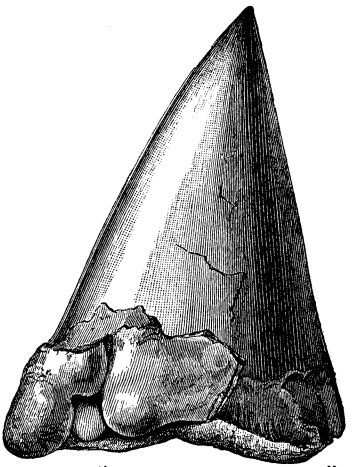
GLOBIGERINA OOZE FROM 1900 FATHOMS IN THE ATLANTIC.
MAGNIFIED 25 DIAMETERS.

frustules of Diatoms and Radiolaria, and then we find a pure white siliceous deposit at the bottom, which is called a Diatom Ooze. Still further to the north, when the influence of the warm northern currents commences to be felt, the Diatoms are largely replaced on the surface by the calcareous shells of Foraminifera and Pteropods, and at the bottom of the sea in these latitudes the Diatom Ooze gives place to a pinkish-white Globigerina Ooze, composed chiefly of carbonate of lime. Still further to the north, about the latitude of 40° S., the sea is often about 3 miles in depth, and in such depths where far removed from continental land, the calcareous shells are for the most part dissolved, and there is a very remarkable deposit at the bottom, composed of a fine Red Clay, manganese nodules, zeolitic crystals, magnetic and metallic spherules of extra-terrestrial origin, thousands of sharks' teeth, and the remains of whales and other Cetaceans. In these red clay areas the

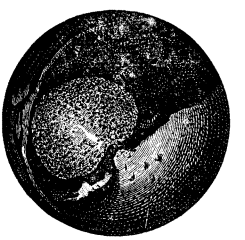
trawl brought up in a single haul over one thousand five hundred sharks' teeth, some of them as large as—and not to be distinguished from—the specimens of *Carcharodon* of Tertiary age; associated with these teeth were fifty or sixty ear-bones of Ziphioid whales and other Cetaceans.* From a careful consideration of all the conditions, it seems to me that deposition is, in these places, at the minimum, and that since Tertiary times there may not have been over a few inches of deposit laid down in these red clay areas. A new expedition might thoroughly explore one of these peculiar and instructive deposits.

All over the floor of the Antarctic Ocean there is a most abundant fauna, apparently more abundant and more peculiar than in any other region of the ocean's bed. In one haul made by the *Challenger* in a depth of 2 miles in lat. 47° S., the trawl brought up (excluding Protozoa) over two hundred specimens belonging to eighty-nine species of animals, of which seventy-three were new to science, including representatives of twenty-eight new genera. This and similar trawlings show a larger number of individuals, genera, and species than any single haul from similar depths in other regions of the oceans, and I am inclined to think this is intimately connected with the large number of surface creatures which are killed in these latitudes by the mixing of waters from the tropics and waters from the Antarctic; for these organisms, on falling to the bottom, afford a larger supply of food to deep-sea animals here than in other localities.

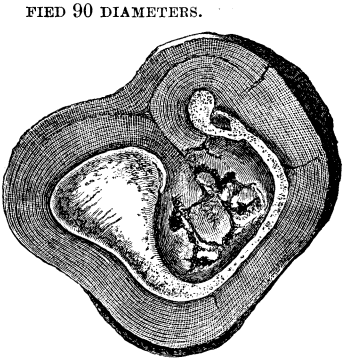
The accompanying table exhibits the total result of the *Challenger's* nine



TOOTH OF "OXYRHINA TRIGONODON," DREDGED BY H.M.S. "CHALLENGER" IN THE SOUTH PACIFIC, 2350 FATHOMS.



BLACK COSMIC SPHERULE WITH EXTERNAL COATING BROKEN AWAY TO SHOW THE METALLIC NUCLEUS, ATLANTIC, 3150 FATHOMS. MAGNIFIED 90 DIAMETERS.



SECTION OF MANGANESE NODULE, SHOWING TYMPANIC BONE OF "MESOPLODON" IN THE CENTRE, DREDGED BY H.M.S. "CHALLENGER" IN THE SOUTHERN OCEAN, 2600 FATHOMS.

* See Murray and Renard, *Challenger* Report on Deep-Sea Deposits, p. 360: 1891.

trawlings and dredgings south of the 43rd parallel, in depths greater than 1200 fathoms: 830 animals were captured (excluding the Protozoa) belonging to 398 species, of which 326, or nearly all those described, were new to science. Of these 162 new species, and 30 new genera, were not obtained in any other region of the bed of the ocean. Among these were 8 new genera and 56 new species of Echinoderms, many of them exhibiting marked peculiarities.* Many other forms, such as some species of Serolis among the Crustacea, are limited to the deep water of the Southern Hemisphere. The absence of some groups, such as the Brachyura, in all these dredgings is likewise suggestive.

It is most probable, indeed almost certain, that the floor of the ocean, as well as all pelagic waters, have been peopled from the shallow waters surrounding continental land, and here in the deep waters of the Antarctic we appear to have very clear indications of the existence of the descendants of animals that once inhabited the shallow water along the shores of Antarctica, while in other regions of the ocean the descendants of the shallow water organisms of the northern continents prevail. This is a subject of great interest to all biologists, and can best be studied by a more efficient exploration of these southern latitudes.

ANIMALS (EXCLUDING THE PROTOZOA) OBTAINED IN THE TRAWL AND DREDGE BY THE "CHALLENGER" EXPEDITION TOWARDS THE ANTARCTIC REGIONS IN DEPTHS GREATER THAN 1200 FATHOMS.

Latitude.	Station.	Depth in Fathoms.	Number of Specimens.	Number of Species.	Number of New Species.	Number of New Genera.*
Between 43° and 50° S.	146	1375	200	78	66	17
	147	1600	200	89	73	28
	159	2150	20	10	7	4
	160	2600	50	30	25	10
Between 50° and 60° S.	157	1950	150	79	69	25
	158	1800	70	45	33	13
Between 60° and 65° S.	152	1260	20	12	10	4
	156	1975	100	37	32	13
S. of 65° S.	153	1675	20	18	11	5
			830	398	326	119

* One hundred and sixty-two new species and thirty new genera were not obtained outside this Antarctic area during the cruise.

* Namely, *Thaumatocrinus*, *Chitonaster*, *Ophioplinthus*, *Ophiocymbium*, *Spatagocystis*, *Echinocrepis*, *Genicopatagus*, and *Scotoanassa*. Alexander Agassiz says: "The slipper-shaped *Echinocrepis* and the *Galerites*-like *Urechinus* (found only in the deep water of the Antarctic area), remind us of types which flourished in the Cretaceous Seas."

This rapid review of the present state of our knowledge concerning the Antarctic should, if in any way successful, have at the same time furnished distinct indications as to the great extent of our ignorance concerning all that obtains within the South Polar regions. It should likewise have enabled you to appreciate the great advantages which would flow from successful exploration in the immediate future.

Within the past few months I have been in communication with geographers and scientific men in many parts of the world, and among them there is complete unanimity as to the desirability, nay, necessity, for South Polar exploration, and wonder is expressed that an expedition has not long since been fitted out to undertake investigations which, it is admitted on all sides, would be of the greatest value in the progress of so many branches of natural knowledge. Professor Neumayer, who has so long advocated South Polar exploration, says :—"It is certain that without an examination and a survey of the magnetic properties of the Antarctic regions, it is utterly hopeless to strive, with prospects of success, at the advancement of the theory of the Earth's magnetism." Other eminent geographers and scientific men urge the advantages which would accrue to other branches of science.*

* Professor ALEXANDER AGASSIZ writes :—"I wish you the best success with your proposed Antarctic expedition. What you propose doing is the right thing to do, and the results ought to be most interesting, judging from the little we know of the few islands which have been hastily visited. Your scheme of having the ships kept at work, sounding, dredging, &c., while the land-parties are exploring the land, is the most practical and economical way of carrying on such an expedition. It has always seemed to me such a waste of time and money to have the ships and their crews wait on the landsmen."

Professor ERNST HAECKEL writes : *—"I have heard with great interest that England has the design of setting on foot a great scientific expedition for the exploration of the Antarctic Ocean. The task is in fact as interesting as it is pressing and important. It is remarkable how much money and how many lives have been offered by Europe and North America for North Polar expeditions, while the much less known South Pole has seemed almost forgotten since Ross's time. And how many great and important problems await solution there! The British nation seems to me called upon before all others to carry out this great task, and to send a ship for several years (including wintering at a station) to the South Polar Sea. The fruits of such an expedition would certainly form a worthy sequel to those which you have attained through the incomparable *Challenger* expedition with its wealth of results. It would lay the foundation for all time. I hope and wish from my heart that the English Government views it in this light, and will grant the large supplies necessary for this expedition. I send you my best wishes for the speedy completion of the concluding volume of the great *Challenger* work. This 'standard work' will remain for all time the foundation for all biological and thalassographical investigations, in relation to Plankton and Benthos alike especially of the deep sea. The thorough investigation of the Antarctic Ocean with its fauna and flora seems to me a necessary supplement to the *Challenger* work."

Professor F. E. SCHULTZE writes * :—"You wish for my opinion on the subject of a more extensive exploration of the Antarctic region. I believe I shall be in agreement,

* Translation.

To determine the nature and extent of the Antarctic continent; to penetrate into the interior; to ascertain the depth and nature of the ice-cap; to observe the character of the underlying rocks and their fossils; to take magnetical and meteorological observations both at sea and on land; to observe the temperature of the ocean at all depths and seasons of the year; to take pendulum observations on land, and possibly also to make gravity observations at great depths in the ocean; to bore through the deposits on the floor of the ocean at certain points to ascertain the condition of the deeper layers; * to sound, trawl, and dredge, and study the character and distribution of marine organisms. All this should be the work of a modern Antarctic expedition. For the more definite determination of the distribution of land and water on our planet; for the solution of many problems concerning the Ice Age; for the better determination of the internal constitution and superficial form of the Earth; for a more complete knowledge of the laws which govern the motions of the atmosphere and hydrosphere; for more trustworthy indications as to the origin of terrestrial and marine plants and animals, all these observations are earnestly demanded by the science of our day.

How then, and by whom, is this great work to be undertaken? I can never forget my sensations when once in the Arctic I was for several hours lost in a small boat in a fog, and at one time there seemed little chance that I would ever regain the ship. Nor again can I forget

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not only with all representatives of physical geography, but especially with all the biologists in the world, when I say that there is no region of the surface of our globe which is so little known, but so much deserves a thorough investigation as precisely this of the Antarctic. Allow me also to call your attention to the fact that, of all the oceans, the southern and central part of the Indian Ocean has hitherto been least explored, and that therefore it might be advisable, if opportunity offered—say, during a winter—to make an excursion to the central part of the Indian Ocean. In the hope that to the great *Challenger* expedition may be added one similar and equally rich in results for the exploration of the Antarctic, I wish success to this important undertaking from my heart."

Professor J. THOULET writes:*—"There is only one way in which to answer the letter you have been so good as to write to me, namely to send you my warmest encouragement to continue the great and noble task of discovering the secrets of the Antarctic regions. May you succeed in accomplishing this glorious work, which is not only scientific but also humanitarian. . . . All who are occupied on science in the whole world earnestly wish for your success. To tell you the truth, I have never been very enamoured of Arctic expeditions: the North Pole is continental, and is in consequence the domain of irregularity, and in my opinion its conquest is not worth the efforts which it has already cost. But it is quite otherwise with the Antarctic regions, which are oceanic, and therefore subject to rule. The Arctic phenomena are complications or exceptions; the Antarctic are general phenomena, and their discovery is bound to conduce to the formulation of natural laws—the final aim of science."

* It is believed that gravity determinations might be made, as well as the deposits bored into by specially-constructed instruments let down to the bottom from the ships.

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* Translation.

one night in the Antarctic when, with much anxiety, Captain Nares, his officers, and men, piloted the *Challenger* during a gale through blinding snow, ice, icebergs, darkness, and an angry sea. The remembrance of these experiences makes one almost fear to encourage good and brave men to penetrate these forbidding regions. But it is not all gloom and depression beyond the Polar circles. Sunshine and lively hope soon return.

A few months ago I bade good-bye to Nansen, and said I expected within two years to welcome him on his return from the Arctic; but I expressed some doubt if I should again see the *Fram*. "I think you are wrong," was the reply; "I believe you will welcome me on this very deck, and, after my return from the Arctic, I will go to the South Pole, and then my life's work will be finished." This is a spirit we must all admire. We feel it deserves, and is most likely to command, success. All honour to those who venture into the far North or far South with slender resources and bring back with them a burden of new observations.

A dash at the South Pole is not, however, what I now advocate, nor do I believe that is what British science, at the present time, desires. It demands rather a steady, continuous, laborious, and systematic exploration of the whole southern region with all the appliances of the modern investigator.

This exploration should be undertaken by the Royal Navy. Two ships, not exceeding one thousand tons, should, it seems to me, be fitted out for a whole commission, so as to extend over three summers and two winters. Early in the first season a wintering-party of about ten men should be landed somewhere to the south of Cape Horn, probably about Bismarck Strait at Graham's Land. The expedition should then proceed to Victoria Land, where a second similar party should winter, probably in Macmurdo Bay near Mount Erebus. The ships should not become frozen in, nor attempt to winter in the far South, but should return towards the North, conducting observations of various kinds along the outer margins of the ice. After the needful rest and outfit at the Falklands or Australia, the position of the ice and the temperature of the ocean should be observed in the early spring, and later the wintering parties should be communicated with, and, if necessary, reinforced with men and supplies for another winter. During the second winter the deep-sea observations should be continued northwards, and in the third season the wintering parties should be picked up and the expedition return to England. The wintering parties might largely be composed of civilians, and one or two civilians might be attached to each ship; this plan worked admirably during the *Challenger* expedition.

What, it may be asked, would be the advantages to trade and commerce of such an expedition? It must be confessed that no definite or very encouraging answer can be given. We know of no extensive

fisheries in these regions. For a long time seal and sea-elephant fisheries have been carried on about the islands of the Southern Ocean, but we have no indication of large herds or rookeries within the Antarctic circle. A whale fishery was at one time carried on in the neighbourhood of Kerguelen, but this right whale, if distinct from or identical with *Balæna australis*, appears to have become nearly, if not quite, extinct. Some expressions of Ross would lead one to suppose that a whale corresponding to the Greenland right whale inhabits the seas within the Antarctic ice, but we have no definite knowledge of the existence of such a species. Although "sulphur bottoms" (*Balænoptera musculus*), "finbacks" (*Balænoptera sibbaldii*), and "humpbacks" (*Megaptera boops*) are undoubtedly abundant, they do not repay capture. Ross and McCormick report the sperm whale within the Antarctic ice, but there is still some doubt on this point. Though penguins exist in countless numbers they are at present of no commercial value. Deposits of guano are not likely to be of any great extent. But it is impossible to speak with confidence on the commercial aspects of such an expedition—the unexpected may quite well happen in the way of discovery.

With great confidence, however, it may be stated that the results of a well-organised expedition would be of capital importance to British science. We are often told how much more foreign governments do for science than our own. It is asserted that we are being outstripped by foreigners in the cultivation of almost all departments of scientific work. But in the practical study of all that concerns the ocean this is certainly not the case, for however closely we may now be pressed by some foreign nations, we have had up to the present time to acknowledge neither superiors, nor even equals in this branch of investigation, and if we be a wise and progressive people, British science will always lead the way in this direction. When Queen Victoria ascended the throne we were in profound ignorance as to the condition of all the deeper parts of the great ocean basins; now we have a very accurate knowledge of the conditions which obtain over the three-fourths of the Earth's surface covered by the waters of the ocean. This—the most splendid addition to earth-knowledge since the circumnavigation of the world—is largely due to the work and exertions of the Royal Navy in the *Challenger* and other deep-sea expeditions, and the Mercantile Navy in our telegraph ships.

This country has frequently sent forth expeditions, the primary object of which was the acquisition of new knowledge—such were the expeditions of Cook, Ross, and the *Challenger;* and the nation as a whole has always approved such action, and has been proud of the results, although they yielded no immediate return. Shall it be said that there is to be no successor to these great expeditions? The prestige of the navy does not alone consist in its powers of defence and attack. It has in times of peace made glorious conquests over the powers of Nature,

and we ask that the officers and men of the present generation be afforded the same opportunities as their predecessors. There should be no observations, no experiments, no investigations, no work of any kind, no knowledge of any kind, with reference to the ocean, of which the navy has not had practical experience. And what better training for officer and man than in an expedition such as that now advocated?

A preliminary responsibility rests on the geographers and representatives of science in this country. It is necessary to show that we have clear ideas as to what is wanted, to show that a good workable scheme can be drawn up. When this has been done it should be presented to the Government with the unanimous voice of all our scientific corporations. Then, I have little doubt that a Minister will be found sufficiently alive to the spirit of the times, and with sufficient courage to add a few thousand pounds to the navy vote for three successive years, in order to carry through an undertaking worthy of the maritime position and the scientific reputation of this great empire.

Before the reading of the paper, the President, Mr. CLEMENTS R. MARKHAM, said:—This evening we have assembled to hear what will be a most interesting and, in my belief, a most important address from Dr. John Murray of the *Challenger*. All geographers are acquainted with the scientific fame of Dr. Murray, and therefore it is unnecessary for me to say more; and without further preface I have to request him to read his paper.

After the reading of the paper the following discussion took place:—

Sir JOSEPH HOOKER: There is a point which should not be lost sight of in view of further exploration of the Antarctic area, being of importance in regard to the prospects of success in future, and as an indication what should be the procedure in the case of another expedition being despatched to that region. It is this—that the successes of the two voyages that have yielded the greatest results—those of Weddell and Ross—have been due rather to accidental circumstances than to foreknowledge, forethought, or foresight on the part of their commanders. I say this with no idea of disparaging either the efforts of the courageous and experienced men who conducted those expeditions or the value of their discoveries. But what are the facts? Weddell found himself unexpectedly in the open sea in a high latitude, and with great gallantry pushed his little cutter south to the 75th degree. With Ross the case was very different; but in his case success was no less due to accident. The Antarctic expedition was not despatched primarily with a view to discovery in the Antarctic area, but to lay down the lines of magnetic force in the Southern Ocean, and especially to ascertain the position of the South Magnetic Pole, and if possible to reach it. Now it was very well known before Ross sailed that the South Magnetic Pole was somewhere near the meridian of Australia, and in the 60th or 70th degree of south latitude. It was this that directed Ross's course to a position where he, by great good fortune, met with pack-ice through which his ships could be pushed. He steered for the position of the Magnetic Pole, and after passing through much loose ice, met the main pack, about lat. 67° S. and long. 174½° E. It was a formidable pack. Neither he nor any of the Arctic officers or men, of whom there were not a few in the ships, had ever seen anything like it in the North: nevertheless Ross determined to try it, and, in doing so, the boldest held his breath for a space. In four or five days he pushed through it, and entered comparatively open water. Pursuing his course to the south-west he discovered

ANTARCTIC RESEARCH

OF MAPS ILLUSTRATING Dr. JOHN MURRAY'S ADDRESS

SOUTH POLAR REGIONS

BY J. G. BARTHOLOMEW, F.R.S.E.

SHOWING HEIGHT OF LAND AND DEPTH OF SEA

Note

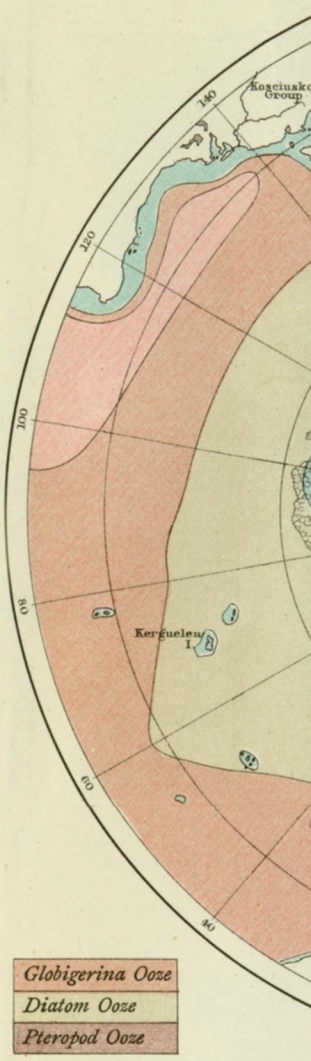
Ocean Soundings in Fathoms 2500

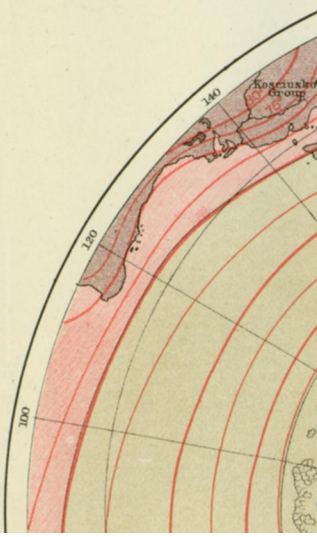
Soundings, no bottom reached 600

Heights in English Feet 1500

Limits of Pack Ice

Points reached by Explorers & dates * Cook 1773





H

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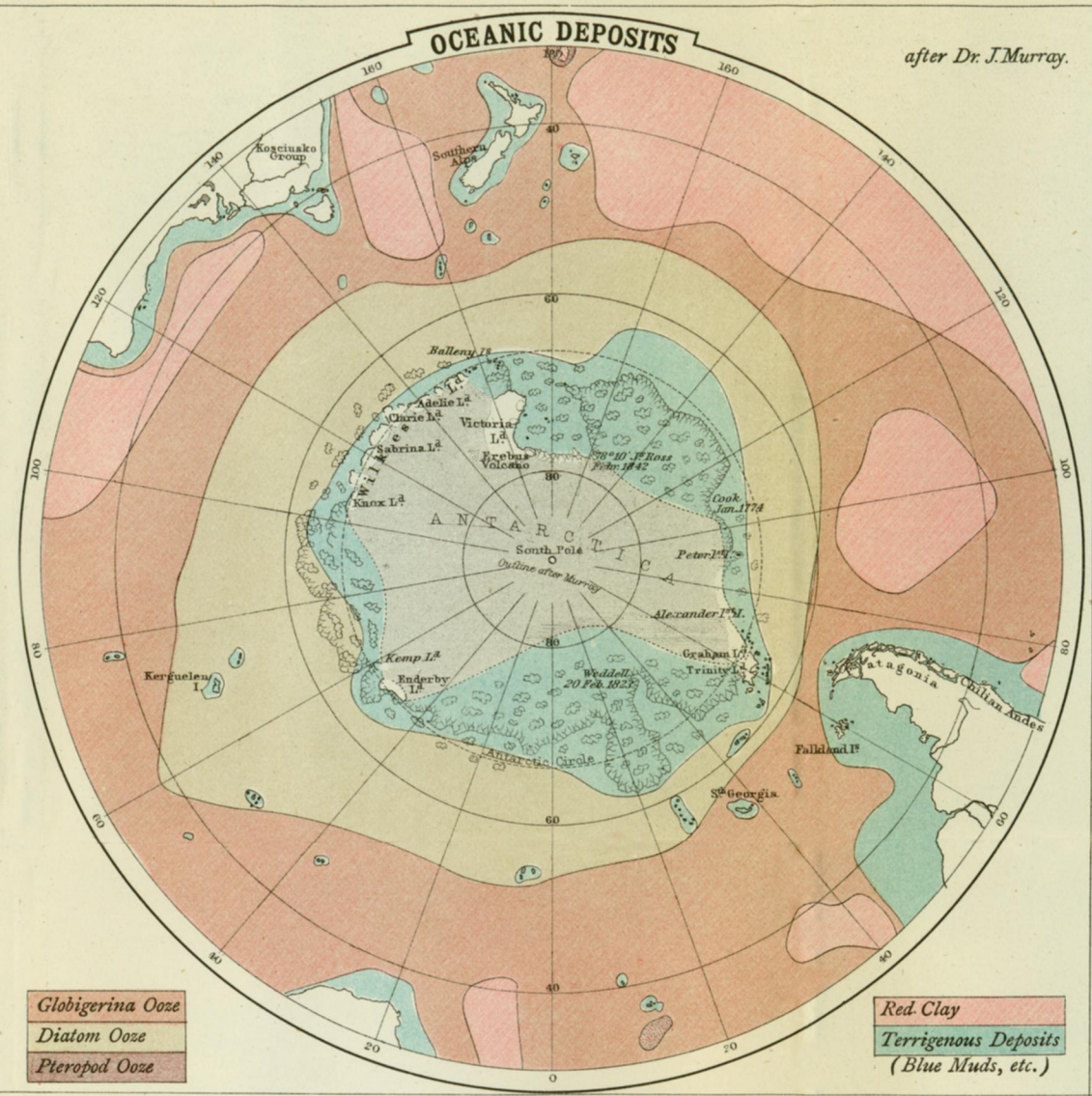
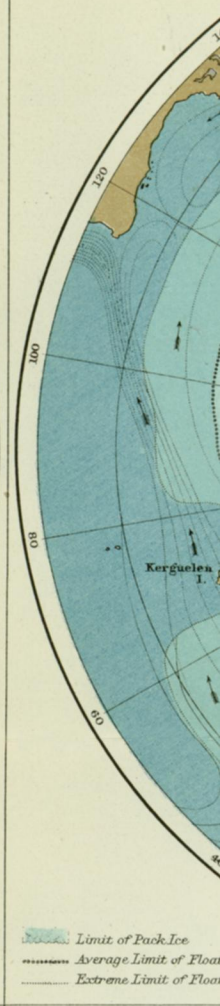
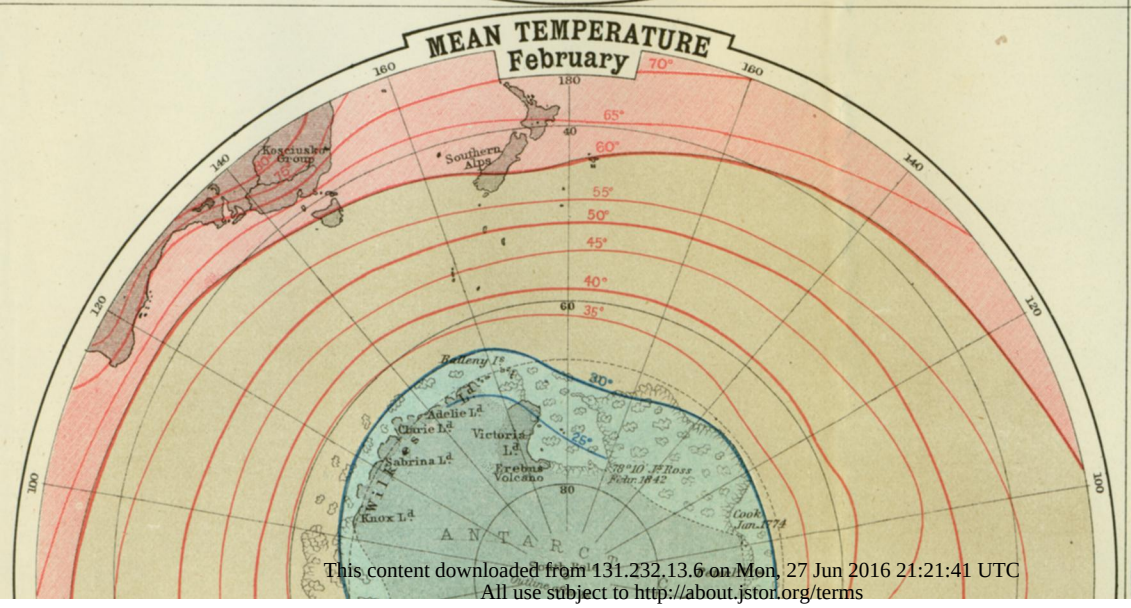
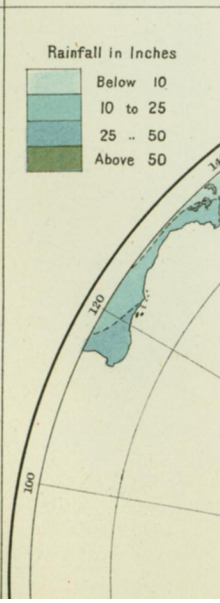
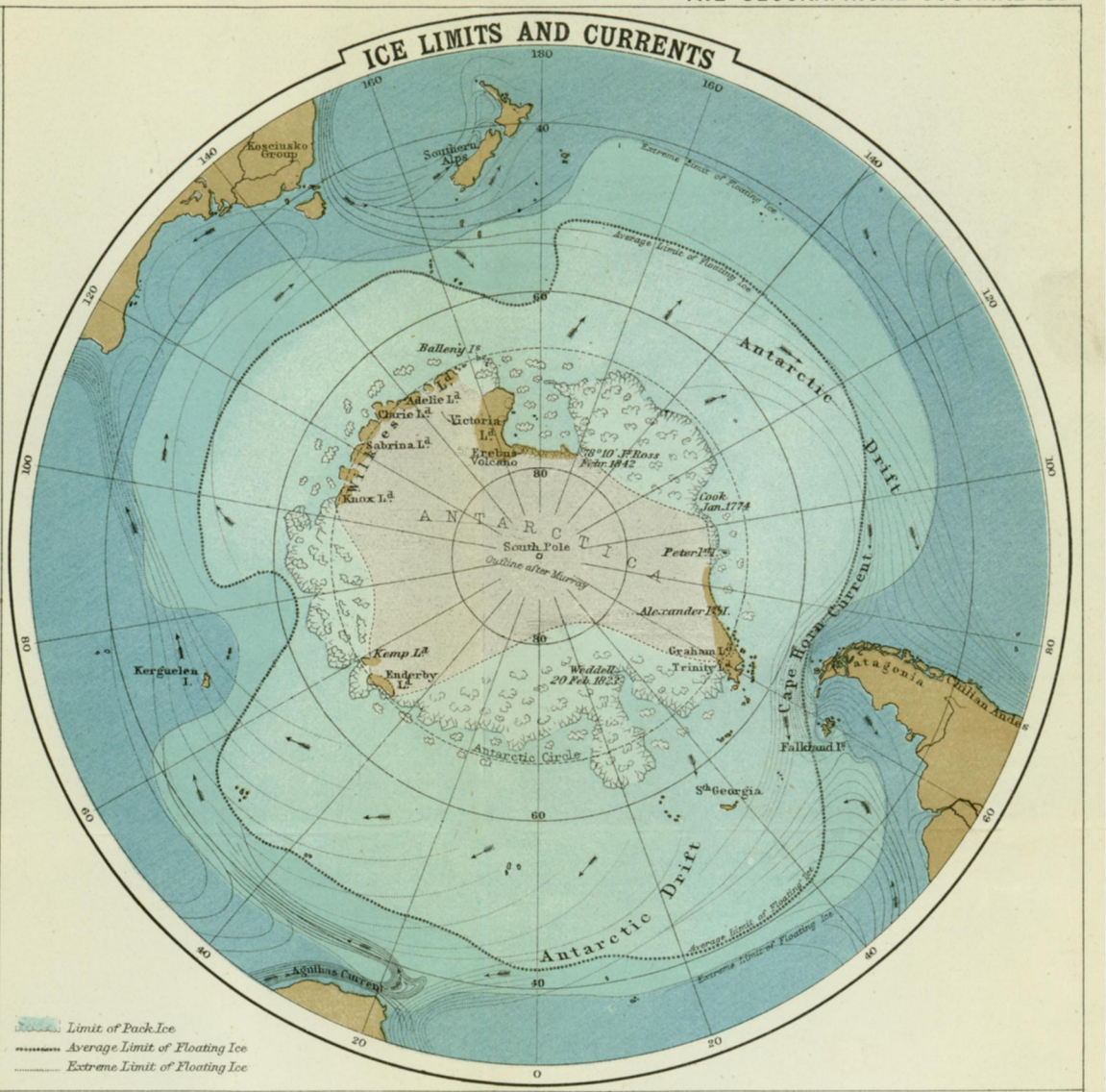


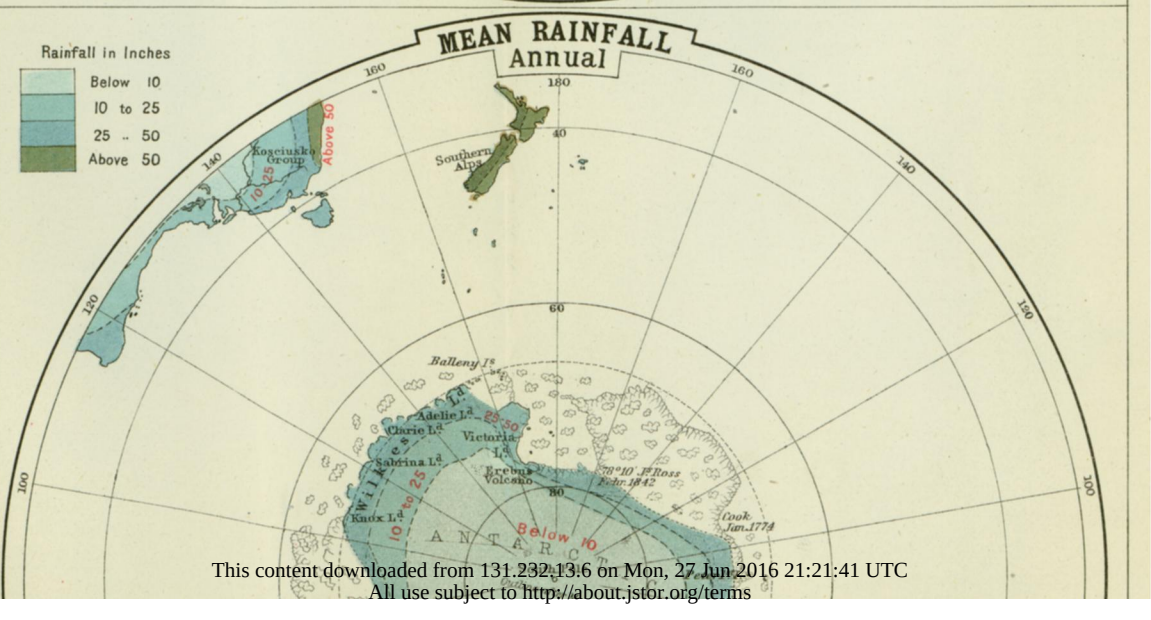






J. Murray.



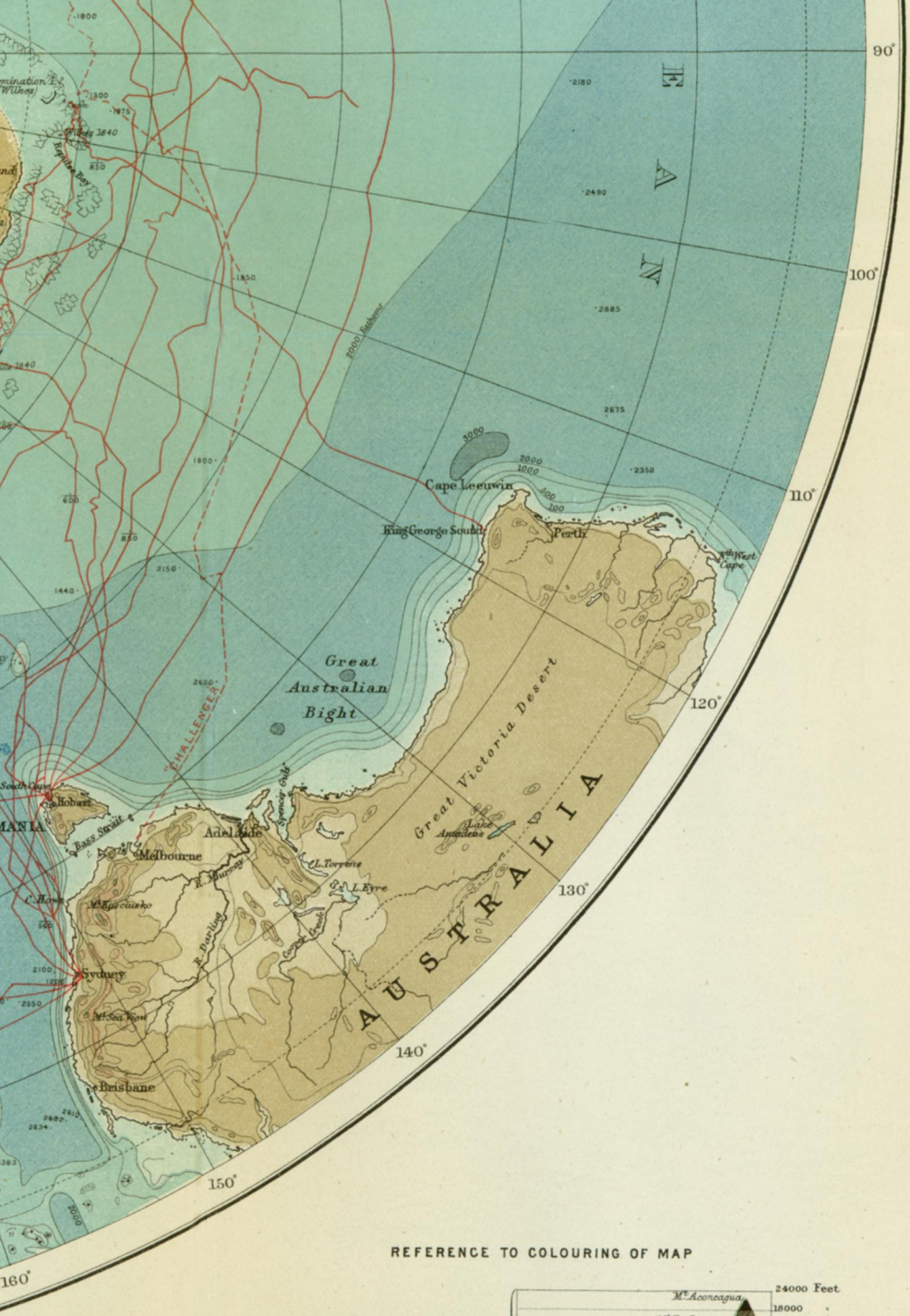


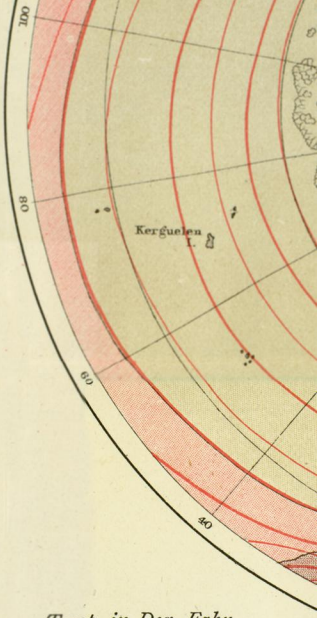
The Princip
in Red, thu

NOTE.

The Principal Explorers' Routes within South Polar Regions are marked in Red, thus showing what is ascertained, and what is hypothetical.

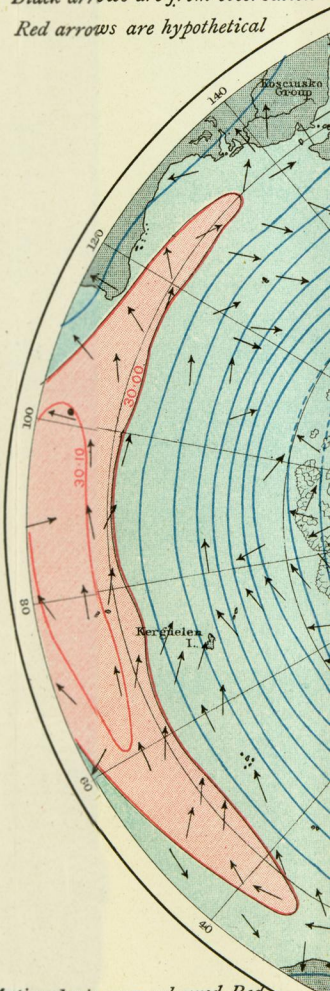
CONTOURS SHOWIN
DEPTH OF SEA





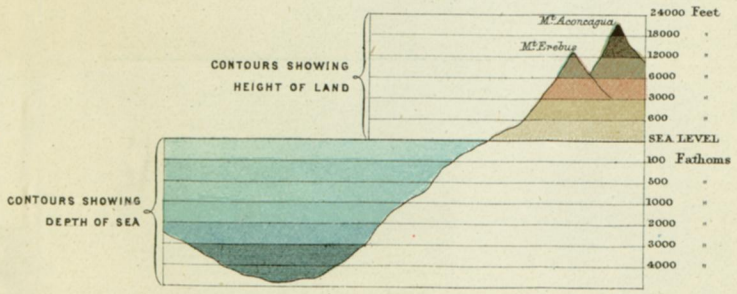
Temp. in Deg. Fahr.

The arrows indicate direction of wi
Black arrows are from observation
Red arrows are hypothetical



Anti-cyclonic area coloured Red
Areas of Low Pressure coloured Blue
The dotted Isobars are hypothetical

REFERENCE TO COLOURING OF MAP



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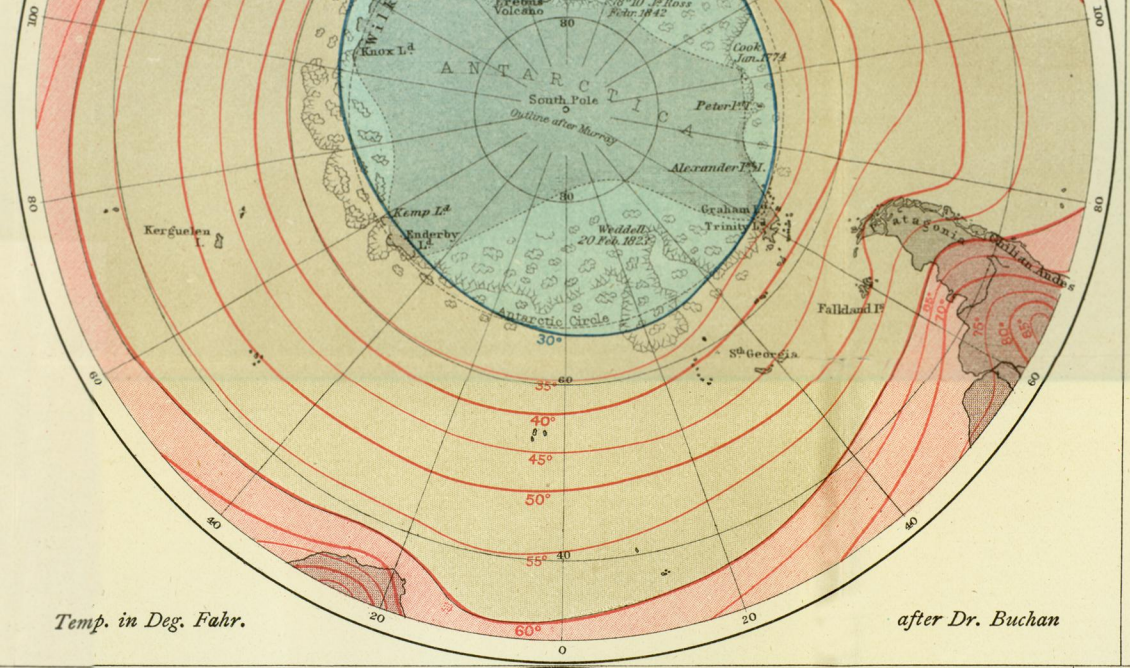

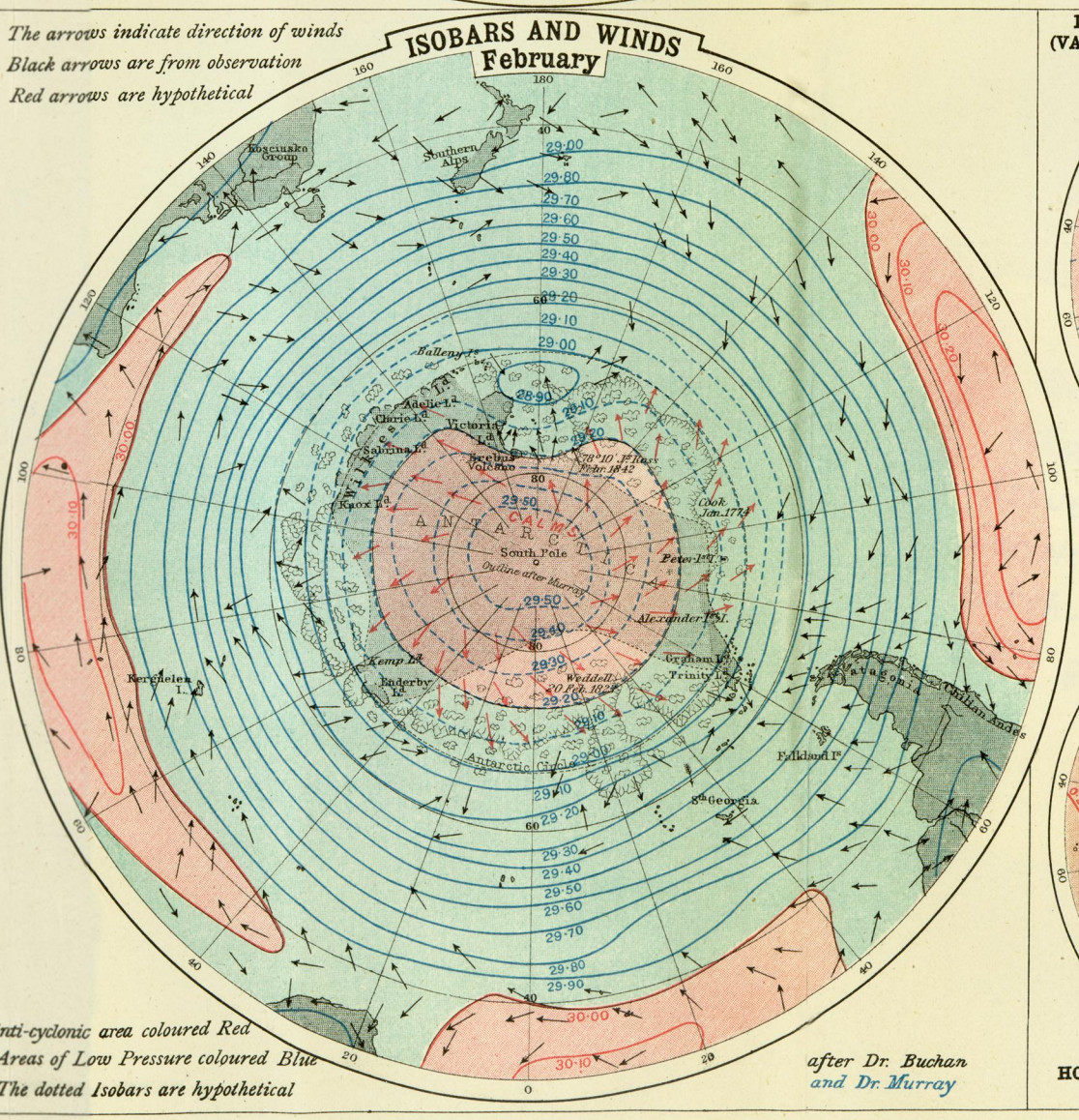

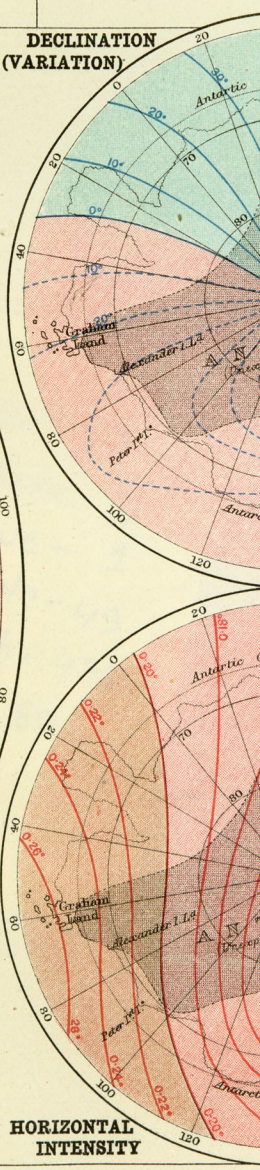

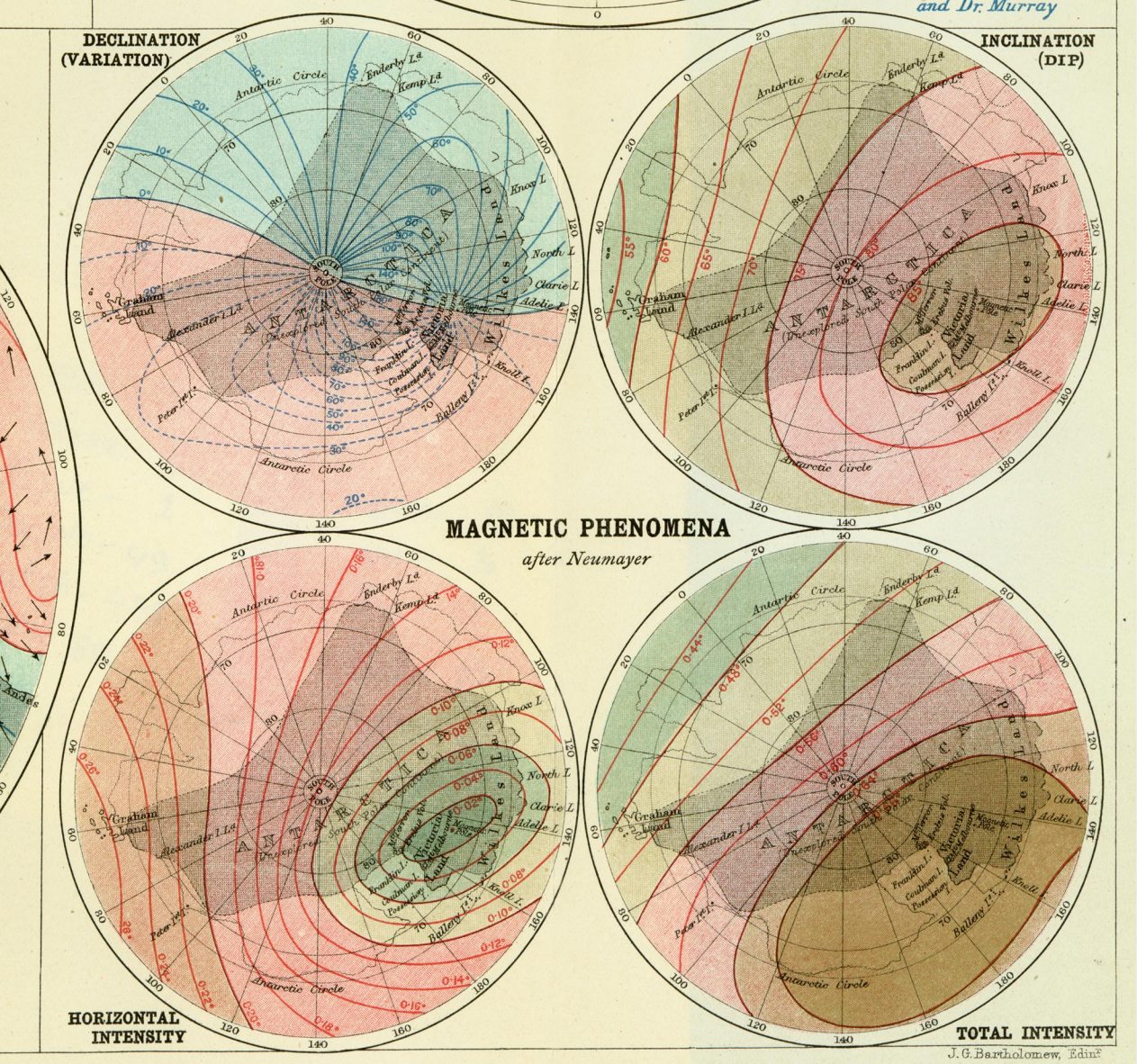

J.G. Bartholomew, Edin.r