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Source: *The Geographical Journal*, Vol. 34, No. 5 (Nov., 1909), pp. 481-500
Published by: geographicalj
Stable URL: http://www.jstor.org/stable/1777278
Accessed: 27-06-2016 01:05 UTC

The

Geographical Journal.

No. 5. NOVEMBER, 1909. Vol. XXXIV.

SOME RESULTS OF THE BRITISH ANTARCTIC EXPEDITION, 1907-9.*

By E. H. SHACKLETON, C.V.O.

The British Antarctic Expedition, 1907-9, left Port Lyttelton, New Zealand, on January 1, 1908, for the south. In this article I will not attempt to deal in detail with the preliminary arrangements and with the equipment. The amount of money at my disposal had been limited, and economies had been necessary in various directions; but I had been able to get together a small body of well-qualified men, and we were fully equipped as far as food, clothing, sledges, etc., were concerned. We had a motor-car, ponies, and dogs for haulage purposes. The generosity of the Admiralty in lending the expedition a number of instruments enabled me to make the scientific equipment fairly complete. The *Nimrod*, in which the journey to the winter quarters on the Antarctic continent had to be undertaken, was certainly small for the work, and left Lyttelton with scarcely 3 feet of freeboard, a somewhat serious matter in view of the fact that very heavy weather had to be faced. On the other hand, the ship was very sturdy, well suited to endure rough treatment in the ice.

The shore party consisted of fifteen men, my companions being as follows:—

Lieut. J. B. Adams, R.N.R., meteorologist.
Bertram Armytage, in charge of ponies.
Sir Philip Brocklehurst, assistant geologist.
Prof. T. W. Edgeworth David, F.R.S., geologist.
Bernard Day, electrician and motor expert.

* Maps, p. 592.

Ernest Joyce, in charge of general stores, dogs, sledges, and zoological collections.
Dr. A. F. Mackay, surgeon.
Dr. Eric Marshall, surgeon, cartographer.
G. E. Marston, artist.
Douglas Mawson, mineralogist and petrologist.
James Murray, biologist.
Raymond Priestley, geologist.
William Roberts, cook.
Frank Wild, in charge of provisions.

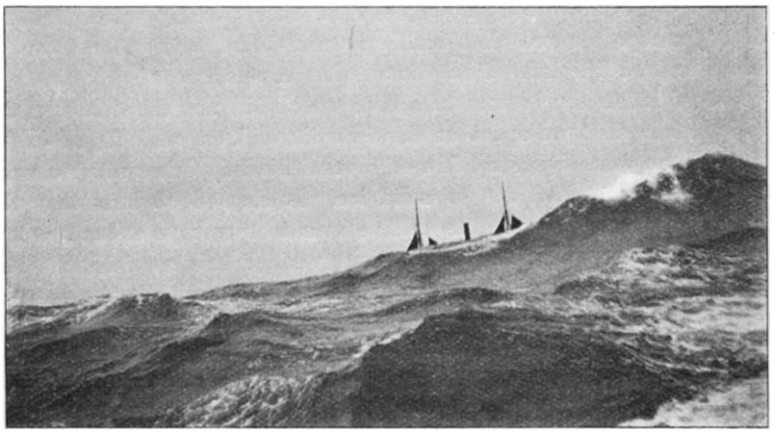
Prof. David, of Sydney University, joined the expedition at the last moment, and the services of such an experienced scientific man were invaluable. Douglas Mawson was lecturer in mineralogy and petrology at the Adelaide University. James Murray had been biologist on the Scottish Lake Survey, and had made a special study of microscopic zoology, a circumstance that led to most important discoveries in the frozen lakes of Ross island. Joyce and Wild, like myself, had served on the National Antarctic Expedition.

My original intention was to winter on King Edward VII. Land, a part of the Antarctic continent at present quite unknown. The *Nimrod* was towed to the Antarctic circle, a distance of 1500 miles, in order that her small supply of coal might be conserved, and we were soon in the belt of ice that guards the approach to the Ross sea. The navigation of the ice was not more than usually difficult, and on January 16 we entered the Ross sea in 178° 58′ E. long. (approximate). Keeping a south-westerly course, we sighted the Great Ice Barrier on January 23, and proceeded to skirt the ice-edge in an easterly direction towards Barrier inlet (Balloon bight), the spot selected by me as the site for the winter quarters. I knew that the inlet was practically the beginning of King Edward VII. Land, and that it would be an easy matter for the ship, in the following summer, to reach us there, whereas the land sighted by the *Discovery* Expedition might be unattainable if the season were adverse. In 165° E. long., near the point where Borchgrevink landed in 1900, we sighted, beyond 6 or 7 miles of flat ice, steep-rounded cliffs, having the appearance of ice-covered land. We could not stop to investigate.

The plan proved impracticable, for we found that Barrier inlet had disappeared. Many miles of the Barrier edge had calved away, and instead of the narrow bight there was a wide bay joining up with Borchgrevink's inlet, and forming a depression that we called the Bay of Whales. We accordingly made an attempt to reach King Edward VII. Land, but here again we were unsuccessful. The way was barred by heavy consolidated pack, into which bergs were frozen, and this ice stretched far to the north. The season was advancing; the *Nimrod* was leaking, as a result of severe gales on the journey south, and I decided

that we had better proceed direct to McMurdo sound, and establish the winter quarters there. The *Nimrod* entered the sound on January 29, and was brought up by fast ice 20 miles from Hut point, the spot at which the *Discovery* Expedition wintered in 1902 and 1903. The ice showed no signs of breaking out, and on February 3 we proceeded to land stores, and erect a hut on Cape Royds, the spot selected, under pressure of circumstances, for the winter quarters of the expedition. On February 22 the *Nimrod* went north again, leaving the shore-party at Cape Royds. The ship was to return in the following summer.

The first work of importance undertaken after the winter quarters had been established was the ascent of Mount Erebus. This active volcano, which has an altitude of over 13,000 feet, was of particular interest from the geological and meteorological standpoint, and though the ascent was likely to prove difficult, it seemed that the attempt



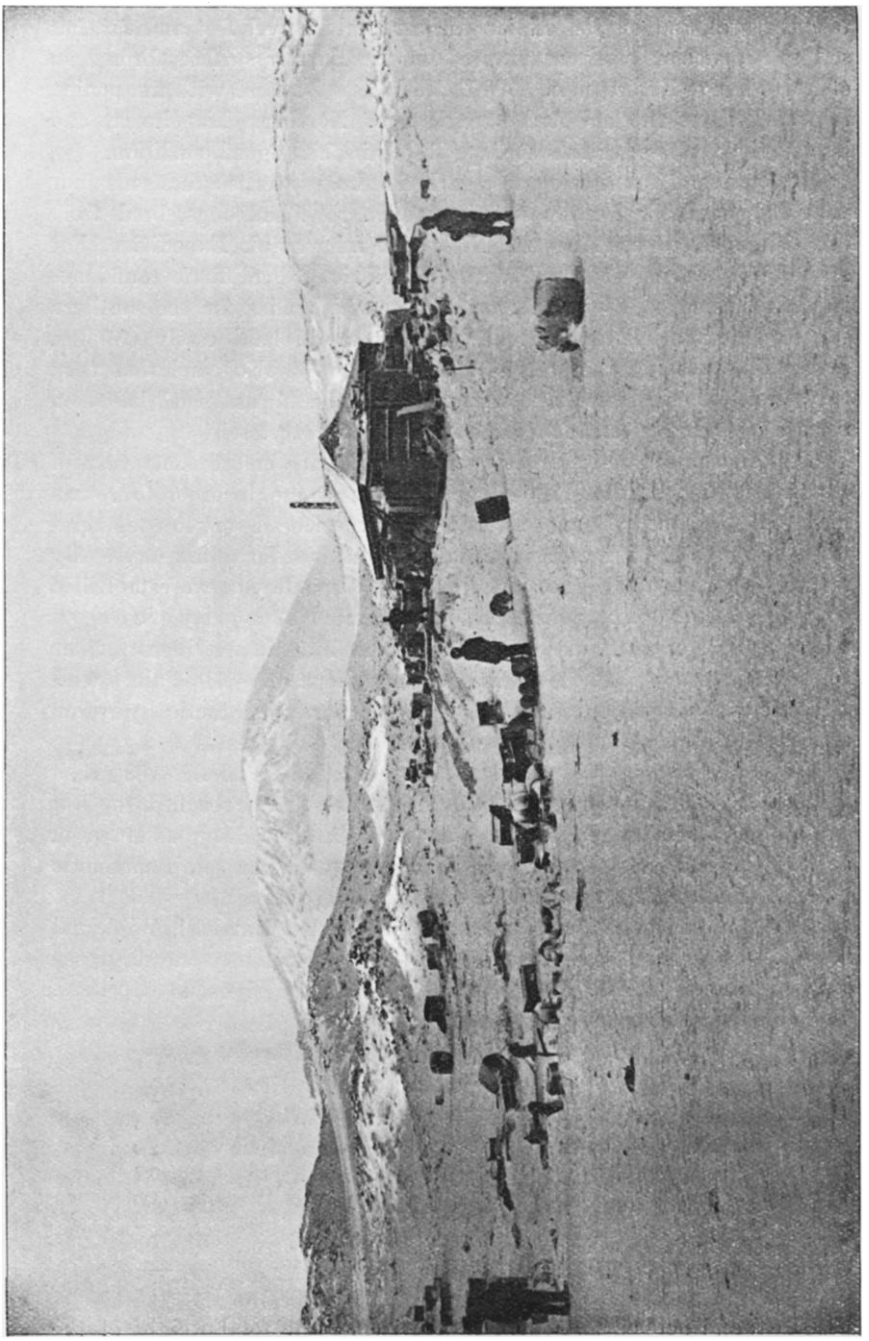
KOONYA TOWING *NIMROD.*

should be made. A party of six set out from the winter quarters on March 5, and on the morning of March 10 five of the men stood on the edge of the active crater, the sixth having been left at the last camp with frostbitten feet. The scientific results of the journey were both interesting and important. The party found that the height of the active crater is 13,350 feet above sea-level, the figures being calculated from aneroid levels and hypsometer readings, in conjunction with simultaneous readings of the barometer at the winter quarters. It was noted that the moraines left at the period of greater glaciation ascend the western slopes of Mount Erebus to a height of fully 1000 feet above sea-level. As the adjacent portion of McMurdo sound is at least 1800 feet deep, the ice-sheet at its maximum development must have had a thickness of not less than 2800 feet. Two distinctive features of the geological structure of Mount Erebus were the ice-fumaroles, and the vast

quantities of large and perfect felspar crystals. Unique ice-mounds have been formed in the cup of the second crater, from which rises the present active cone, by the condensation of vapour round the orifices of fumaroles. Only under conditions of extremely low temperature could such structures come into existence. The felspar crystals, found in enormous quantities mixed with snow and fragments of pumice in the second crater, were from 2 to 3 inches in length, and very many were perfect in form. The fluid lava which had surrounded them had been blown away by the force of the explosions which had ejected them from the crater. The valuable meteorological observations made cannot be stated within the scope of this article.

The most important event of the winter months was the discovery by the biologist of microscopical life in the frozen lakes of the Cape Royds district. Investigations showed that algæ grew at the bottom of the lakes, which are frozen during the greater part of the year, and in some cases thaw completely only in exceptionally warm seasons. The microscope showed that rotifers, water-bears, and other forms of minute animal-life existed on the weed. A shaft was sunk through 15 feet of ice to the bottom of a lake which did not thaw during the two summers that we spent at Cape Royds, and on weed found under the ice there were living rotifers of several kinds. Other rotifers were found on weed melted out of solid ice. It seemed obvious that the microscopic animals were able to live at a temperature at least as low as 40° below zero Fahr., and experiments verified this conclusion. The animals were not killed by that temperature, though all the natural functions were suspended, including the bearing of young among the viviparous species. They were alternately frozen and thawed weekly for a long period, and took no harm. They were dried and frozen, thawed and moistened, and still they lived. They lived in brine so salt that it froze only at a temperature of about zero Fahr., and many of them survived the test of being dried and placed in a bottle, which was then immersed in boiling water. Some of the weed carrying the animals was dried and conveyed to London, being subjected to tropical temperatures on the way. It was moistened in London, and the animals were found to be still living. They survived a final test of immersion in frozen gas at a temperature of −81° C. The whole subject is one of extraordinary interest to biologists, and the scientific memoirs of the expedition will embody the results of all Murray's observations and experiments.

Early in the spring of 1908 we began to make arrangements for the sledging journeys. One party, led by myself, was to go south towards the geographical pole; Prof. David was to take a second party north, and attempt to attain the south magnetic pole; and a third party was to undertake geological work in the mountains west of McMurdo sound, with the special object of discovering fossils. The motor-car had not



WINTER QUARTERS, CAPE ROYDS.

proved a success. The petrol engine ran well, even at low minus temperatures, and on the sea-ice the car could travel fast and far, but soft snow, such as was encountered on the Barrier surface, formed an effective bar to its progress. We had left New Zealand with ten ponies, imported from the sub-Arctic regions of Northern Manchuria, and landed eight of the animals at Cape Royds in fairly good condition.

Unfortunately, four were lost early in the winter, so that only four were left available for the sledging work. We had dogs, bred from the Eskimo dogs used by the Newnes-Borchgrevink Expedition, but after the experience of the *Discovery* Expedition I had little confidence in these animals. I pinned my faith on the ponies for the southern journey. Experiments showed that they could haul easily 650 lbs. each, this including the weight of the sledge (60 lbs.), and that they travelled well on bad surfaces, thus realizing the hopes I had based on reports of their performances in their native country.

I made a preliminary journey on to the Barrier before the return of the sun, taking with me Prof. David and Armytage, in order to get an idea of the surface to be encountered. We experienced very low temperature, below $-57°$ Fahr., and we only stayed out for a few days. By means of a series of sledging journeys from Cape Royds, we established a depôt of stores at Hut point, and on September 22 a party started out to lay a depôt on the Barrier beyond Minna bluff in readiness for the southern journey. The temperature got down to -59 Fahr., with blizzard winds, and the petroleum for the cookers was practically frozen at times, while off Minna bluff we got amongst crevasses.

On October 6 we laid the depôt in lat. 79° 36′ S., long. 168° E., a distance of 120 miles from the winter quarters. We reached the hut again on October 13. In the mean time, Prof. David, Douglas Mawson, and Dr. Mackay had started on their journey to the south magnetic pole. I did not see them again until March 1, 1909.

The southern party was to consist of Adams, Marshall, Wild, and myself. I decided to take provisions and oil for ninety-one days, the daily allowance of food, as long as full rations were given, to be 34 ozs. The allowance was made up as follows:—

	ozs.
Pemmican	7·5
Emergency ration	1·5
Biscuit	16·0
Cheese or chocolate	2·0
Cocoa	0·7
Plasmon	1·0
Sugar	4·3
Quaker oats	1·0
	34·0

Tea, salt, and pepper were used in addition. The total weight of the provisions taken was 773 lbs. 8 ozs. Each pony was to draw an 11-foot

sledge. In regard to our own clothing, we made a radical reduction in weight as compared with previous expeditions. We wore Burberry windproof gaberdine over Jaeger woollen undergarments, and used furs only for the hands and feet and for the sleeping-bags. I am satisfied that we could not have travelled as far as we did in the time at our disposal had we worn the usual heavy garments. The other articles of our equipment were along the lines laid down by other polar explorers, weight having been reduced to the minimum in each case. The scientific equipment included a 3-inch theodolite with stand, three chronometer watches, three pocket compasses, one hypsometer, eight thermometers, one case surveying instruments, two prismatic compasses, one sextant with artificial horizon, and camera with plates. The food

NIMROD OFF CAPE ROYDS.

for the ponies consisted of maize and Maujee ration, with a little Australian compressed fodder, 900 lbs. in all, the allowance for each pony being 10 lbs. per day.

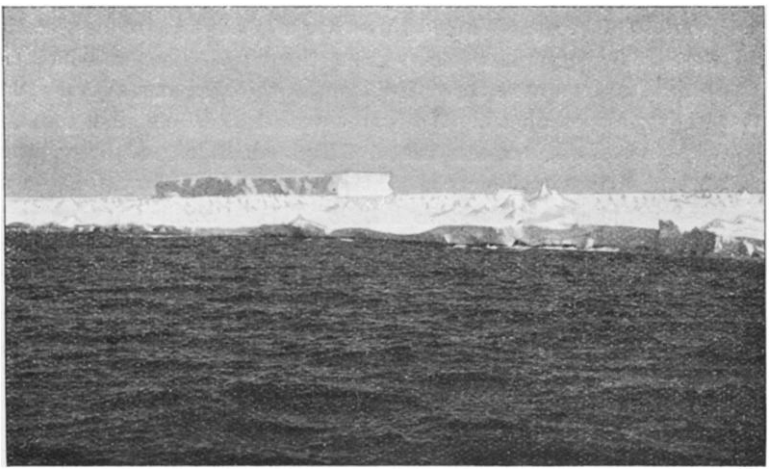
The southern party left the winter quarters on October 29, accompanied by a supporting party of six men. Progress at first was slow, heavy weather and crevassed ice being encountered; and it was not until November 15 that we reached the depôt laid out on the spring journey, the supporting party having left us some days previously. The ponies were pulling well, and I was feeling very satisfied with the change from the dogs used when I accompanied Captain Scott on his southern journey in 1902. The surface was soft, but we were able to move south at the rate of about 15 miles each day. Our course lay further from the land than the course followed by the previous expedition, as is shown on the accompanying chart. Good marches were

made in the days that followed, and on November 26 we camped in lat. 82° 18½′ S., long. 168° E., having passed the "furthest south" record. New land had come within our range of vision by this time, owing to the fact that we were far out from the base of the mountains, and I had noted with some anxiety that the coast trended south-south-east, thus threatening to cross our path and obstruct the way to the pole. We could see great snow-clad mountains rising beyond Mount Longstaff, and also far inland to the north of Mount Markham. On November 26 we opened out Shackleton inlet, and looking up it sighted a great chain of mountains, while to the west of Cape Wilson appeared another chain of sharp peaks, about 10,000 feet high, stretching away to the north beyond Snow cape, and continuing the land on which Mount A. Markham lies. The first pony had been killed on November 21, when we were south of the 81st parallel, and we had left a depôt of pony-meat and ordinary stores, to provide for the return march. We started at once to use pony-meat as part of the daily ration, and soon found that scraps of raw, frozen meat were of assistance on the march in maintaining our strength and cooling our parched throats. A second pony was shot on November 28, and a third on December 1, by which time we were closing in on the land, and it had become apparent that we would have to find a way over the mountains if we were to continue the southern march. We were still sighting new land ahead, and the coast-line had a more distinct easterly trend. We camped on December 2 in lat. 83° 28′ S., long. 171° 30′ E., opposite a red granite mountain about 3000 feet in height. On the following day we climbed this mountain, and from its summit saw an enormous glacier, stretching almost due south, flanked by huge mountains, and issuing on to the Barrier south of our camp. We decided at once that we had better ascend the glacier, and on the following day made our way, with two sledges and the last pony, on to its surface.

We encountered difficulties at once, for the snow-slopes by means of which we gained the glacier surface gave way to blue ice, with numberless cracks and crevasses, many of them razor-edged. Travelling on this surface in finesko was slow and painful work. On December 5 Marshall and Adams, who were ahead looking for a route, reported that at a point close to the granite cliffs, a bird, brown in colour, with a white line under each wing, had flown over their heads. They were sure it was not a skua gull, the only bird likely to have been attracted by the last dead pony. It was a curious incident to occur in lat. 83° 40′ S. We left the fourth depôt close to the foot of the glacier, at the foot of a wonderful granite cliff, polished by the winds and snows of ages. On December 6 we took six hours to pass about 600 yards of severely crevassed ice, over which all our gear had to be relayed, and on the following day we lost the last pony, which fell into a crevasse disguised, like so many others, by a treacherous snow-lid.

Wild was leading the pony with one sledge, while Adams, Marshall, and myself went on ahead with the other sledge and pioneered a practical path. We had passed over a snow-covered crevasse without noticing it, but the greater weight of the pony broke through the lid, and the animal dropped through, probably to a depth of several hundreds of feet. Happily the swingle-tree snapped with a sudden strain, and Wild and the sledge were saved. This accident left us with two sledges and a weight of about 250 lbs. per man to haul. Our altitude at this time was about 1700 feet above sea-level.

During the days that followed we made steady progress up the glacier, experiencing constant difficulty with the crevasses. We hauled well ahead of the sledges, so that when one of us dropped through a snow-lid the harness would support him until he could be hauled up



HEAVY PACK-ICE.

again. We had many painful falls as a result of having no footgear suitable for the ice-climbing, and any future travellers would do well to take boots with spikes. A special form would have to be devised, on account of the low temperature rendering impracticable the use of ordinary mountaineering boots. New land appeared day after day, and we were able to make small geological collections and to take some photographs. The rocks were sedimentary, the lines of stratification often showing clearly on the mountain-sides, and we made two geological discoveries of the first importance. In lat. 15° S., Wild, who had climbed the slope of a mountain in order to look ahead, found coal, six seams ranging from 4 inches to 7 or 8 feet in thickness, with sandstone intervening. Close to this point I found a piece of sandstone showing an impression, and microscopic investigation has shown that this was fossil coniferous wood.

The glacier proved to be about 130 miles in length, rising to an altitude of over 9000 feet. Christmas Day, 1908, found us in lat. 85° 55′ S., a plateau with icefalls appearing to the south. Much glaciated land trended to the south-east, apparently ending in a high mountain shaped like a keep. The land to the west had been left behind. It was evident that we were still below the plateau-level, and, though we were getting free of the crevasses, we were hindered by much soft snow. The level was rising in a series of steep ridges about 7 miles apart. We had started to reduce rations before leaving the Barrier surface, and by Christmas Day were marching on very short commons. Our temperature was 2° sub-normal, but otherwise we were well and fit.

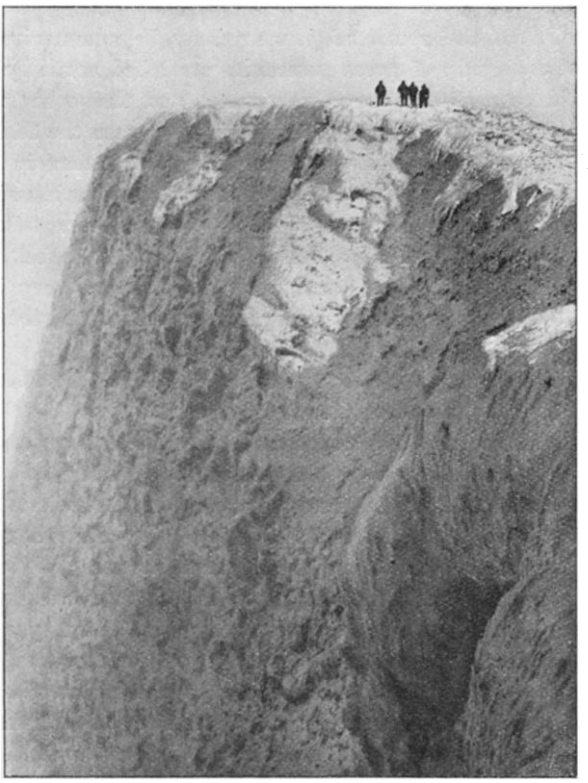
On December 31 we camped in lat. 86° 54′ S. We had not yet reached the plateau-level, for slopes still lay ahead, and our altitude was about 10,000 feet. We had three weeks' food on a reduced ration, and were 186 geographical miles from the pole. The land had been left behind, and we were travelling over a white expanse of snow, still with rising slopes ahead. We were weakening from the combined effects of short food, low temperature, high altitude, and heavy work. We were able to march on the first six days of January, and on the night of January 6 camped in lat. 88° 7′ S. We had increased the daily ration, for it had become evident that vitality could not be maintained on the amount of food we had been taking. I had been forced to abandon the hope of reaching the pole, and we were concentrating our efforts on getting within 100 miles of the goal.

A fierce blizzard blew on January 7 and 8, and made any march impossible. We lay in our sleeping-bags, frequently attacked by frost-bite. The wind ceased at 1 a.m. on January 9, and at 4 a.m. we started south, leaving the camp standing, and taking only instruments, food, and the flag. At 9 a.m., after five hours' marching over a fairly hard surface, we calculated we were in lat. 88° 23′ S., and we hoisted the flag. The snow plain stretched southward to the horizon without a break.

The homeward march was rendered difficult by shortage of food and attacks of dysentery, due to the meat from one of the ponies. We picked up a depôt left on the plateau on January 4, and made rapid progress to the north. The blizzard winds from the south, which had hampered us on the outward journey, now proved of assistance, for we made a sail from the floorcloth of a tent, and travelled fast with our one remaining sledge. On January 19 we covered a distance of 29 miles down the glacier. On January 16 we ran out of food when 16 miles from the glacier depôt, and we marched for thirty-one hours with only a little tea and chocolate. We were able to reach the depôt in an exhausted condition. We left the glacier and reached the Barrier surface on January 28, but Wild was attacked by dysentery, and a little

later we all suffered. The trouble was evidently due to the meat from one pony, and as the frozen flesh could not have become tainted in the usual way, we assumed that it was due to the toxin of exhaustion, the animal having been killed when very weary.

We were assisted on the southward march over the Barrier by snow mounds erected on the outward journey, and we picked up the depôts without any difficulty, reaching each with our food-bags empty. We could not march at all on February 4, owing to acute dysentery, but we



THE TOP OF EREBUS.

were able to continue on the following days, and on February 23 we reached a depôt laid out off Minnu bluff in readiness for our return by a party from the winter quarters. We were all safe on board the *Nimrod* on March 4.

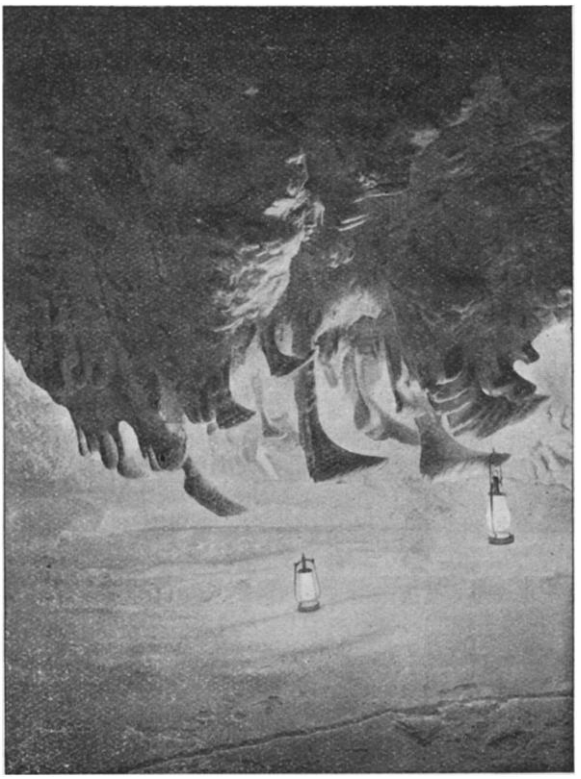
The latitude observations made on the southern journey were taken with the theodolite, as were all the bearings, angles, and azimuths. Variation was ascertained by means of a compass attached to the theodolite, and the steering compasses were checked accordingly. At

noon each day the prismatic compasses were placed in the true meridian, and checked against the theodolite compass and the steering compasses. The last latitude observation on the outward journey was taken in 87° 22′ S. and the remainder of the distance towards the south was calculated by sledge meter and dead reckoning. The accuracy of the sledge meter had been proved by the fact that the daily record of distance travelled agreed roughly with the observations for position. We took only one observation on the return journey, on January 31, and then found that our position had been accurately recorded by the sledge meter.

The results of the southern journey may be summarized briefly. We found that a chain of great mountains stretched north by east from Mount Markham as far as the 86th parallel, and that other ranges ran towards the south-west, south, and south-east between the 84th and the 86th parallels. We ascended one of the largest glaciers in the world on to a high plateau, which in all probability is a continuation of the Victoria Land plateau. The geographical pole almost certainly lies on this plateau, at an altitude of between 10,000 and 11,000 feet above sea-level. The discovery of coal and fossil wood has a very important bearing on the question of the past geological history of the Antarctic continent.

The Northern Party consisted of Prof. David, Dr. Mackay, and Douglas Mawson. The three men left Cape Royds on October 5, and travelled on the sea-ice along the coast as far as the Drygalski Barrier tongue. They had neither dogs nor ponies, and as they could not haul the whole of their load at one time they had to relay their two sledges, thus covering the ground three times. They reached the Drygalski tongue on November 30, and from that point struck inland in a north-west direction, with a lightened load, towards the south magnetic pole. They crossed the Drygalski glacier with very great difficulty, a fortnight being occupied in gaining 20 miles over steep ice ridges and crevasses, and twice failed in attempts to climb on to the inland plateau, first by means of the Mount Nansen glacier and then up the Bellingshausen glacier. Finally, they succeeded in finding a path up a small tributary glacier to the south of Mount Larsen and gained the plateau. Then came a painful march over the plateau, which gradually rose to an altitude of over 7000 feet, in the face of blizzards, broad undulations, and high sastrugi. On January 16, 1909, the party reached lat. 72° 25′ S., long. 155° 16′ E., the approximate position of the magnetic pole as calculated from the observations taken by Mawson with the Lloyd-Creak dip circle. The journey back to the coast had to be made by forced marches, for the party knew that the sea-ice would have broken out and that their hope of safety depended largely on the *Nimrod*, which was to cruise along the coast as far as Cape Washington early in January. They reached the Drygalski Barrier tongue on January 3,

and on the following morning, by a happy combination of circumstances, were picked up by the ship, which was on its way back to the winter quarters, after a fruitless search along the coast. The party did very useful geographical work in the course of its journey, for Mawson triangulated the coast of Victoria Land from McMurdo sound to the Drygalski barrier, and many new peaks, glaciers, and tongues were discovered, as well as two small islands. Prof. David studied the geological conditions with good results.



CURIOUS ICE FORMATION.

The Western party consisted of Armytage, Priestley, and Brocklehurst, and it first proceeded up the Ferrar glacier as far as the Solitary rocks, with the special object of searching for fossils in the Beacon sandstone formations. Priestley made a thorough geological search of the neighbourhood, but without success, so far as fossils were concerned. The party descended the glacier with the object of joining the Northern party, according to my instructions, but the junction was not effected, owing to the delays that had overtaken Prof. David and his companions.

Priestley was able to work at the Stranded Moraines and in Dry valley. The party was picked up by the *Nimrod* on January 25, after narrowly escaping disaster on a drifting icefloe.

All the members of the expedition were aboard the *Nimrod* on March 4, 1909, and we proceeded north under steam at once, for the season was advancing, and the sea-ice had commenced to form. We were off Cape Adare on March 6, and I made an attempt to push on west of Cape North, with the object of securing knowledge of the coast-line. The pack-ice, which was thickening rapidly, and threatened to prison the ship, prevented the *Nimrod* going as far as I had hoped, but we got to long. 166° 14′ E., lat. 69° 47′ S., and on the morning of March 8, from that position, we saw a new coast-line stretching first to the southwards, and then to the west for a distance of over 45 miles. We took angles and bearings, and sketched the outline. Then we went north, and on March 22 reached New Zealand.

The geological work of the expedition was carried on by Prof. T. W. Edgeworth David and Raymond Priestley. I have already mentioned matters connected with the Great Ice Barrier. Their conclusions in regard to other points are summarized as follows:—

(1) Throughout the whole of the region of Antarctica examined by us for 16° of latitude there is evidence of a recent great diminution in the glaciation. In McMurdo sound this arm of the sea, now free from land ice, was formerly filled by a branch of the Great Ice Barrier, whose surface rose fully 1000 feet above sea-level, and the Barrier ice in this sound, in areas from which the ice has retreated, was formerly about 3000 feet in thickness.

(2) The snowfall at Cape Royds from February, 1908, to February, 1909, was equal to about 9½ inches of rain.

(3) The *névé*-fields of Antarctica are probably of no great thickness.

(4) The southern and western sides of the sector of Antarctica south of Australia is a plateau from 7000 to 10,000 feet high, which may possibly extend across the south pole to Coats' Land and Graham's Land.

(5) Ross sea is probably a great subsidence area.

(6) The Beacon sandstone formation, which extends for at least 1100 miles from north to south in Antarctica, contains coniferous wood associated with coal-seams. It is probably of Palæozoic age.

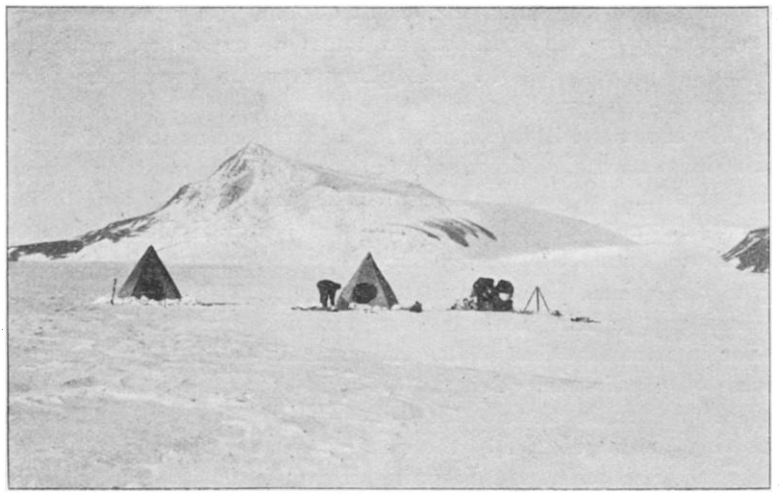
(7) Limestones, pisolitic in places, in 85° 25′ S., and 7000 feet above sea-level, contain obscure casts of radiolaria.

Radiolaria, in a fair state of preservation, occur in black cherts amongst the erratics at Cape Royds. They appear to belong to the same formation as the limestone. These radiolaria appear to be of older Palæozoic age.

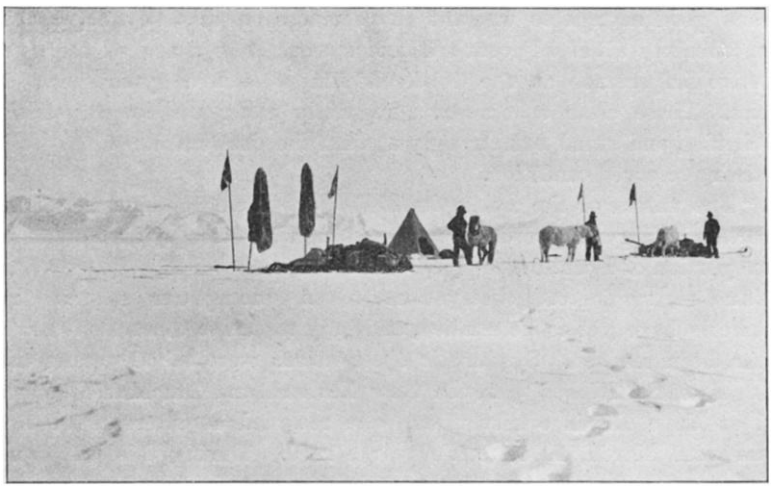
(8) The succession of lavas at Erebus appears to have been first trachytes, then kenytes, then olivine basalts. Erebus is, however, still erupting kenyte.

(9) Peat deposits, formed of fungus, are now forming on the bottoms of some of the Antarctic glacial lakes near 77° and 78° S.

(10) Raised benches of recent origin extend at Ross island to a height of at least 160 feet above sea-level.



CAMP, SOUTHERN JOURNEY.



CAMP ON SOUTHERN JOURNEY.

The fossil in Beacon sandstone found by the southern party in lat. 85° S. is described as follows by Mr. E. J. Goddard, B.SC., Macleay Research Fellow of the Linnæan Society, New South Wales :—

"Longitudinal sections of the included dark masses give a homogeneous banded appearance of a distinctly organic nature. The banded appearance is due to the vascular nature of the organic elements composing the mass. The whole structure recalls to one's mind the appearance given by longitudinal sections of the xylem portion of the vascular area of a gymnosperm, such as *Pinus*. Only the xylem area is represented in the specimen, no traces of medullary, cortical, or phloem tissue being visible. Medullary rays are present, as shown in the micro-photograph.

"The xylem itself is composed of a homogeneous mass of vessels, tracheidal in nature, no differentiation as regards the vascular elements being present. In places one may readily make out in longitudinal sections dark opaque bands of much greater size individually than the tracheides. These, in all probability, represent resin passages belonging to the xylem. It would seem, further, that these masses might be considered as being nothing more than an aggregation of material similar in nature to that of the walls, and due to changes under the process of petrifaction. This, however, is opposed by the fact that they occur even in these small sections fairly commonly and at the same time are all of exactly the same size as regards width. At all events, they represent some definite structure, and in all probability resin passages.

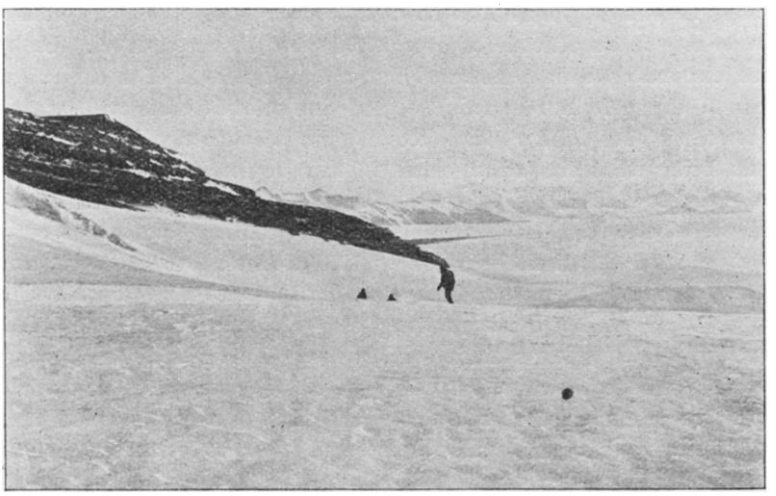
"The walls of the tracheids themselves, seen under the high power of the microscope, appear to be pitted; but the preservation is by no means good enough to warrant any remarks on this, beyond that in the common wall of adjacent tracheides occur clear spaces of the same relative importance as the bordered pits of such a gymnosperm as *Pinus*. These clear spaces occur regularly along the length of the tracheides, and stand out strongly against the dark colour of the walls in their preserved condition.

"The nature of the xylem itself leads to the conclusion that it is a portion of a gymnospermous plant, resembling strongly in nature the same portion of a coniferous plant."

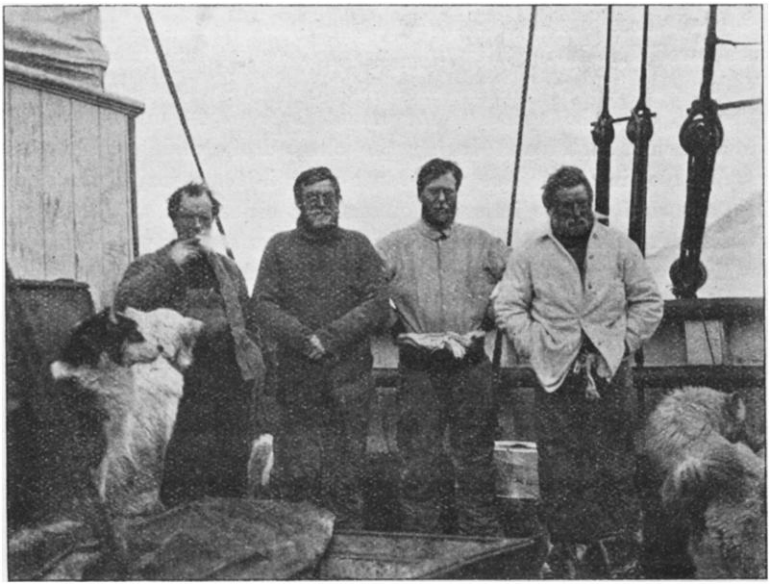
The meteorological observations taken during our stay in the Antarctic have yet to be studied, and only tentative conclusions have, so far, been reached. Systematic observations were taken during the vogages of the *Nimrod* between New Zealand and MacMurdo sound, and at Cape Royds observations were recorded at intervals of two hours from March, 1908, to February, 1909. During this period no rain fell. The lowest temperature definitely recorded was $-57°$ Fahr. near White island on the Great Ice Barrier on August 14, 1908. We were able to secure interesting observations of the upper currents of the air at Ross island. Reporting on this subject, Prof. David and Lieut. Adams state—

"At Mount Erebus our winter quarters were situated in an

exceptionally favoured position for observing the upper currents of the atmosphere. Not only had we the great cone of Erebus to serve as



VIEW OF LAND WHERE COAL WAS FOUND.



SOUTHERN PARTY AFTER THEIR RETURN.

a graduated scale against which we could read off the heights of the various air-currents as portrayed by the movements of the clouds

belonging to them, but we also had the magnificent steam column in the mountain itself, which, by its swaying from side to side, indicated exactly the direction of movement of the higher atmosphere. Moreover, during violent eruptions like that of January 14, 1908, the steam-column rose to an altitude of over 20,000 feet above sea-level. Under these circumstances it penetrated far above the level of a current of air from the pole northwards, so that its summit came well within the sweep of the higher wind blowing in a southerly direction, the result being that the steam-cloud in this region was dragged over powerfully towards the south-east. On such occasions one usually saw evidence of two high-level currents, the one coming from a northerly direction, its under limit being about 15,000 feet above sea-level; and the other, or middle current, from a southerly quarter, usually blowing towards the east-north-east, having its upper limit at 15,000 feet normally, while its lower limit was between 6000 and 7000 feet above sea-level. While these two currents were blowing strongly, there would frequently be a surface current blowing gently from the north. This would bring up very dense masses of cumulus cloud from off Ross sea. The cumulus would drift up to the 6000 or 7000 feet level on the north-west slopes of Erebus, and then the tops of the cumulus would be cut off by the lower edge of the northward-flowing middle current. Wisps of fleecy cloud would be swept along to the east-north-east, torn from the tops of these cumulus clouds by the middle current. Our observations showed that during blizzards the whole atmosphere from sea-level up to at least 11,000 feet moves near Cape Royds from south-east to north-west, and the speed of movement is from 40 up to over 60 miles an hour. After and during the blizzard the middle air-current, normally blowing from the west-south-west, is temporarily abolished, being absorbed by the immense outrushing air-stream of the south-east blizzard. During a blizzard the air was generally so thick with snow that we were unable to see the top of Erebus. At the end of a blizzard the air-current over Erebus became suddenly reversed, the steam-cloud swinging round from the south to the north. After a time, following on the conclusion of a blizzard, a high-level current was seen to be floating the cirrus clouds from the south-east towards the north-west, and the steam of Erebus would stream out towards the north-west. We could not account for this high-level south-easterly current. It looked like a reversal of the usual upper wind, and it appears to be a fact new to meteorological science."

In this article I can only indicate the scientific results of the expedition, as apart from the new geographical knowledge secured. We were able to throw some additional light on the problem presented by the Great Ice Barrier. The disappearance of Balloon bight shows clearly that the recession noted since the days of Sir James Ross continues, and suggests that very large portions of the Barrier edge

may occasionally "calve off." The trend of the mountains discovered on the southern journey indicates that the Barrier is bounded by mountains which run eastward along the 86th parallel, about 300 miles from the sea-edge. The great glacier up which we marched to the polar plateau shows that the Barrier is fed to some extent from the highlands of the interior. It would seem, however, that in the main the Barrier is formed of superimposed layers of snow, and some interesting observations were secured in this connection. We formed the opinion that at Cape Royds the annual snowfall is equal to about 9·5 inches of rain. The southern depôt party, in January, 1909, found depôt A, left by Captain Scott in 1902 on the Barrier off Minna bluff. A careful examination showed that the depôt had been moving bodily to

PROF. DAVID, DOUGLAS MAWSON, AND DR. MACKAY AT THE SOUTH MAGNETIC POLE.

the east-north-east at the rate of a little over 500 yards a year, while there had been an accumulation of about 13 inches of hard snow above the depôt during each year. A determination of the density of the snow showed that the snowfall on that part of the Barrier had been equal to about 7·5 inches of rain per year. If it is assumed that the rate of accumulation of solid snow over the Barrier is 12 inches of consolidated snow per year, then it follows, since the Barrier extends south for about 300 miles, and is moving northward at the rate of about one-third of a mile per year, that a layer of snow deposited 300 miles inland will be covered by a depth of 900 feet of snow when it reaches the Barrier edge 900 years later. This theory suggests that the Barrier is an accumulation of snow rather than of glacier ice, and was supported by the

evidence of bergs which were examined by the expedition. The typical Antarctic berg is formed of consolidated snow. The question of what becomes of the ice from the inland glaciers remains unanswered. The Barrier is certainly afloat at its northern edge, and perhaps the ice, weighed down by superimposed snow, is thawed away by the sea-water. Some true icebergs are found in the Antarctic.

The expedition made a special study of meteorological optics, and some very interesting observations were made, and will be dealt with by the scientific members in the memoirs. The curious "earth shadows" were observed in a variety of forms. Some of them seemed clearly to have a relation to the relative positions of Mount Erebus and the sun. Other forms were not so easily explained. In the spring, when the sun was low in the northern sky, we saw above us six parallel earth-shadow beams, directed from the sun.

The scientific memoirs of the expedition will deal in detail with geology, biology, meteorology, magnetism, physics, chemistry, and mineralogy, tides and currents, optics, and other scientific subjects. We were a small party, and of necessity a considerable part of our time was occupied in the necessary routine duties incidental to daily life in the Antarctic, but we tried to cover all the ground possible in the various branches of scientific knowledge. It is probable that most of the volumes containing our scientific records and conclusions will be published within the next twelve or eighteen months.

The last stage of the expedition was a search by the *Nimrod* for some of the charted southern islands, the existence of which is doubtful. The ship sailed over the positions assigned to the Royal Company island, Emerald island, the Nimrod islands, and Dougherty islands, without having sighted land.

CHANGES ON THE EAST COAST OF ENGLAND WITHIN THE HISTORICAL PERIOD.

I. YORKSHIRE.*

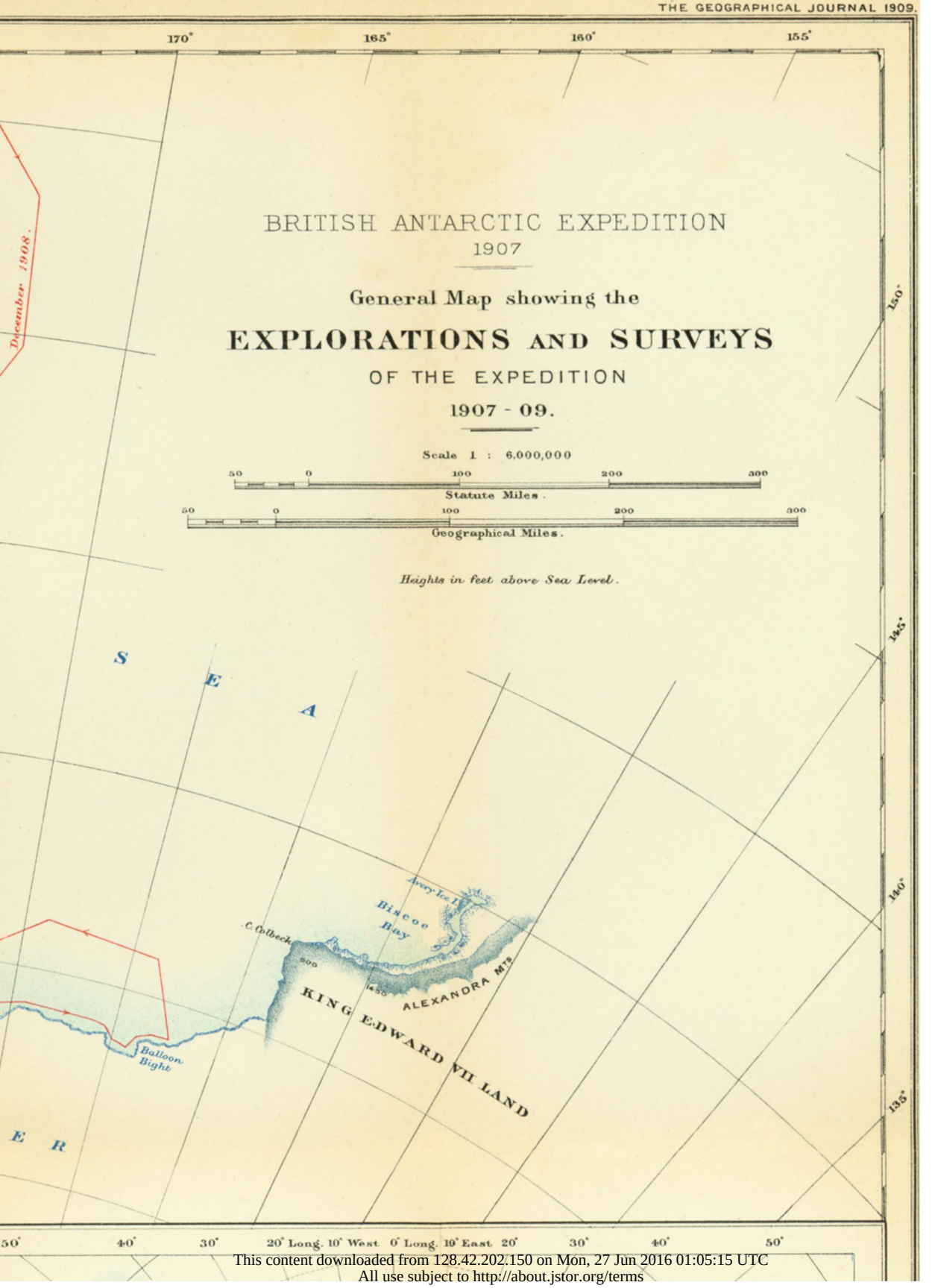
By T. SHEPPARD, F.G.S., The Museum, Hull.

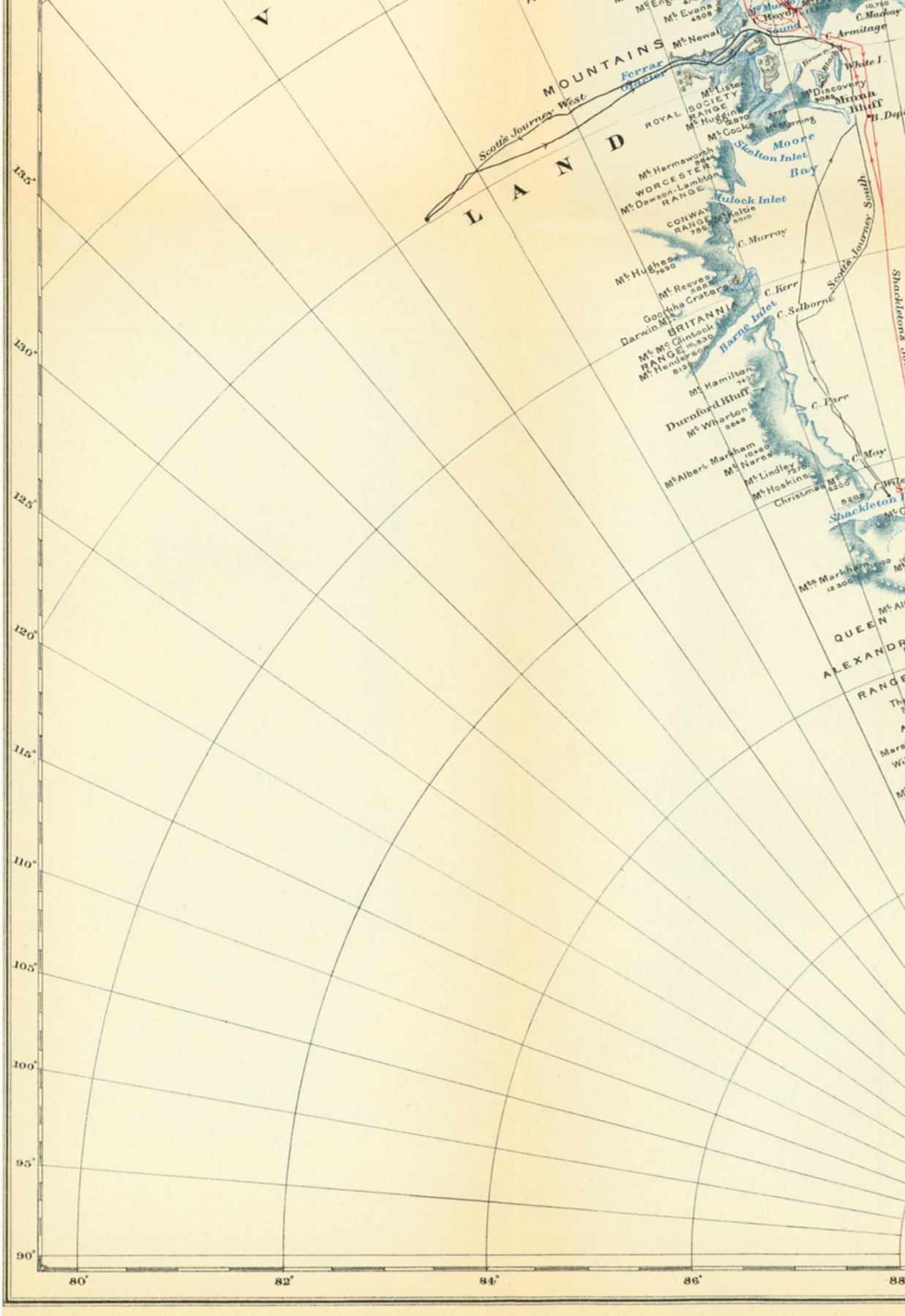
Coast Changes in Holderness and the Humber Estuary.

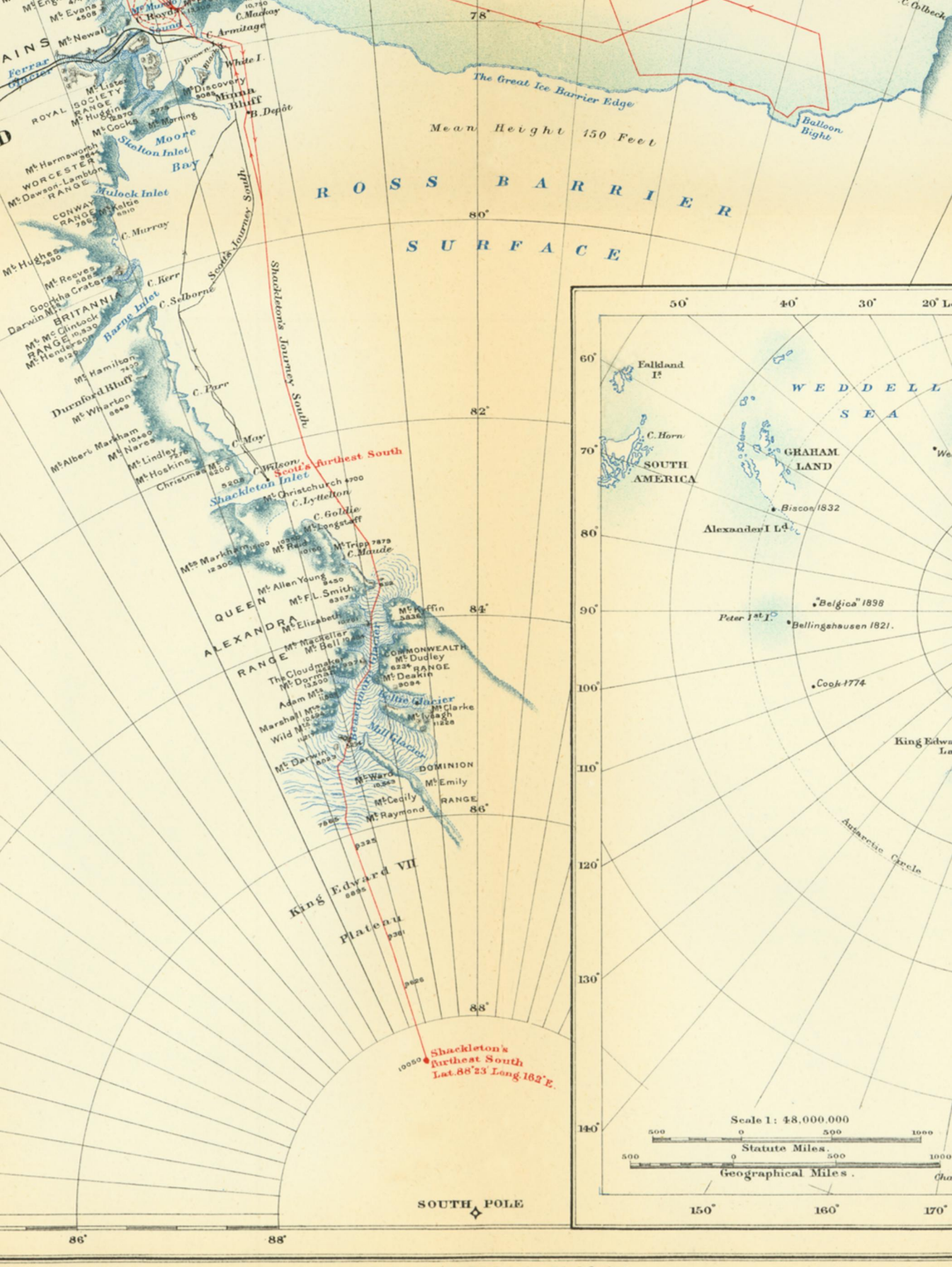
Possibly no district in the British Isles offers such a variety of lessons as does the coast-line between Bridlington and Spurn Point and the Humber estuary. On the one hand, enormous tracts of land have disappeared within historic times; whilst on the other, large areas have been formed, embanked, and cultivated.

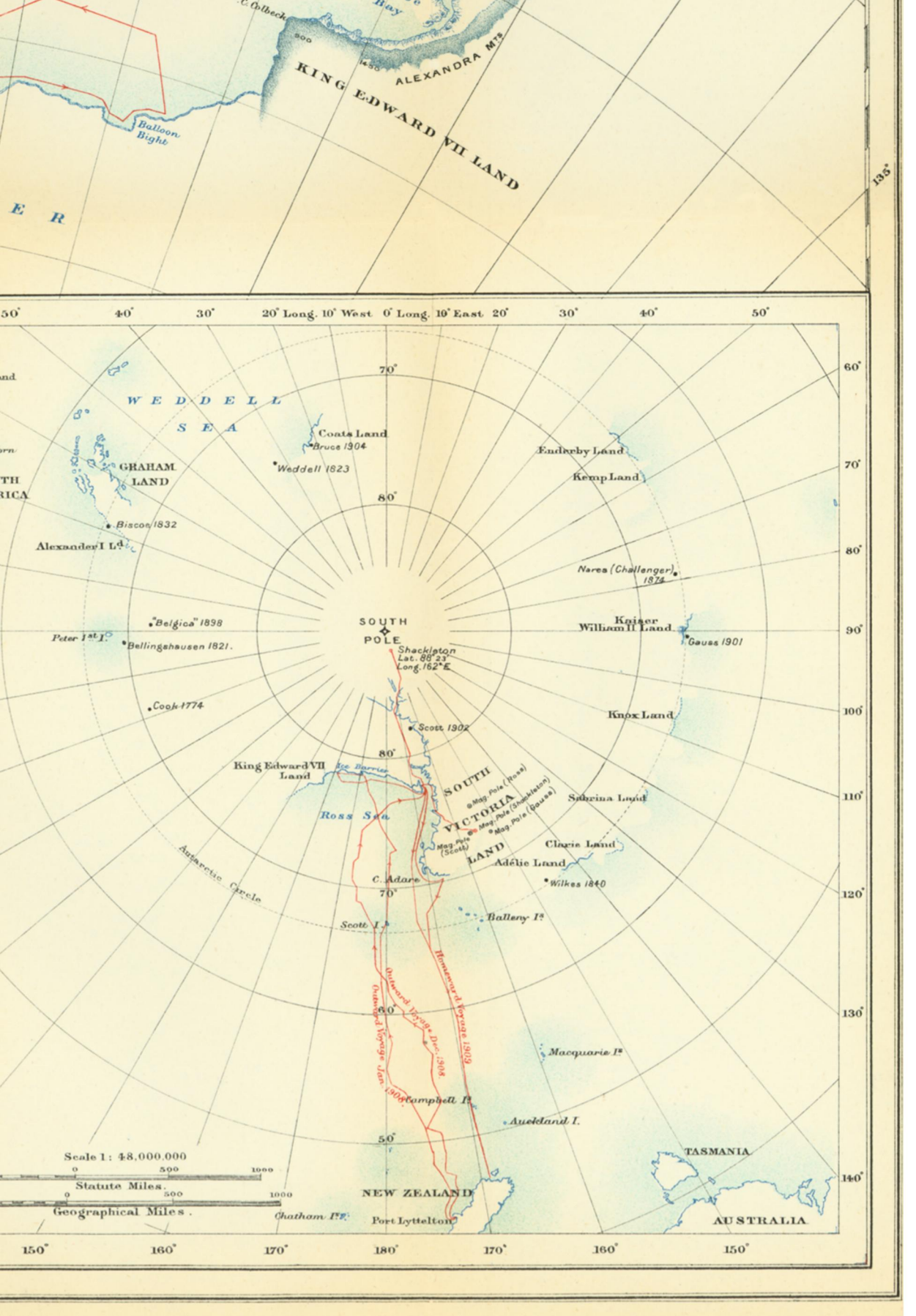
The district is also especially worthy of attention from the fact that data of a most reliable character relating to these changes are available.

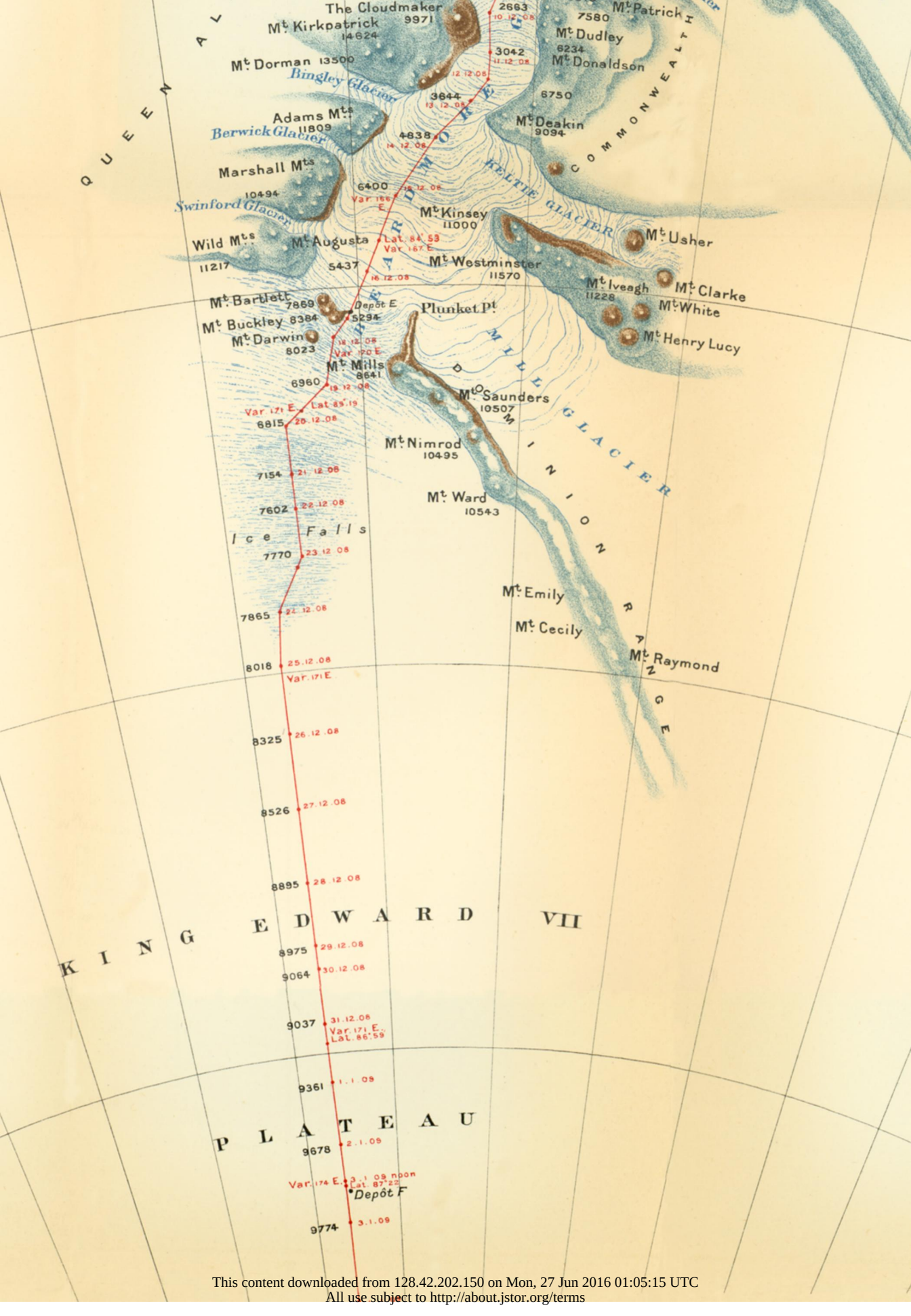
* Research Department, June 17, 1909.

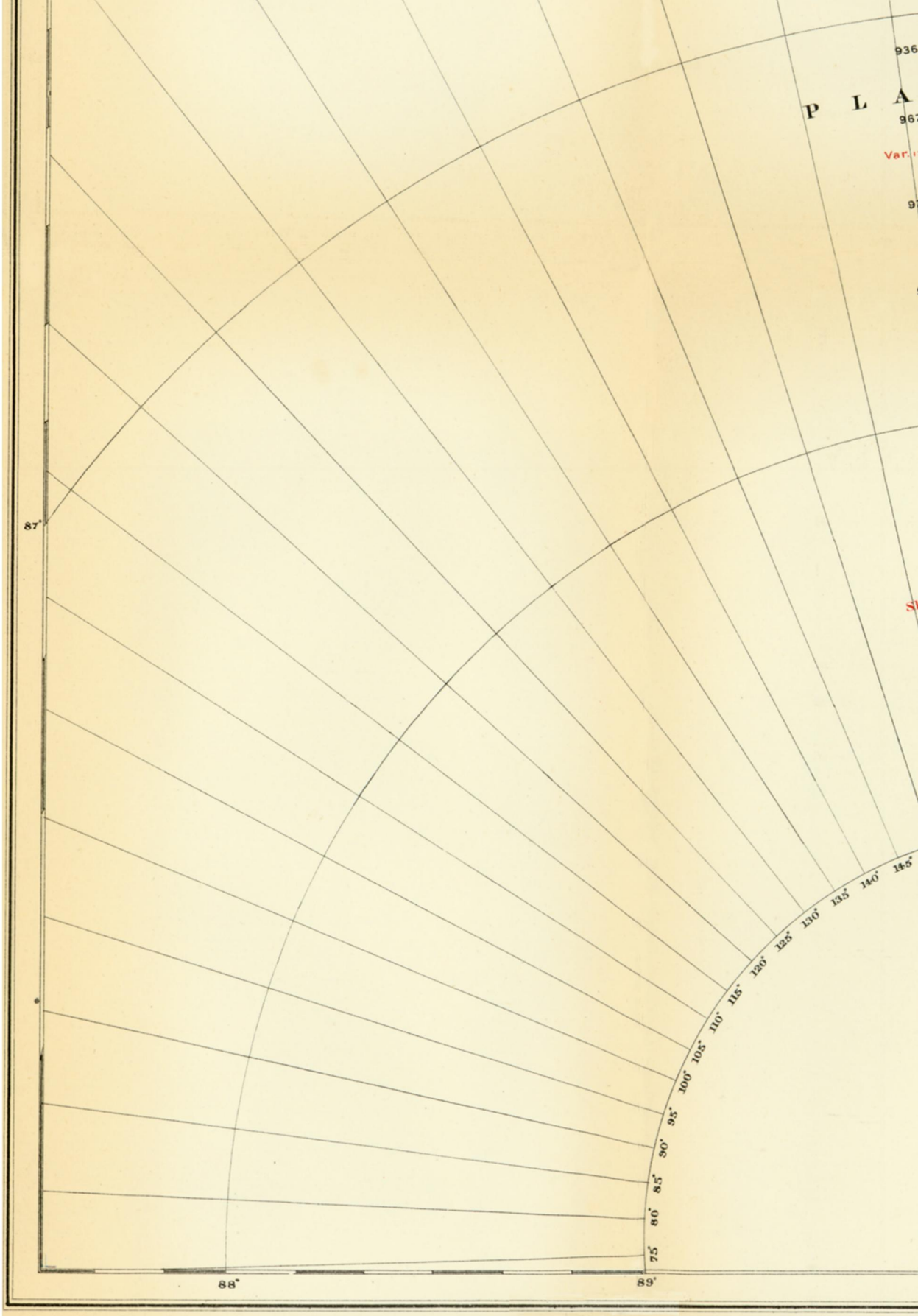


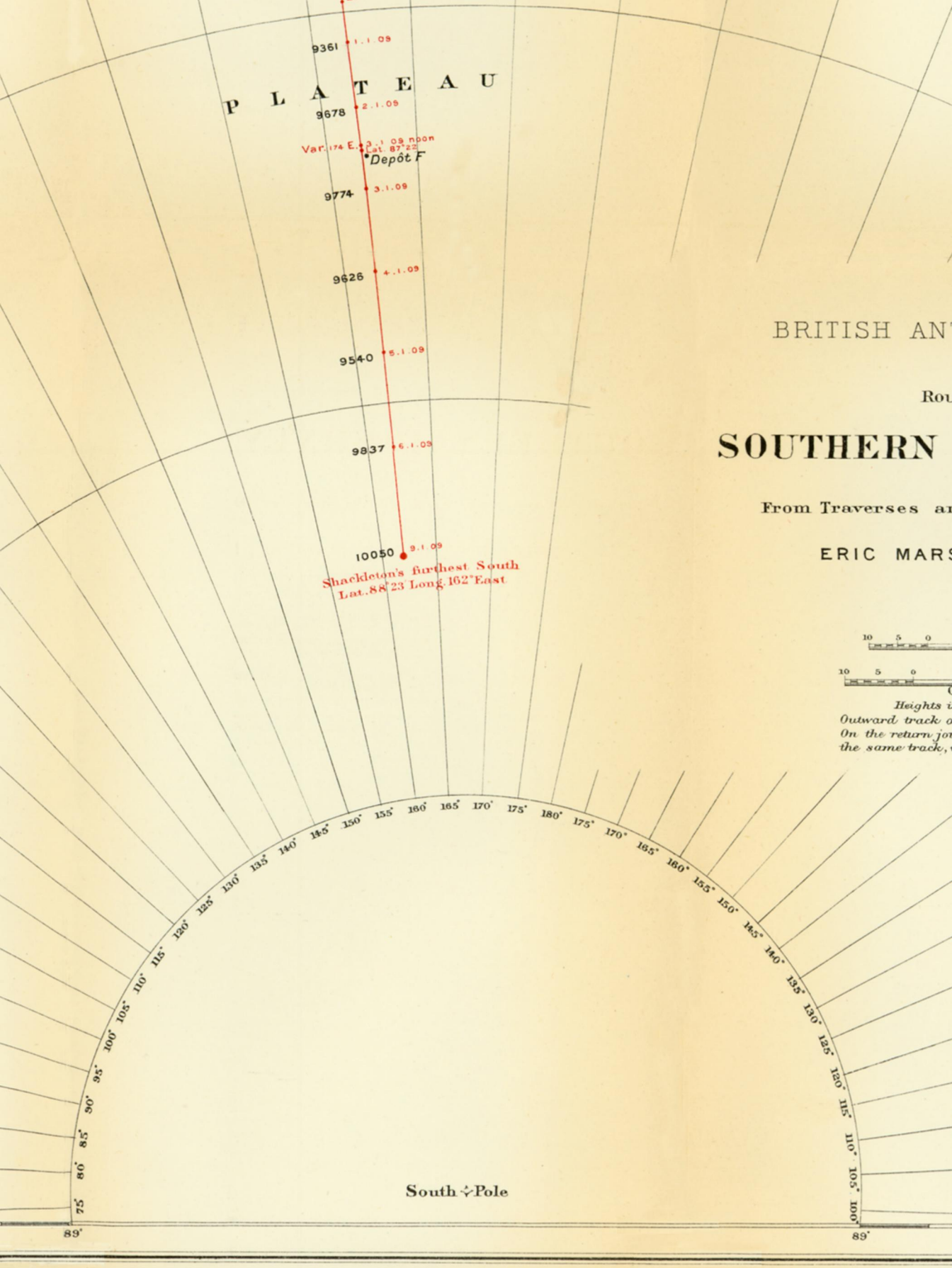












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BRITISH ANTARCTIC EXPEDITION

1907

Route and Surveys
of the

SOUTHERN JOURNEY PARTY

1908-09.

From Traverses and Astronomical Observations
by

ERIC MARSHALL, M.R.C.S., L.R.C.P.

Cartographer.

Scale 1:1,500,000

10 5 0 10 20 30 40

Statute Miles

10 5 0 10 20 30 40

Geographical Miles

Heights in feet above sea level.

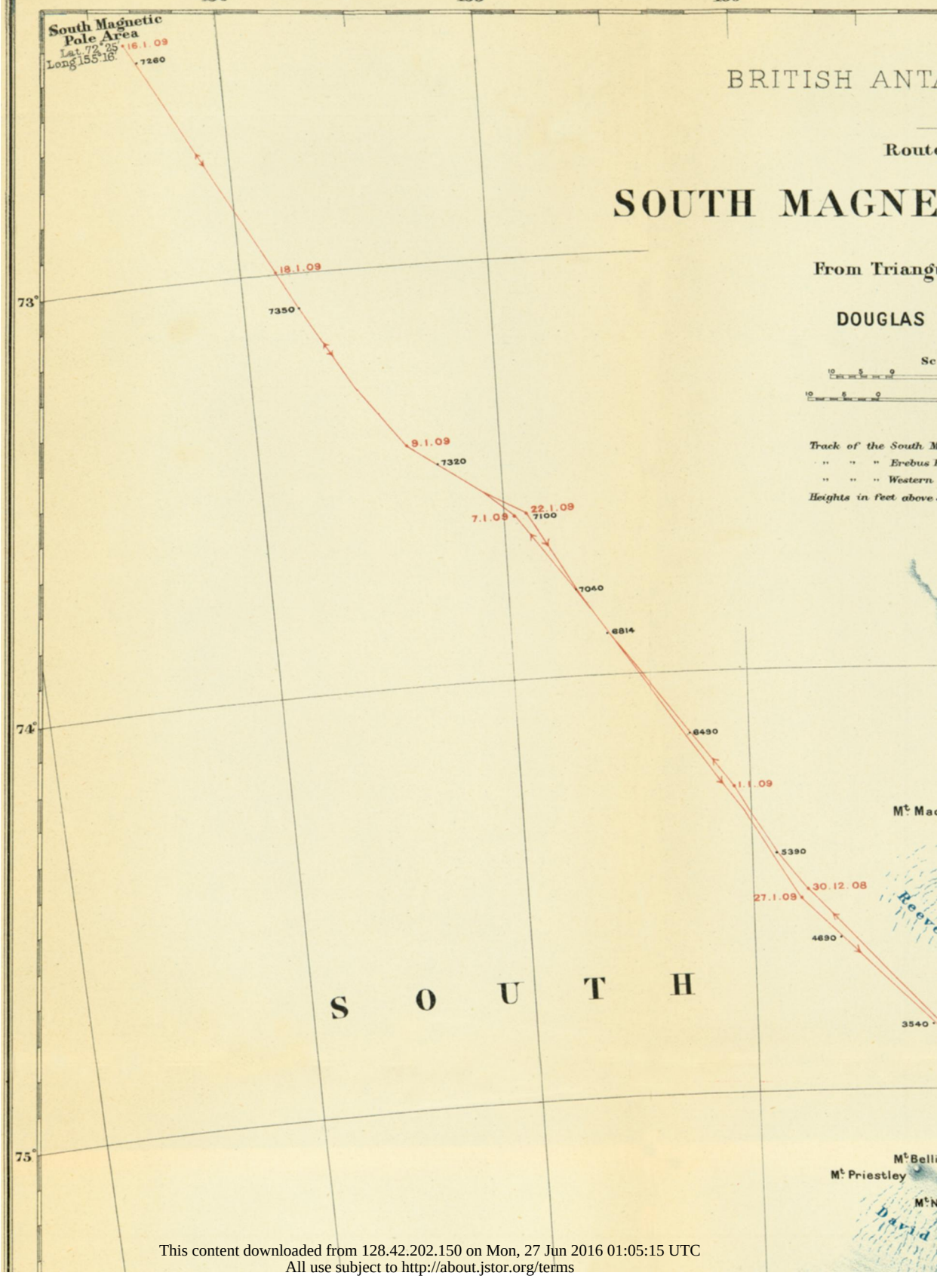
Outward track of Southern journey ———

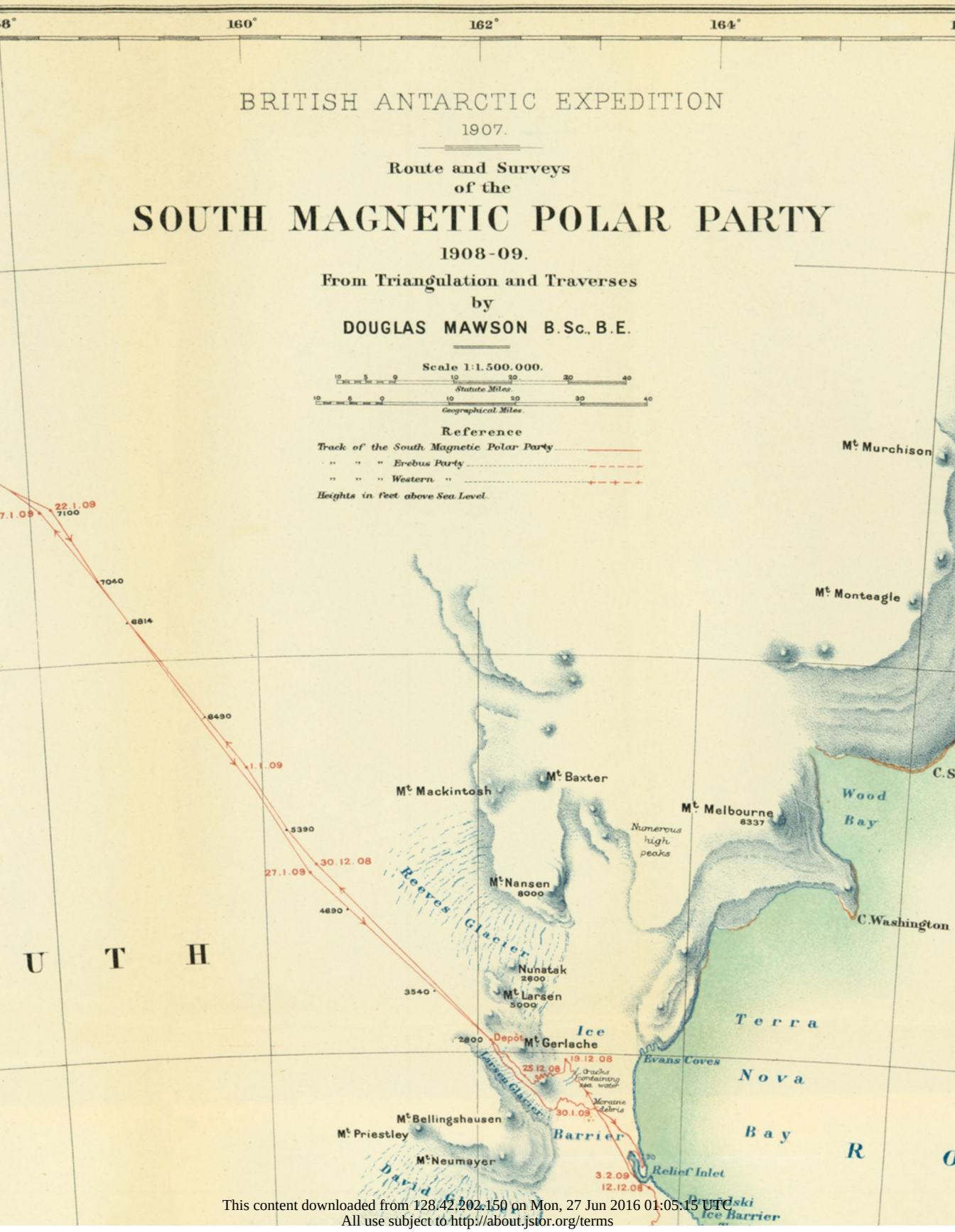
On the return journey Mr. Shackleton's party followed the same track, with very slight variations.

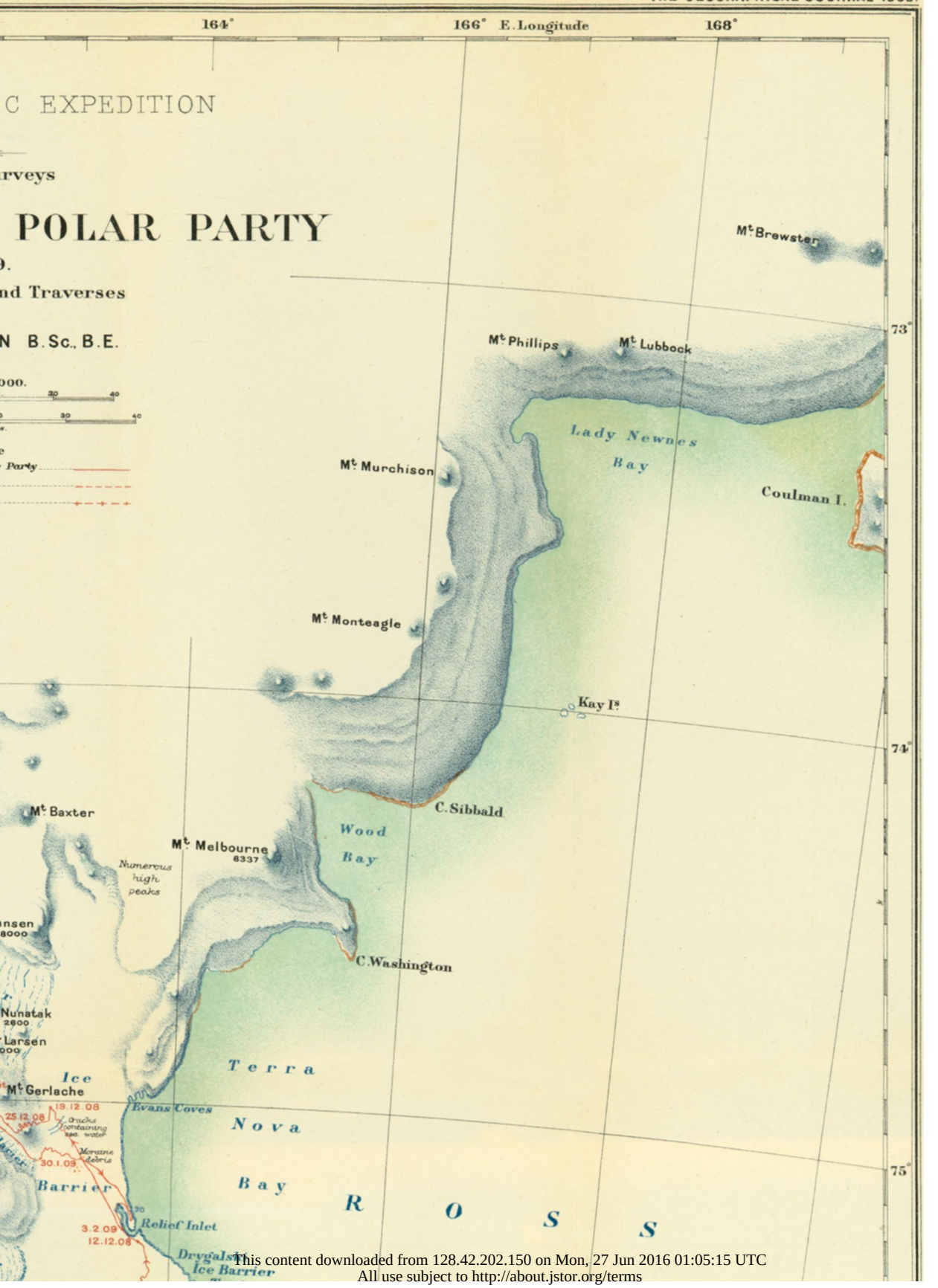
87°

185° 180° 155° 150° 145° 140° 135° 130° 125° 120° 115° 110° 105° 100°

89° 88°







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