



Exploration of Antarctic Lands

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for a distance of nearly 200 miles, I riding on an ox, while our baggage was carried by porters. The rains were now in full swing, the grass was green and very high, and we lived in a perpetual state of moisture. At Fort Possel, on the Ubangi, we again took to canoes, while the latter part of our voyage to Brazzaville was made by steamer. From Bangi onwards I had the benefit of the company of M. Bonnel de Mézières and M. Mercuri, the former from the sultanates of the Bahr-el-Ghazal, the latter from the upper Ubangi and the country of Senussi.

We everywhere met with the most cordial reception, and from Brazzaville had an easy journey by rail to Matadi, where I took ship for France, happy in the thought that my work was now accomplished.

EXPLORATION OF ANTARCTIC LANDS.*

By HENRYK ARCTOWSKI.

ON Friday, January 14, 1898, the *Belgica* left St. John harbour in the morning, and obtained a sounding near the shore giving a depth of 162 fathoms; a second sounding later in the day gave a depth of 855 fathoms. Next day we lost sight of Staten island, and obtained a sounding of 2209 fathoms. This was our first discovery—an unknown depression lying close to the extremity of the Andes, the steep slope of the mountains being evidently continued under the sea. The prolongation of the great mountain chain is to be looked for to the east of Staten island, which forms the last fragment of the Andes; but in that case, what can we make of the Diego Ramirez islands south-west of Cape Horn? The latitude at which we had found the deep sounding was within a few minutes of that of the Cape, the exact position being $55^{\circ} 51' S.$ and $63^{\circ} 19' W.$ One is led to speculate as to whether the chain of the Andes does not open out like a fan, as so many other mountain chains do.†

On January 19, Commandant de Gerlache pointed out the ice-blink in the south. The sky was uniformly covered with a thin layer of stratus, and just at the horizon a white line appeared like a longitudinal slit, detaching itself by its brightness from the grey of the sky. It was discontinuous, a little undulated, not rising more than from 10' to 25' above the horizon. At 8 p.m. Lecointe reported the first iceberg, which appeared like a dome rising sharply out of the sea at a distance of about 10 miles. The soundings had given depths of 2105, 2078, and

* Personal narrative of the twenty landings on the lands discovered by the Belgian Antarctic Expedition.

† Arctowski, "The Bathymetrical Conditions of the Antarctic Regions" (*Geogr. Jour.*, July, 1899); and Arctowski, "Observations sur l'intérêt que présente l'exploration géologique des terres australes" (*Bull. Soc. Géol. de France*, 1895, p. 589).

that morning 2018 fathoms; the depth was thus diminishing towards the south.

On the 20th we sounded in $62^{\circ} 2' S.$ with a depth of 1586 fathoms, and at 4 p.m. land was sighted on the horizon, and the depth in $62^{\circ} 11' S.$ was found to be 1028 fathoms. Thus the bed of the ocean was rising fairly steeply when near shore. At 6 p.m. we were able to make out high mountains, the summits standing out black against the sky, and the

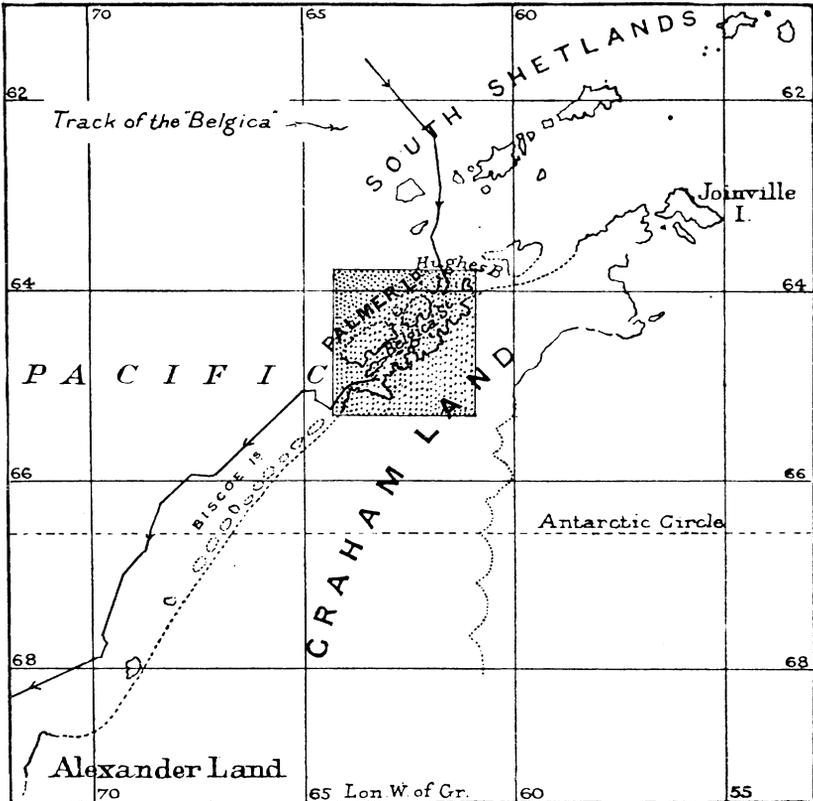


FIG. 1.—PART OF THE TRACK OF THE *BELGICA*.

gentler slopes covered with snow; these were the South Shetlands, discovered by Dirk Gerritsz in 1599, and re-discovered by William Smith in 1819. At 9 p.m. the profile of the land was so clearly visible that by means of a field-glass I was able to make a sketch of Livingstone island. Smith island, which was visible to the right of Livingstone island, plunged almost perpendicularly to the sea; it appeared to be a rounded mass cut here and there into cliffs. We had to pass between these two islands. A large iceberg appeared in the south-south-east, and others

lay off the islands; at eleven o'clock we passed some pieces of floating ice, and saw more towards the south, and then a little fog, accompanied by fine rain, shut out the view.

On Friday, January 21, while we were at breakfast, a little after eight o'clock, we felt a sudden shock, which seemed to lift the ship twice; rushing on deck, we found that a thick fog made it impossible to see any distance, but on the starboard side there was a large mass of ice, here and there vague forms of icebergs loomed up ahead, and quite close to us we saw the rock on which the ship was fast. The fog lifting a little, let us see that we were surrounded by rocks. Some of the large blocks of ice were aground, others afloat. On deck no one spoke; nothing was to be heard, although the weather was calm, but the roar of the breakers on the rocks and the cracking of the ice. The engine went astern, and after a few moments we were afloat again. Splinters of wood torn from the keel rose to the surface, and helped us to realize the gravity of the danger we had escaped.

The splendid spectacle of the icebergs, however, made us forget all else. One of these was like a tower cut out of a great block of sugar; another, a mountainous island, with a bay in which the billows broke in foam; yet these were mere fragments of icebergs, broken and of fantastic outline.

At eleven o'clock more ice appeared, and also more rocks, which gave an anxious time to Leconte, who was on watch. The fog lifted about noon, and for a few minutes we could see a low land covered with great fields of snow, which terminated in the sea as perpendicular cliffs of ice; this was probably Snow island. Other land could be seen further to the east, with summits bare of snow. Several large bare rocks rose abruptly in front.

On Saturday, January 22, the number of the ship's company was unhappily reduced to eighteen, poor Wiencke being carried overboard by a wave and drowned. It was terrible to be quite near a man who was fighting with death, and yet to be unable to help him. All our efforts were in vain; twice he was almost saved, but Fate willed otherwise.

Bad weather commenced at night; all day the wind had been blowing in heavy squalls, and the sea was rough. The fog continued, and in the afternoon snow began to fall. Since morning icebergs had always been in sight, looming up vaguely through the fog, or appearing in all their splendour during the short clear intervals. Many of them were tabular; complicated forms were less common, for they had come from no great distance, doubtless originating in the land which was in sight. The ship had at length to be laid-to, and, the gale increasing still further, it was necessary to seek the shelter of an island, which no doubt was Low island. At 6 p.m. the weather cleared, and allowed us to see the island, which is extensive and surrounded by large bare rocks, but

itself completely covered with a thick mantle of ice and snow, which hides all irregularities under a uniform surface, and descends to the sea in perpendicular cliffs of ice. Bird-life was very abundant in the "rookeries" which we saw round the island, full of penguins, and lending a strong odour of guano to the breeze. We resumed our way, and the island dropped out of sight.

On Sunday, January 23, the sky cleared at last, the clouds parted, the sun shone, and our radius of vision gradually extended. We were to the west of Low island, which we could now see much more clearly. It seemed to be low and entirely surrounded by huge rocks and abrupt islands quite free from snow. The air was poisoned by the smell of guano. M. de Gerlache changed the course to east-south-east, in order to enter Hughes gulf, and we passed again some icebergs seen on the previous night. One of these was particularly fine and characteristic, with a height of 130 feet and a length of 250 yards. I made two drawings of this berg from different sides. These represent it as a plateau bordered by cliffs and topped by a mound. On one side one could see that the summit was composed of thin layers of snow, perfectly parallel and horizontal. The colour of the ice at the base was a very pale greenish blue, but the blue was intense in a large hollow—a veritable azure grotto. Position at noon, $63^{\circ} 28' 30''$ S., long. $62^{\circ} 13'$ W.

On leaving the island the floating ice was gradually left behind, the weather again became squally with fog and rain, and about 3 p.m. more ice appeared again; generally in a tabular form, but sometimes as isolated peaks or as tables dipping to one side, in which case the lines of stratification remained parallel to the surface of the berg. The weather gradually cleared, and land was sighted, at first a series of islands and rocks, and then a more extensive coast. At 7 p.m. we passed close to a headland, which very probably was Cape Cockburn, but as we went on the charts became valueless; what we saw corresponded to nothing that they represented, and Lecointe proceeded to take bearings at frequent intervals, which allowed him to construct an approximate chart. At 10 p.m. land seemed to block further advance towards the south; high mountains appeared on the horizon, and islets and rocks were scattered over the great bay at whose entrance we had arrived. Many places were clear of snow, and numerous peaks projected above the ice-sheet, so that it would be possible to study the geology. At 10.30 we were close to an island, and de Gerlache, Racovitza, Cook, and I got into a boat and made our first landing in the antarctic regions (see Fig. 2, I.). A considerable part of the island was uncovered. The upper part was like a lava-flow of prismatic structure; lower down the rock was completely cracked, and seems to decompose in large superimposed blocks with straight surfaces. It is an eruptive rock of great density, very hard and brittle, and rings on a blow with the hammer. It is not basalt, but of granitic structure and very fine-grained; its colour is a very deep green,

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and I thought that I saw small crystals of hornblende—if so, the rock is a diorite. I had no time to examine the snow, as it grew dark, and we had to return on board.

Monday, January 24, was a day of discoveries, and it is impossible to put down here all that I saw, or even everything which struck me as of special interest. During the night the *Belgica* had to be

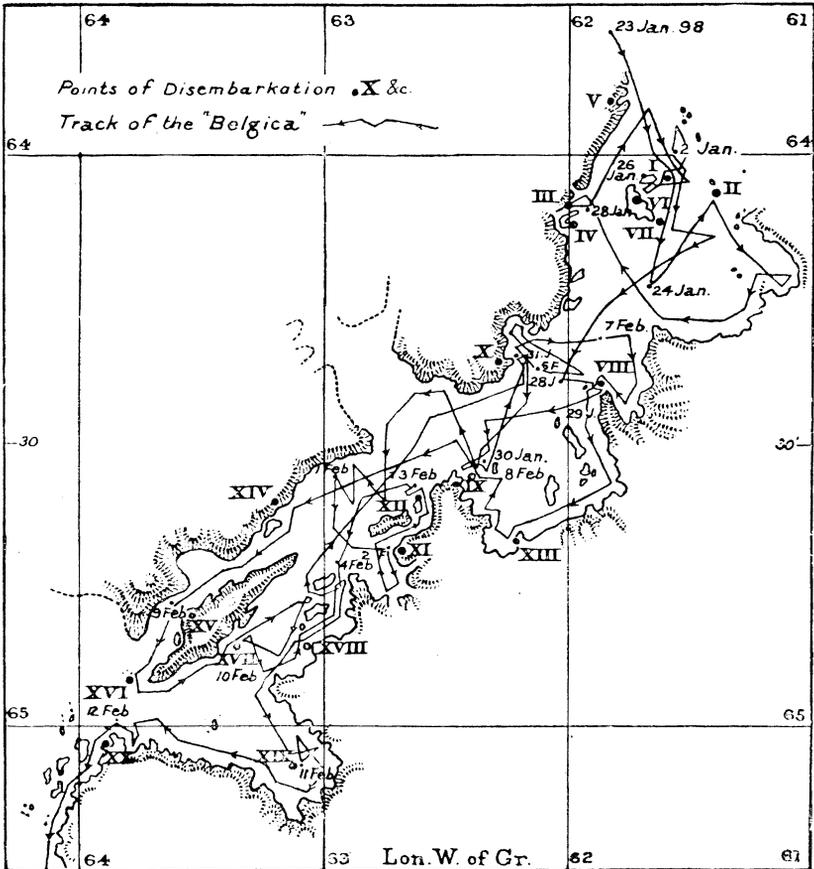


FIG. 2.—PART OF THE TRACK OF THE *BELGICA*, SHOWING LANDINGS.

manœuvred to avoid icebergs, and to prevent being driven on shore by the wind. In the morning it was necessary also to go out of our way a little in order to recognize our bearings of the night before, and to find the islet on which we had made our first landing. In passing close to an island which was almost free from snow, Racovitz, Danco, Amundsen, and I got a boat out and landed for the second time (II. on map, Fig. 2). It was a small narrow island, no more than 100 feet

high, and appeared to be surrounded by a close colonnade on account of the regular vertical cracks in the rock, which were doubtless produced by extreme cold. The surface was frequently mammilated and worn smooth by the ice. A little sandy clay mixed with guano was found in small pockets between the rocks, and while examining this clay I had the pleasure of discovering the first antarctic insect, almost microscopic in its dimensions.

In the afternoon a breeze sprang up suddenly, and the sky gradually cleared; but the fog descended on us again with equal suddenness, just as it does on mountains above the cloud-level. Every now and again a momentary clearing revealed a beautiful picture of mountain peaks, the bases of which were covered, of great glaciers losing themselves in the clouds, or of fantastic icebergs, everything appearing larger than nature because there was no perspective, and the fine pictures themselves were vaguely framed in cloud. The light, however, was abundant, the low clouds which sometimes touched the sea were white and even brilliant, and sometimes a beam of sunlight threw a sparkling lustre on the ice, or on the great snow-fields, or on the sea.

The silence which brooded over this unknown world was singularly impressive, but occasionally a mountain of ice would collapse with a thundering crash. One could hardly believe one's eyes when these changes in the fairy-like scene occurred, were it not for the dull rumbling growl of the disrupted glaciers. In fact, this realm of eternal ice is so different from anything one had seen that it appeared another world altogether; in sober truth, I do not believe that in any fable the human imagination has described what we have seen there.

From the point of view of astronomical observations Lecointe has been unfortunate, as the sun had rarely shown itself, and he had only been able to fix the latitude ($64^{\circ} 9'$ at noon). He kept up a continuous survey of the coast as we passed near the shore, and so succeeded in making a chart of Hughes gulf. The only maps which we possessed—and they are all that exist—were the British Admiralty chart, No. 1238, and Friederichsen's map. The general result of the day's work had been the discovery of an elevated land where Friederichsen's map bore the inscription, "No land in sight (Larsen)." Towards the east and south an uninterrupted coast-line stretched as far as the eye could reach, but in the south-west a large strait opened into the gulf, and this it was necessary to explore. The land in the north-west was also divided by a channel, towards which the commandant first directed the ship. The large bay which we had coasted during the afternoon was very free from ice, although as we went further into the bay the number of bergs increased, but still the *Belgica* had no difficulty in approaching close to the shore. At the head of the bay my attention was particularly drawn to the floating ice. Several of the numerous icebergs were of quite respectable dimensions; their form varied considerably, but usually

more or less tabular; one of the bergs was pierced, forming a floating triumphant arch. The stratification of the ice was rarely noticed, but in diffused light it is not easy to make out the difference between the alternate layers of blue and white ice; still, in the upper part of the walls the stratification of the *névé* was often seen. The blue colour of the hollows in the ice was more intense as the light was stronger. Each berg was surrounded by a wide horizontal groove formed by the waves at the level of the sea, and one could often see the grooves of former levels, which showed that the position of equilibrium had changed, and one little iceberg to which we were very close showed two such lines which crossed each other. The surface of the ice reflected so much light that Cook was able to take instantaneous photographs of the floating ice down to the moment of sunset, and even a little later; they were rather faint, it is true, but the outlines were quite clear. It was very difficult to judge distances, one piece of snow-covered land lying in front of another appearing to be part of it, and thus it was necessary to follow the coast very closely in order to distinguish islands from peninsulas.

The quantity of snow which has been accumulated in this region is really formidable. The westerly and northerly winds coming from the ocean doubtless bring great falls of snow, and this is always accumulating, mountains of ice being reared on the top of the mountains of rock. So far as I could judge from the ship, the ice was nowhere uncovered, but thick snow seemed to lie on the glaciers down to the very edge of the sea.

The sunset was very fine, and after it, about 9.30 p.m., the clouds were brilliantly coloured, and the south-western horizon became remarkably clear. At ten o'clock the ship was stopped quite close to the shore, at the entrance to the north-western passage, which doubtless led to the ocean. I was anxious to land to collect some geological specimens, but it was necessary to manœuvre the vessel all the time, in order to avoid shoals and floating ice, and, besides, the commandant did not see the use of landing here, so I had to give it up. About midnight, Lecointe, who was on duty, saw something floating which appeared exactly like a fragment of wood. This was a good opportunity for launching a boat, so Racovitz, Tollefsen, and I set out to see what it was, and after having found that it was only a piece of ice filled with pebbles and clay, we naturally rowed ashore and landed in a little bay (III. on map, Fig. 2), where I had the good fortune to come upon a moraine, which I believe was a ground moraine. There was water behind the moraine, and then a cliff of ice, the end of a great glacier which covered the whole slope of the mountain. Although it was growing very dark and the specimens were collected hurriedly, we found more than ten different varieties of rocks, but none of sedimentary formation. The pebbles were as a rule perfectly round and usually large, while there were also many big blocks.

Tuesday, January 25, was fine and calm, the air perfectly transparent, the sky cloudless, and the heat of the sun intense. We landed at 7 a.m., Lecointe and Dobrowolski in order to make astronomical observations, Danco for magnetic work, Racovitza to search for plants and animals, Cook to take photographs, and I to collect geological specimens. Amundsen went with us. We landed on the promontory of an island (IV. on map, Fig. 2), and it was not without difficulty that all the delicate instruments were got ashore on the steep rocks. By dint of hard work and by division of labour, we were ready to go on board again by ten o'clock. Lecointe had been able to fix the position of this fourth landing* exactly, and also that of Two Hummocks island, which lay right opposite.

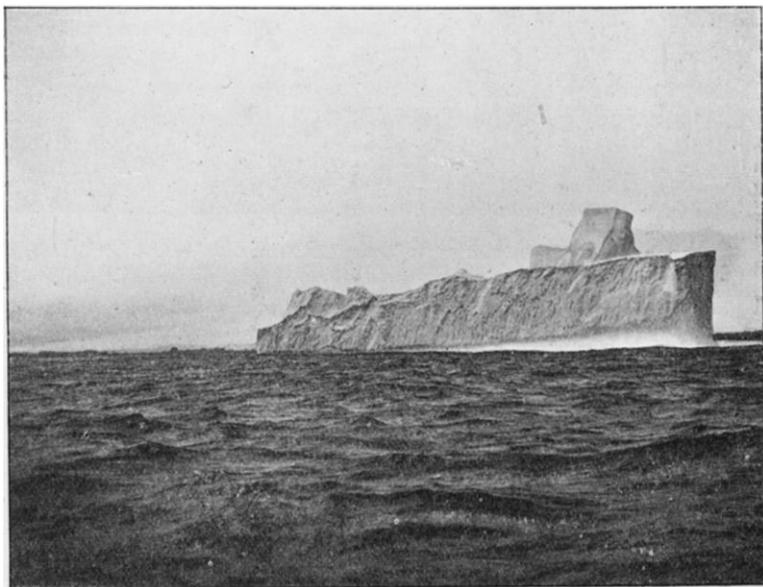


FIG. 3.—A TABULAR ICEBERG.

While Racovitza was studying the patches of moss and lichens which were found here and there on the rocks, the doctor and I made use of Canadian snow-shoes to visit the higher part of the island, and we found them a great aid in crossing the snowy slopes, which were usually gentle, though there were dangerous crevasses in places. A thick mantle of snow stretched to the crest of the promontory and stopped abruptly, the further side being perpendicular. Great blocks of ice must sometimes fall over this precipice. I ventured to cross a longitudinal crevasse, and found myself upon a somewhat unstable mass of

* Lat. $64^{\circ} 6' 24''$ S., long. $61^{\circ} 59' 30''$ W. of Greenwich.

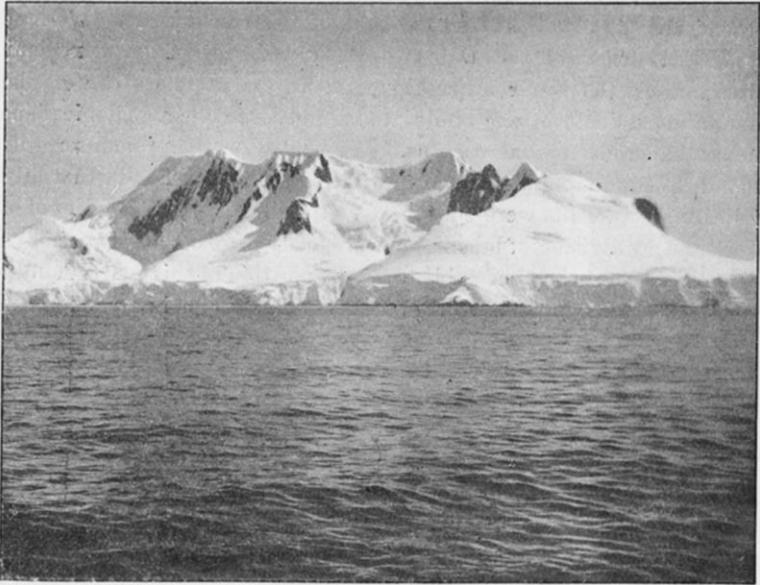


FIG. 4.—GLACIATION OF NORTHERN ISLAND OF PALMER.

ice, poised on the edge of the cliff. A cape which was visible a short distance to the south showed exactly what usually happened. It was too steep for snow to rest upon the seaward slope; but a thick snow-field occupied the top, and numerous vertical furrows marked the places where avalanches had occurred. At the base there was a mass of snow piled against the rocks, its lower portion hardened into ice.

The heat from the sun reflected by the field of snow was so intense that I preferred not to continue the walk with Cook, but sat down in the midst of the silent solitude to allow the grandeur of the magnificent polar landscape to produce its full impression on my mind. To the south and south-east the head of the great bay was formed by a stretch of land extending as far as one could see. It was a region quite alpine in its character, but completely buried by glaciers. The snow-fields rose towards the interior, forming a veritable ice-cap, terminating in a perfectly continuous sky-line. Peaks, mountain ranges, and profound gorges there might be, however they were not to be seen, but lay buried beneath the inland ice. Lower down the relief of the land could be divined beneath its robe of snow, and here and there a bare peak pierced the covering. Nothing like an exposed chain of mountains was to be detected, although near the sea a coast range could be made out, its sides cut by valleys, through which glaciers of various sizes made their way. Along the shore some of the promontories were bare, but on the lower ground the ends of the glaciers were covered by a field

of snow, and were for the most part confluent, forming a platform of ice which gave origin to icebergs. That valleys exist, though they do not show on the surface, is clear from the differences in the size and appearance of the glaciers. The largest are of gentle slope, the smaller steep and broken by numerous crevasses. Some of the glaciers suspended from the cliffs were of extraordinary dimensions. Thus by the appearance of the surface of the ice, and nothing else, one could see that the configuration of the buried land was complicated, and underneath each glacier there must be a great excavated valley, along the bed of which the ice glides downward. The proof of the existence of valleys is very interesting, for it points to a time when there was no ice, but dry land being eroded by the running water of rivers. On the other hand, the thought of these buried valleys brought to my mind the channels of Tierra del Fuego, as they must have appeared in the glacial period, when the end of the Andean chain lay under just such an ice-sheet.

At 11 a.m. we were once more on board the *Belgica*, steering north-east in order to follow and survey the south-east coast of Palmer Land. At 2 p.m. we were opposite a cape where the coast-line changed its direction, and here we made our fifth landing at the head of a little bay where the pebbly boulder-strewn beach sloped so gently that we had to wade ashore, and pull the boat out of the water for safety (V. on map, Fig. 2). The rocks of the beach were erratics from a moraine, and consisted mainly of a grey hornblende granite, but other granites also occurred, especially one with orthoclase. There were also numerous ancient eruptive rocks, some fine boulders of gneiss, as well as quartzites, porphyries, and a metamorphic schist. It was a fascinating problem to consider how so great a variety of rocks came together here. They did not seem to have been carried by floating ice, and two hypotheses suggested themselves: Either the rocks were brought by the glacier which entered the head of the bay, or they dated back to a time when the glacial conditions were very different from those now prevailing. The

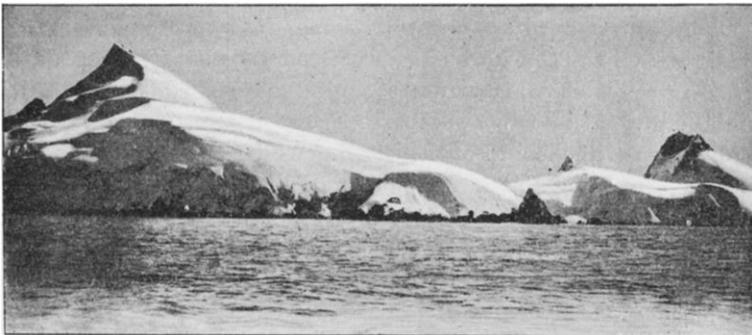


FIG. 5.—THE MOUNT NEAR FIFTH LANDING.

former hypothesis seemed improbable, for the stones were worn, as if they had come from far; although this argument is not a very strong one, since the waves had made their action felt also. On the other hand, the relief of the land was opposed to the formation of an important glacier at this place. The mountains which border the island along which we had been sailing are very near the shore, very steep, sometimes even perpendicular, and their crests are often completely free from ice. Only the lowest part of the flanks of the mountain are covered with suspended glaciers separated from the snow-fields above, and terminating either on the beach or beyond it in the water. Hence the ice which enters the bay cannot come from any great distance, and the material which it carries must be that of which the mountain is composed. Again, the variety of rocks in this moraine is too great to be derived from the neighbouring mountains; they unquestionably come from different places extending over a wide region. Hence, if these rocks are not to be found in Palmer Land, they must come from a southern continent, and have been deposited here as the lateral moraine of a vast glacier which must have filled up the whole of Hughes gulf; and in any case there is evidence of a former great extension of glaciers, that is to say, of a glacial period. Lecoq made an astronomical observation.*

At 4 p.m. we were under way again, steering S. by E. towards the island where we had first landed. The sky was somewhat overcast, at first by flame-shaped cirrus, then by alto-cumulus, the cirrus becoming transformed into cirro-stratus, and finally before sunset a low haze formed on the sea, grew thicker for a while, but shortly after sunset it cleared once more, and we saw the islands and mountains in the south quite distinctly.

Wednesday, January 26, was entirely spent between Two Hummocks island, the island of our first landing, and two groups of islets situated further north. In the afternoon Lecoq, Danco, and Racovitza landed on the island of our first landing in order to make magnetic and astronomical observations, while Cook, Amundsen, and I landed on Two Hummocks island (VI. on map, Fig. 2). Taken as a whole, this island presents a very characteristic form; it is narrow and entirely covered with a thick mantle of snow, which gives it a convex appearance. Two pyramidal mountains project like nunataks, contrasting with the general smooth outline; these two hummocks are ranged in the direction of the length of the island. We landed on the north coast in the hope of being able to climb one of the mountains, and found that the shore was formed by a cliff of ice with only a few promontories of bare rock. I did not see the ice actually immersed in the water at any point; a very narrow strip of bare rock always separated it from the sea. Where we landed the shore was bordered by *roches moutonnées*,

* Lat. 63° 57' 4" S., long. 61° 47' 34" W.

either awash or rarely rising so much as a yard or two above the surface. A little snow rested even on these rocks, and the sea-leopards were sleeping upon them very tranquilly. Along the coast there are deep crevasses in the ice, so that the cliffs have all the appearance of an icefall. The rock of the island is a grey granite, with thick and very regular veins of a dark and compact green rock, and also smaller red veins. There were some erratics also, but these might very well have been carried by floating ice. In attempting to ascend the island, we were stopped in a fog, when at a height of about 350 feet, by crevasses which we could hardly see, although on returning we were able to make out snow-bridges by which we could have crossed some at least. The crevasses lay parallel to the shore—that is to say, at right angles to the slope. We did not see ice exposed at any place, although in the crevasses there was a fine blue colour, but that this was not necessarily due to ice is shown by the fact that on making a hole about 5 feet deep by driving an alpenstock into the snow, one could see in it a patch of intense blue. The snow was soft, not compact, but agglutinated, although of too small a grain to be called *névé*. As the boat was some time in returning for us, we had to pass several hours on a little patch of rock shut in by white cliffs of ice on either side, which we could not even approach in safety. The clay and sand lying in the hollows contained no trace of animal or vegetable life; there was nothing but bare polished rock, a few pebbles, and in the water some seaweeds and a very few molluscs. The fog cleared in the evening; the boat came at last and took us on board. We continued to survey the islands as we passed, in order to complete the chart of the north of the bay.

On January 27 we landed at 10 a.m. on a little islet not far from Two Hummocks, where there was no snow-covering, though its highest point was 100 feet at least. The islet (VII. on map, Fig. 2) was scored by numerous cracks which cut the rock into lozenge-shaped pieces and covered the surface with angular fragments, the whole resembling the lofty crests of the granitic masses of the Alps. The only snow to be seen remained in the dark recesses of the cracks. The island was a rookery of penguins and cormorants, and in places some guano mixed with clay and birds' feathers was found.

Towards the afternoon the *Belgica* steered south-westerly, and in the evening we entered the large strait stretching towards the south, which turned out to be very wide, and in parts we saw high mountains and great glaciers enclosing the headlands, and in one case at least extending beyond the coast into the sea.

On Friday, January 28, the weather was foggy, and we made a sounding in the centre of the channel, finding a depth of 342 fathoms. We were surrounded by whales (*Balænoptera*), whose blowing could be heard constantly, a mysterious sound to break in upon our solitude as we floated between the grey sky and the dark surface of the sea, on

which they played without paying the least attention to our presence. We approached the coast in order to attempt a landing. Amongst several islets and rocks there was one which presented an appearance of stratification with a slight dip; it was flat and almost completely bare, showing that the snow-line here does not descend to sea-level. We could not see the mountains, for only the lowest part of the coast appeared beneath the clouds. A very large moraine, almost completely bare, was seen running along the shore in a north-east and south-west direction. There was a good deal of floating ice. We saw several places where there were great cliffs of ice with curved indentations, doubtless marking the places where icebergs had broken off; the crevasses on Two Hummocks island represented complete fractures, which only required a slight impulse to launch the detached berg.

At dinner there was a great discussion between Lecointe and de Gerlache as to whether these were islands or a continuous coast—a question of great difficulty, for what with the fog and the uniform white glare without shadow or perspective, it was quite impossible to make out the detail of the land. For geographical purposes an approximate sketch-map is not to be tolerated; it is little use to advance far into an unknown region if all that can be inscribed on the map of the Earth is the track of a ship. Such a result, no doubt, is highly creditable to a navigator, but a scientific expedition ought to have other aims. Lecointe was certainly right to insist that the work which had been commenced must be carried through.

At 2 p.m. we landed on the island one mile from shore, which showed an appearance of stratification (VIII. on map, Fig. 2). It was difficult to get ashore on account of the sea, but when we succeeded we found that the whole surface was a smoothly glaciated rock of eruptive origin, traversed by veins 20 feet thick of a grey compact substance. A little snow remained on the island, but the fog prevented us from continuing our survey, and the wind and sea were rising, so we had to return on board.

On Saturday, January 29, the weather was calm again; the fog had cleared away and revealed a marvellous scene. On every side the thick white covering descended to the sea, and only the steepest slopes were free from snow; perpendicular cliffs and steep hill sides were characteristic of all these coasts. A cliff which bordered a submerged valley where an immense glacier debouched showed an appearance of vertical stratification, but our ninth landing enabled us to prove that this appearance was due merely to cracks in the rock, as in all previous cases. This may possibly be an effect of extreme cold, for the *roches moutonnées*, which are preserved from abrupt changes of temperature by snow covering them most of the year, do not exhibit such cracks, or only to a slight extent. It was a curious landscape in white, grey, and black, yet with plenty of light, although the sun was hidden, and a

wonderful play of shadow. Photographs can say nothing as to the complex tints, while painting often exaggerates them; only an exceptionally good colourist could record the delicacy of the tones. My Russian friend Pokhitonow would make an admirable picture of this landscape, so imposing by its severity. The sea was very dark, slightly greenish in the foreground; the horizon loaded with black and grey stratified clouds, and in the whiteness of the stratus above there was a yellowish tinge. The snow was very white, and the glaciers of a white just faintly bluish towards the base, and in the cracks and below there was the blue of the water; the rock was black, in places touched with brown, and lines of yellowish grey; the clouds, merely elevated fogs, encroached upon the summits of the mountains, gradually thickening upwards.

In the afternoon, while waiting for the sun and a wider view, we landed on a floating cake of ice in order to obtain a supply of fresh water.

At 5 o'clock we landed for the ninth time at the foot of a perpendicular rock, elsewhere a high cliff of stratified snow passing gradually into ice in its lower part, made landing impossible (IX. on map, Fig. 2). The crevasses, which form parallel to the shore, cut this wall of ice into sections. The head of the little bay which we had entered was occupied by the front of a large glacier, which terminated in a *mer de glace*; and here we were happy enough to be present at the formation of a very little iceberg—a great block of ice which tumbled into the water with much noise, raising a cloud of dust from the ice, and starting a series of waves across the bay not large enough to hurt our boat. This glacier rises slowly towards the south, and its mountainous border runs north and south. A very characteristic island resembling Two Hummocks lay in front of us. In the evening, as we were still in the same neighbourhood, I made a drawing to show some large curved crevasses which were very sharply marked, and proved that the ice flowed most readily in a direction at right angles to them. Except for two mountain peaks, the island is completely buried under a thick layer of ice, which is undoubtedly a glacier, and, though differing in appearance from valley glaciers or suspended glaciers, is nevertheless subject to the same laws (Fig. 6).

The night was fine, and the *Belgica* remained in the same position in order to get her bearings next day. The sea extended to a distance towards the south and east of the prominent headland, where our ninth landing was made; there was evidently a great bay, and possibly a passage, but the way seemed to be closed by lofty mountains with majestic peaks. Towards the north-east was the channel which we had undoubtedly entered in too great a hurry, and we had to return on our track in order to make a connection with the land previously discovered. There was also a passage in the north-west, but my attention

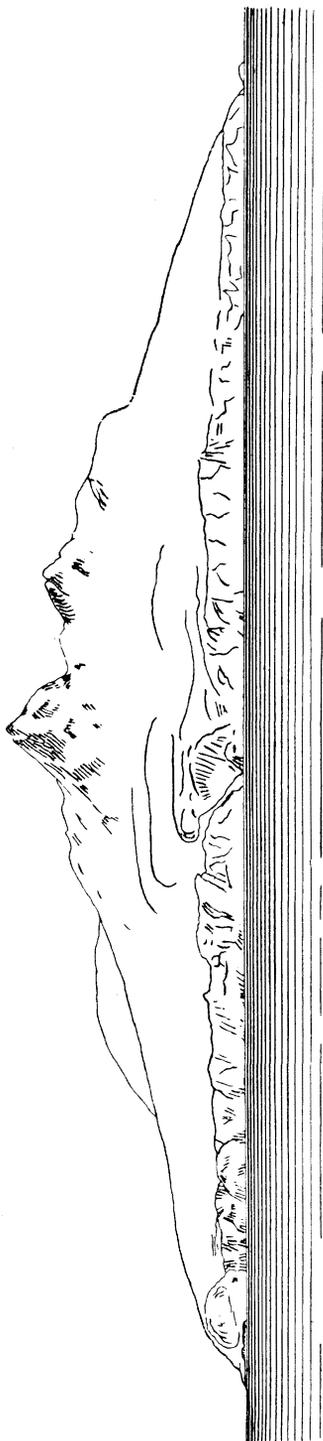


FIG. 6.—TWO HUMMOGS ISLAND.

was particularly attracted by the fine mountain summits of the large island which lay to the north of our position. While pacing the deck with Lecointe, I pointed out to him a place where I thought a landing might be made, and we discussed the possibility of an attempt to climb the mountains. In the distance a gentle and very regular slope could be seen stretching up to one of the peaks, attaining an elevation of about 7000 feet, and it seemed quite possible to ascend in this way and from the summit to sketch the outlines of the land very easily, and obtain a general idea of its configuration. Lecointe was prepared to adopt Admiral Mouchez' method of surveying by utilizing the height as a base, and fixing the distance of points on the coast by measuring the angle with the vertical. Cook was ready to accompany us, and Amundsen did not wish to be left behind.

On Sunday, January 30, we steered north-north-east, in order to land at the foot of the mountains of our ambition. The commandant decided to accompany the land-party, but in that case the *Belgica* would be left without officers, to which Racovitza objected. Lecointe consequently had to remain on board, and Danco, who was to come with us, undertook the theodolite work; but the preparations which had to be made were too elaborate, and the projected excursion was doomed to failure before it started. In order to succeed, it would be necessary to carry supplies on our backs and make a great and sustained effort, being prepared, if the route was bad, to return and choose a better way, for at present we could no longer see the gentle slope which had been visible from a distance, and it was by no means certain that the point at which we were to land would turn out a favourable one. We took with us two sledges of Nansen's pattern, sleeping-bags, a silk shelter tent, a little

aluminium stove, such as was used by Jackson, Norwegian *ski*, Canadian snow-shoes, ice-axes, a 40-foot rope of raw silk, provisions for a fortnight, even changes of underclothing, and all the instruments after that. Certainly there was far too much baggage, and we were not likely to go so far during the eight days we intended to pass in the glacier; still, there was no knowing whether we should not find something interesting to observe. We landed on a little promontory at the head of a fine bay, where a large glacier entered the sea and the snow lay down to the water's edge (X. on map, Fig. 2). There was no difficulty in getting ashore, but the sledges were horribly heavy. Lecointe, Tollefsen, and Johansen helped us to make a start, and then we continued by ourselves, a party of five, de Gerlache, Danco, Amundsen, Cook, and I. The *Belgica* left the bay to continue her surveys in the south, and to return for us later. At a height between 400 and 600 feet we had to cross several crevasses, which were narrow and spanned by snow-bridges solid enough to allow our loads to pass without difficulty. Higher up a great snow-field stretched before us, whence we could look down upon the glacier which cascaded towards the bay. The ice from this dislocated glacier could only break off in small pieces, so that we recognized that the essential condition for the formation of icebergs is a slope gradual enough to prevent the formation of a *mer de glace* at the extremity. The night passed comfortably, though we were too tightly packed in our tent. After breakfasting on the everlasting oatmeal, we set out with our loads, but it was too foggy to allow of much progress being made. While waiting for the fog to lift we pitched camp for the second time, and no sooner had we done so than the weather became fine.

Cook and I set out for a reconnaissance upon the glacier, which formed a continuous plateau rising gradually towards the interior of the island, where two mountain summits rose above the snow. The conditions appeared to be most favourable towards the north-west, and the whole party set out with the sledges in that direction, and we encountered only a few small crevasses, which were easily crossed, then the slope began to increase. At 2.30 p.m., during lunch, I placed the black-bulb thermometers on the snow, and, although the sun was slightly veiled, they showed readings of $102^{\circ}\cdot6$ and 86° Fahr., although the temperature of the air, measured by a sling thermometer, was only $34^{\circ}\cdot2$. The strength of the solar radiation made us all feel very warm. We enjoyed a very extensive view towards the south, and saw the high mountains on the opposite side of the strait diminishing gradually in height towards the east; the direction of the chain seemed to be north-east and south-west. The whole of this mountainous region seems to have subsided, but if the west of these lands has sunk, it may be that there is a large plain of upraised land to the east, the low relief of which would cause the glaciers to be prolonged into the sea, and in such conditions icebergs formed upon the continental shelf itself might attain a

great size. Here, on the contrary, most of the coastal glaciers are of a different type, terminating at the level of the sea. At 7 p.m. we were still mounting upwards, the weather being remarkably fine, and the view of Graham Land grew finer and finer. The relief of that land, although excessively varied, is singularly softened by the glaciers and the accumulated snow, so that it is only because the valleys hollowed by the running water of some epoch are so deep that some crests and very abrupt slopes remain bare. At the height of 1600 feet we were stopped by a crevasse over 30 feet wide, which we could not cross, and other crevasses appeared beyond it, the whole glacier having a terraced structure. We had consequently to descend again to the ice-plain in order to camp for the night. During the whole of Tuesday we were dragging our loads uselessly towards a hill in the west, but in that direction also we were stopped by numerous crevasses, and in any case, if we had reached the hill we should only have been able to see a part of the horizon. Again we had to retrace our steps to the ice-plain to pass the night, and there we left our camp for the two following days, seeing that it was impossible to reach any high summit. We climbed two nunataks in the east, one of which was easily ascended, and on it Danco and de Gerlache made observations with the theodolite. The minimum temperature of the night between Tuesday and Wednesday was $25^{\circ}5$ Fahr., and between Thursday and Friday $24^{\circ}6$ Fahr.

The radiation from the sun during the three days had not sufficed to change the snow into *névé*. On Friday I went over the whole of the plain, and found snow at the surface everywhere, but at a depth of 4 inches there was frozen *névé*. The plain, upon which we camped, is the result of the complete filling of the valley; for it is certainly a valley which descends from these heights, but it is very difficult to give the orography of the lower parts, as the glacier and the accumulation of the eternal snow hid the form of the land. The formation of the ice, however, showed me that the nunataks are the summits of the sides of the valley, and the cascade that we vainly tried to cross is the step which would have led us to another plain of ice, covering a second terrace of the same valley. Amundsen and Cook tried to pass the crevasses by climbing along the walls of rock which bordered that section of the glacier in places, but they were unable to reach their goal.

From the summit of the more distant nunatak Cook and I had a good view of the *mer de glace* in which a large glacier terminated at the head of the bay where we landed; although the broken fragments could not give rise to icebergs as they entered the water, it seemed quite possible that in winter, when the bay is frozen enough, ice might accumulate to form one or more bergs. In any case, it appeared certain to me that the bottom of this great valley extended below the level of the sea; and I was also led to believe, judging from the distances which separated the nunataks and the angle of slope of the walls, that the same holds

good for the valley in which we were camped. We found some lichens and mosses on the nunataks.

On Saturday night we heard the *Belgica* return, and on the morning of Sunday, February 5, we heard her whistle again. We could not go on board, however, because the wind was blowing too strong, and Amundsen, who went to look out, saw the ship leaving the bay. We changed our camp, and as the wind was always tearing the tent, we were obliged to protect it by a wall of snow.

On Sunday afternoon we all got on board the *Belgica*, and found that Lecointe and Racovitza had made two landings in our absence. We steered towards the east, in order to continue our survey of the coast of Graham Land. The air-temperature was high all day, with a maximum of 45° Fahr. At night it rained, at times very heavily, and it must have produced a great effect upon the snow-fields, because we noticed in descending the plateau that the snow had considerably changed its appearance, and we sank deeply in the porous mass. The rain must have produced a much greater effect than a day of strong sunshine.

On Monday, February 7, the sky was overcast, but the weather was clear and the sea calm, and we passed quickly along the southern coast close inshore. The coast was very remarkable, on account of its great indentations. Hughes gulf was followed by a bay, which we had rapidly sailed round, and then came another still larger, of which we followed the shore; but further south Lecointe found yet another bay, in which very large glaciers terminated. We passed so close to the shore that we could not see the high mountains in the interior of the country, but only the ends of the glaciers coming from the inland ice. On the other hand, we could study in detail the innumerable glaciers which are attached to the flanks of the mountains bordering the strait. The rocks are very steep, and in many places exposed to view, but too often in inaccessible positions. We succeeded, however, in landing at the base of a granitic cliff, near which, upon a little promontory, I discovered a metamorphic schist in contact with the granite (XIII. on map, Fig. 2). The direction of the strata was north-west and south-east, and their dip towards the north was about 45°; a very friable schist alternated with a dark quartzite, and dark green strata of a highly metamorphosed rock. The granite is below, *i.e.* in the south, and forms a mountain, close against which is a mountain of dark rock, quite inaccessible except for one cliff, at the base of which I was able to risk myself. The stratification seemed much straighter above than at sea-level. From midday the weather was bad, with rain, snow, and fog, but at night it grew finer.

On Thursday morning I went up in the crow's-nest in order to photograph with my binocular camera the three-quarters of the horizon from north to west. It was splendid weather, and here one was absolutely alone, with nothing and no one to distract the attention.

Even from the mast-head it was impossible to see far into the interior of the land ; only the first wall of the mountains was visible. The region in which we now were seemed to be much less buried in ice than the land at the head of Hughes gulf, and the glaciers appeared to be local, coming from no distance in the interior. It is also noteworthy that here the peaks rising as nunataks and the walls of rock bordering the glaciers are sharp, and only rounded by ice-action for the 500 feet nearest the sea. In the neighbourhood of a great glacier coming from the south, where the twelfth landing was made by Racovitza and Lecointe, there was a very large *roche moutonnée* in front of the end of the

glacier, which is evidently retreating. A little further to the north of that point I saw a nunatak, at the base of which the ice seemed also to be retreating. On the northern side a very characteristic curvature (*a*, Fig.7), with a smoothed surface, was remarked near the snow, while there were large vertical grooves above. I saw very few examples of this kind; as a rule the nunataks were well buried.



FIG. 7.—NUNATAK, AT THE BASE OF WHICH THE ICE WAS RETREATING.

The tenth landing (X. on map, Fig. 2) was on a large island. I saw the channel which separates it in the south-west from another land, and to the north-west the sea horizon was unbroken—it was the Pacific ocean. I saw this confirmation of my theories* with much

pleasure; there was no doubt that we were on the west coast of the continental land symmetrically placed with regard to the Southern Andes. There is no passage to the east, and the Biscoe islands form a parallel chain belonging to the mountain system of Graham Land.

We continued to approach the north-west coast, our course being west-south-west. I noticed a wall forming a little cirque between two promontories, at the foot of which a broad glacier terminated abruptly along the shore and stretched upwards towards the mountains in a gentle slope. A series of curved lines, more or less parallel, could be distinctly seen upon this wall; the last of them followed the outline of the field of *névé*. There were ledges of the rock ranged like steps; the

* *Bull. Soc. Géol. France*, 1895, p. 590.

snow lying on the flat shelves contrasted with the dark colour of the steep slopes and emphasized the structure. The same thing was seen in other places where similar conditions prevailed, and it seemed that these steps were old levels of the snow-field, and their existence proves a former greater extension of the *névé*. While the *névé* remained at one level, the exposed portion of the rock wall crumbled under the influence of atmospheric agencies, while the part covered by snow was protected, hence the cutting of the step.

At noon, Lecointe, Danco, Racovitza, Amundsen, and I landed with the instruments necessary for astronomical and magnetic observations; but, unfortunately, we were too late to observe the meridian altitude, a misfortune the more regrettable because Lecointe had urged

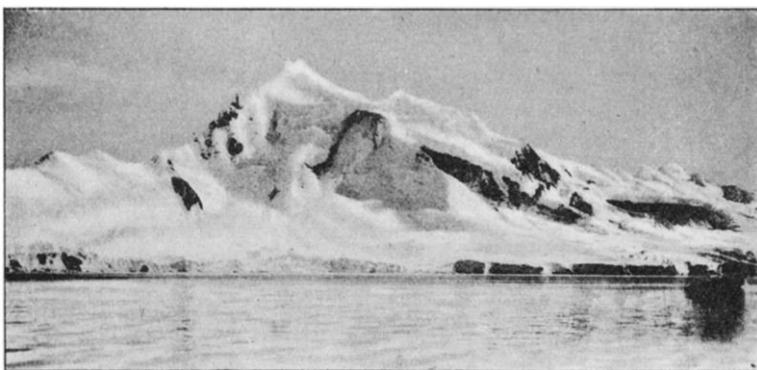


FIG. 8.—MOUNT WILLIAM.

the commandant to allow us to land sooner. We remained some time on the strip of bare rock which was exposed between the field of *névé* and the sea. It was the same black granitoid rock traversed by thick veins and narrow threads of quartz; and there was a great variety of erratic blocks, including specimens of basalt, breccia, several blocks of conglomerate, and some fragments of quartzite. A cave was found in the large-grained porous ice-wall, along the uncovered bed of which a little stream flowed, the first glacier stream I had seen. It came from the direction of a nunatak, and consequently could not have pursued its course to a long distance under the ice; in its bed there were rolled pebbles of eruptive rocks. We were only two hours ashore, so it was impossible to get as far as the nunatak. At our landing-place, and for some distance out from the shore, we saw the bottom of the sea very distinctly, and in some places could even touch it with the cars, it was composed of pebbles and boulders.

At 5 p.m. the *Belgica* resumed her voyage southward, and we entered a channel which narrowed as we proceeded. The mountains on the

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right became lower and their profiles sharper, while on the island to the east of us I saw the snow-fields on the summits merging one into the other, and forming plateaux of ice. A little sierra, composed of five or six peaks in a row, ran in a north-east and south-west direction, and as we were abreast of the first mountain, it presented itself to us as an abrupt wall of rock, the screes at its base partly buried by snow. The other summits further south were much higher. The channel itself had the appearance of a fjord, but there were no mountains at the end, only a low snow-field, and signs of a passage towards the west. As we advanced, the mountain chain on the right became clearer; in the west there was only one high mountain,* and beyond it doubtless the ocean. The sierra on the left showed no trace of stratification. At 7 p.m. we found that the channel curved towards the west almost at right angles, and we entered another channel parallel to the first. There was very little floating ice, and not one iceberg was to be seen. The channel we had entered continued as a great valley into the interior of the island, a glacier descending along its gentle slope from the north. The chain which formed the mass of the island culminated in a high summit entirely snow-covered in the north, and gradually fell off to the south. It would really take years to work out this complex of channels, inlets, and islands, and many facts of general interest would be elicited if the archipelago were to be thoroughly mapped.

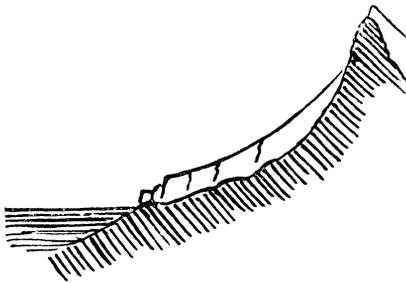


FIG. 9.—SECTION OF SUSPENDED GLACIER.

At eight o'clock we passed some of the flat suspended glaciers characteristic of the island on our left, and a diagrammatic section of one of these is given in Fig. 9. They have always the long crevasses, sometimes slightly curved, with detached berg splinters. The general appearance of these coastal glaciers is a great mass of snow heavily heaped against

the mountain. The surface has a slope far too gentle to produce the effect of a suspended glacier of the Alps, or even of the channels of Tierra del Fuego. The sun set in an orange-tinted horizon, the sky above being intensely blue with little golden clouds, and the mountains facing the sunset flushed pink and changed to red. It would be difficult to imagine any place more beautiful in such perfect weather; the everlasting ice, the grim mountains, and the majestic silence combined to impress the mind with an overmastering sense of the calm severity of nature. Alone in the crow's nest, I rejoiced at my

* Biscoe's Mount William.

good fortune in attaining so great a reward for my voyage as this feast of grandeur and beauty.

On Wednesday, February 9, at 7.30 a.m., we made our fifteenth landing (XV. on map, Fig. 2). The whole coast appeared like one great *roche moutonnée* entirely free from snow, everywhere smoothly polished and scored with sharp grooves, often very deep, running in all directions and crossing each other. The larger were vacant, but others were filled with thin leaves of rock, and some with compact grey veins, giving the rock a schistose appearance. The surface of the granite was strewn with splinters split off by the effects of radiation, usually from one-third to two-thirds of an inch thick, and about a foot in diameter. There were no erratic blocks. The rocks were bare up to a height of about 150 feet, but from this level the snow uniformly covered the island. The sheet of snow gave rise to a trickle of water, forming cascades, under which an abundant vegetation of mosses and algæ had accumulated. A few tufts of moss were found here and there among the stones. The sun shone strongly, and the bare rock grew quite warm. At 8 a.m. on the *Belgica*, when the air-temperature was 41° Fahr., the black-bulb thermometer in the sun read 87°·8, hence the splintering of the surface of the rocks could easily be understood.

At ten o'clock we were on board again, heading south out of the channel, and as we passed along the coast I saw several semi-cylindrical ice-caves from which streams issued, but the tunnels were small compared to the great mass of the ice. At 10.30 we passed the cape at the south end of the mountainous island we had been coasting, and the recording thermometer fell, while the hygrometer rose sharply, as the influence of the ocean made itself felt; and in the distance great icebergs could be seen in the open Pacific. I counted a group of twelve small low islands, mere domes of snow bordering the large island in the south-west; and at eleven o'clock we made the sixteenth landing on one of them (XVI. on map, Fig. 2). Lecointe landed for the noon observation of the sun, making use, as before, of an artificial horizon; Racovitza, Cook, Danco, and I accompanied him. The whole islet was covered with moist snow almost to the water's edge; it was strange to see so great a difference in the height of the snow-line in so short a distance as that separating the XV. and XVI. landings.

These low islets are more exposed to the humid winds from the western ocean, and consequently receive a greater precipitation, the snow not all melting in summer. On the snow we found penguins' feathers, shells carried by the birds, and all sorts of dirt, producing hollows by absorbing heat from the sun, and sometimes these holes were rather deep. The *névé*, which was all oozing with water, was compact at a trifling depth, where it changed into ice. The ice-cap of this islet was crossed by a single narrow crevasse. The rocks round the edge were all iceworn and very flat, in some places scored with cracks, though

to a much less extent than at the place of our previous landing. There were numerous veins of quartz, some quartz in the form of amethyst, and a quantity of copper ore. There were no erratics. All the islets of the neighbourhood had the same appearance, like great whale-backs appearing above the sea. The polished surface extended to just below the surface of the water, and there were also, near the islet where we landed, several glaciated rocks scarcely emergent.

The whole group seems to form a plateau which has been profoundly glaciated, and of which only the higher portions now appear, but this plateau has nothing in common with the continental shelf, the whole of the district which we have explored presenting very clear evidence of a submerged region. From another point of view, these islands are by no means the stumps of mountains worn down by marine erosion; they afford evidence of a great extension of glaciers in some by-gone period. The whole channel, which we were now about to leave, had doubtless at one time been filled by a great glacier which flowed to the Pacific. The cutting off of the summits of these islands may be its work.

At 3 p.m. we turned the southern point of the sierra and steered north-eastward in order to continue our exploration of the main channel, which is divided by low islands into several branches. It is a question of some interest whether it is the Bismarck strait of Dallmann. The sierra reappeared suddenly in the south, on the other side of the entrance to the channel, and continued in a straight line to the south south-west, but a lower parallel ridge appeared west of the main chain, and beyond it a range of islands, the summits of which were still lower, bordered the coast, the whole evidently forming a tectonic chain. Towards the interior a gentle slope of glacier connects the sierra with a higher mass buried under the inland ice. At 4 p.m. we made the seventeenth landing on an islet not far from the east coast of the island we had come round (XVII. on map, Fig. 2). Racovitza, Cook, Danco, and I were left ashore for some hours while the ship continued her route. The end of the island where we landed was a great rookery of penguins and cormorants, and the snow was much soiled for a considerable distance from the shore. The rocks, which are much glaciated, were fairly level, and at the heads of the little bays out of reach of the waves we found numerous pebbles and small erratic blocks of gneiss, various granites, and porphyry, but neither pudding-stones nor basalt; and as I saw no erratics elsewhere, it is probable that these were carried by floating ice. A rocky hill was uncovered to a height of 70 to 100 feet, and above that was the layer of ice, which, in places of more gentle slope, descended to the shore. There was little *névé* on the surface, and all of it melting; water trickled away on every side, though not in any great quantity. The surface of the ice was traversed by vertical cracks, running in different directions, and varying from $\frac{1}{3}$ to 1 inch in width. While the crevasses had vertical sides and were hung with icicles, these

narrow cracks were full of water. This mosaic of cracks occurs on the top of the boss of ice which forms the summit, while on the slopes the crevasses assume a transverse direction, being evidently produced by the tension of the ice as it creeps downwards on every side towards the sea. One main crevasse ran along the whole length of the back of the island. On the side where we landed the ice-covering was pierced by a few scarcely visible points of rock, while the whole southern shore was bordered by a cliff of ice. Another island, similar in every way to the one on which we landed, lay quite near, and on it also

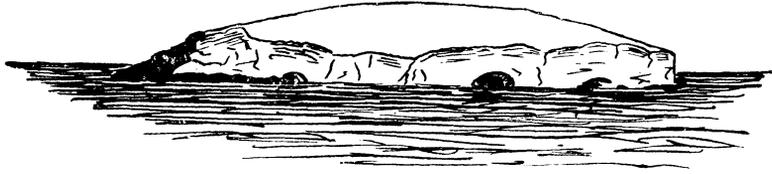


FIG. 10.—ANTARCTIC ISLAND COVERED BY AN ICE-CAP.

streams of water were trickling from the ice. I made a sketch of this island, which is shown in Fig. 10.

From the eastern side the sierra had a much more gentle slope. The cirques in the crest were occupied by very steep glaciers, but lower down the wide snow-fields reduced the slopes to a very gentle gradient. The rocky walls so characteristic of the north-west of the sierra, as seen from the other side of the island, were not represented at all on this. On the northern slopes of Graham Land, on the other side of the wide channel, I saw an immense glacier descending the gentle slopes from the snow-fields which lay about the heights situated in the south-west. It was really a majestic ice-stream filling two large valleys for three-quarters of their depth, while higher up it completely drowned the rocky spur that separated them.

With Cook I walked round our islet, and at its northern end found several fragments of moraines plastered against the slope nearly 80 feet above the level of the sea, and from 15 to 25 feet in height. They contained the same gneiss, granites, and other rocks collected in the little bays of the shore. The predominant rock was granite with hornblende, in fragments which were often angular; the blocks of gneiss were often very large and perfectly polished. Since the granite with orthoclase only occurs in the form of well-rounded pebbles, it doubtless has come from a distance, and the same is true of other rocks. The moraine descends very slightly towards the west, and its direction is that of the channel. This moraine is another decisive proof of the existence of a glacial period in the neighbourhood of Graham Land. In the evening the sky became overcast, the wind rose, and it grew

very cold as we waited for the *Belgica*, which at last returned for us about 9 p.m.

Thursday, February 10, was cloudy and slightly foggy, and for a time we could scarcely see where we were amongst the numerous islands, with the low clouds concealing the characteristic mountain outlines. At noon we made the eighteenth landing, almost opposite the seventeenth, on the other side of the large channel (XVIII. on map, Fig. 2). It was at the base of a pyramidal mountain of red rock, very different in appearance from the surrounding scenery. A great band of red granite seemed to traverse the region from north-north-west to south-south-east. The interesting feature of this landing was the discovery of a moraine at least 70 feet in height, which was set against the mountain-side along part of the beach in the direction of the channel. The rock itself was highly glaciated to just below the level of the water.

The boulders were mainly angular fragments of red granite, and, on the crest of the moraine, numerous blocks of well-polished gneiss. There were also pebbles of hornblende-granite, porphyry, and other rocks, including a white quartzite with small crystals of pyrite, and a very compact black schist. Since we were always in sight of the coast, I never ceased to ask for more landings; I urged Lecointe, de Gerlache, and the others again and again, but not with so much effect as I could wish. The commandant showed himself very obliging; but with a little good-will we could have landed in many other places and collected much more geological material than we did. For this eighteenth landing he conducted me himself, but for ten minutes only. A few strokes of the oars brought us to the beach amid cries of "Hurry up, Arctowski!" I gave a hammer to Tellefsen, with orders to chip here and there down by the shore, while I hurriedly climbed the moraine, picking up specimens as I ran, took the direction with my compass, glanced to the left and right, and hurried down again full speed to get a look at the rock *in situ*; meanwhile Cook had taken a photograph of the place from the ship—and that is the way geological surveys had to be carried out in the antarctic.

At 4 p.m. we passed a fine iceberg, which appeared like the face of a glacier, and must have been recently detached, for it still bore the marks of crevasses. It was about 100 feet high by nearly 700 long.

At 5 p.m. I was again in the crow's nest, and we were heading south-east, perhaps to cut another slice off the northern end of Graham Land. It was not clear, but we could make out enough to recognize landmarks. What seemed to be a channel turned out merely a wide fjord which got slightly narrower towards the head. The amount of floating ice and icebergs increased; some of the latter were over 500 yards, and one was certainly over 1100 yards, in length. Although there was no sunshine, we heard the thunder of the avalanches from the land. In the north-east we saw the front of a very large glacier, but

the upper part was swathed in cloud. At the head of the fjord there were no rocks to be seen; a wall of ice met the water all round—the nature of it, however, was not quite the same at every point.

On Friday morning at 9 o'clock we made the nineteenth landing on a little islet, or rather a big *roche moutonnée* under a great shield of snow, rising gently from the water (XIX. on map, Fig. 2). The strip of bare rock between sea and snow reached only 2 or 3 yards above the level of the water, and was remarkably smooth and glossy. There were two islets of this kind, and between them a moraine just appeared above the sea; it consisted of very large blocks of rock, probably diverse, but I could not get to see them. Lecointe, who landed for an observation on this island, was certainly very hard pressed for time.

The weather cleared a little in the afternoon, and we continued to search for a passage to the east, but there was none—it was merely a fjord. I only caught a glimpse, in a clear moment, of one of the lofty summits which must exist to the east, from which the great glaciers flow. From the head of the fjord valleys radiate inland like fingers from a hand, each filled by a great glacier. Some of the glaciers at the head of this fjord were very large; descending by an easy gradient, they formed a broad flat base, which launched great table-topped bergs of much regularity. In turning to the west after completing our circuit, we met more floating ice. About 6 p.m. we were surrounded by ice, and in fog, which remained at some little height above the water. Here we observed a strange and very beautiful phenomenon. At a given moment the ice suddenly assumed an intense blue colour, of extraordinary purity, a little tinged with purple near the horizon, and becoming lighter higher up, changing into a steely tint above, but showing no trace of green. Fog and ice were coloured alike, hence they must both have been illuminated by blue light. In the south-west, about 15° above the horizon, the blue disappeared and was succeeded by a luminous steel-grey sky, and above this white light a yellowish stratum faded off upwards into a faint orange glow, and finally, beyond 25° above the horizon, the whole sky was a dull grey mass of cloud. The phenomenon was at its maximum intensity about 7 p.m., when the sun was $18^{\circ} 30'$ above the horizon, and at eight o'clock it had become very faint. The air was clear enough to allow us to see floating ice a mile away. Soon after eight the fog closed in again, and when going dead slow the *Belgica* collided with a small berg, but the shock was not severe, although the bow-sprit was damaged.

On Saturday, February 12, a good deal of floating ice was in sight in pieces of all sizes, and there was a little field-ice. The sky cleared and high mountains appeared in the south. At 9 a.m. two rocky points loomed out of the mist, and there seemed to be a passage between them. We followed the coast very closely, and soon found ourselves in a bay, on leaving which we admired a very fine cape which rose in two lofty

needles (Fig. 11). It was the most westerly promontory of this part of Graham Land, for the coast changed its direction here and turned towards the south-south-west. We rounded this point, and left for the time the strait which connects Hughes gulf and the Pacific.

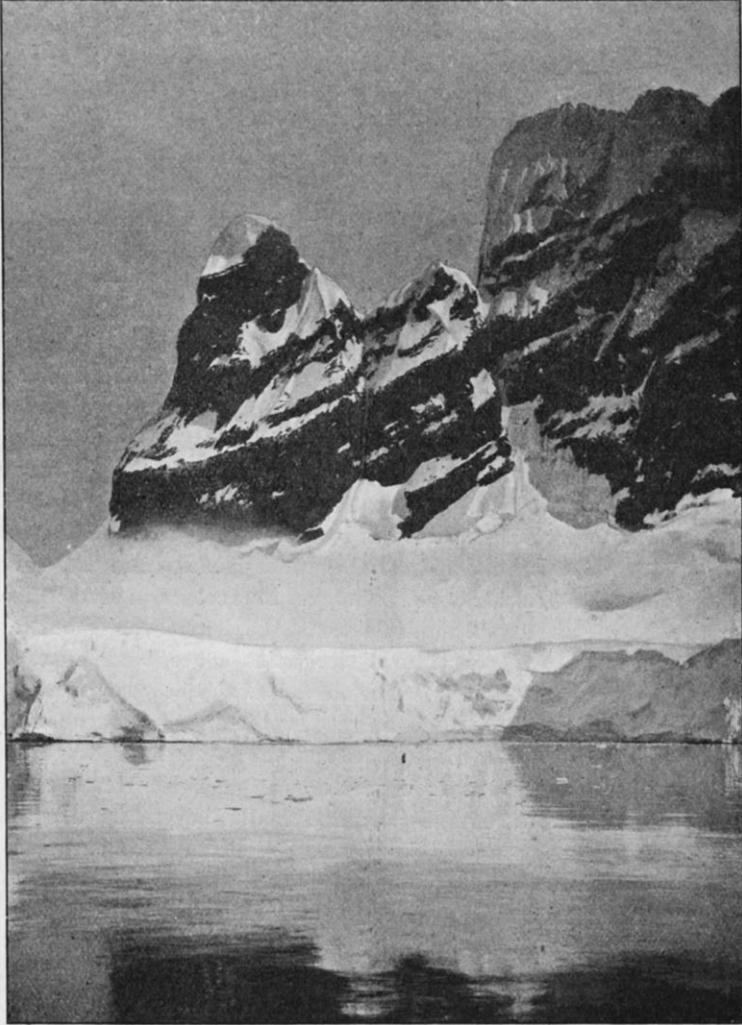


FIG. 11.—ONE OF THE NEEDLES FORMING THE NORTHERN EXTREMITY OF GRAHAM LAND (DISCOVERED BY BISCOE).

At 10 a.m. we made our twentieth landing on the Pacific slope of the Needles, which form the northern cape of Graham Land, to make magnetic and astronomical observations and collect what objects of interest we could find. This landing-place (XX. on map, Fig. 2)

was quite similar to that on the coast west of the sierra. In places the beach was quite free from snow; elsewhere there were little glaciers clinging to the slopes of the mountain and terminating seawards in cliffs of ice. The steep rocky slopes above were absolutely bare up to a height of 700 or 1000 feet, and beyond that rose fields of *névé*. Cook and I climbed a little ridge running at right angles to the range of the Needles. An inclined plain of snow, interrupted here and there in the upper part by transverse crevasses, which were easily crossed, led us to the rocky wall, which there was no difficulty in climbing, thanks to the numerous joints widened by weathering so as to cut up the face of rock into superimposed blocks, and thanks also to the narrow chimneys down which the *débris* of the rock slipped. It is remarkable that these rocks remained quite bare at an elevation far above the snow-line. It is not sufficiently accounted for by the steepness of the slope, though that would make it possible for only a small quantity of snow to accumulate; but the dark walls were so strongly heated by the sun that the snow was actually melted. In making the ascent we found that the low cloud, so characteristic of these regions, was very thin and level on both sides. We passed through the belt of mist between the altitudes of 150 and 300 feet, and above that there was an absolutely clear sky and dazzling sunshine, while at our feet the cloud extended as a smooth grey sea. If such a condition often occurs, it is easy to see how the higher rocks become free of snow in summer, while those near sea-level remain covered. At 3 p.m. the mist cleared completely from the side of the land, and we were able to proceed, passing through a narrow and beautiful sound which separated a group



FIG. 12.—THE NEEDLES, SEEN FROM THE PACIFIC.

of islands from the coast. The mountains rose almost perpendicularly at various points, and on the rocks I again noticed parallel lines following the outline of the tops of the small coast glaciers (*a, a, a* on Fig. 5; *c, c* are crevasses).

The *Belgica* passed on, steering south. It was a pity to leave this most interesting region, where we could so easily collect quantities of valuable scientific material, and of which we could have made a complete geographical study, now that the outlines of the great strait had been charted. We ran close along the coast of Graham Land, noting

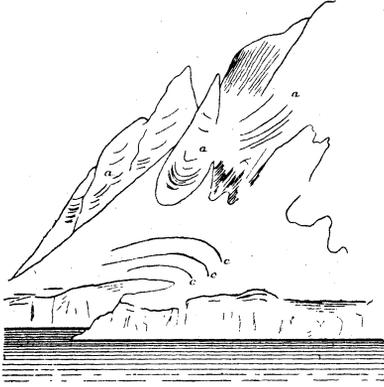


FIG. 13.—MARKS ON ROCKS ABOVE GLACIERS.

that many islets and rocks extended to a considerable distance from the shore. Many icebergs were met, and we also encountered a good deal of sea-ice. At 8 p.m. we passed several typical table-bergs, large, flat-topped, rectangular, the ice stratified horizontally with great regularity, and only a few narrow vertical crevasses to be seen. They rose about 50 feet out of the water; about 40 feet consisted of ice as white as the *névé* which capped it; compact ice was only seen near the base. Just in

the line of the three icebergs of this kind which we saw, we found an enormous flat glacier spreading to the sea without any interruption in the form of an ice-fall.

On Sunday, February 13, the coast was so encumbered with ice that we had to keep out to sea towards the Biscoe islands. About 11 a.m. we traversed a little light pack-ice, and passed near some table-bergs. The melting sea-ice had a dirty yellow colour, and on examining the melted ice under the microscope, Racovitza found it swarming with diatoms. We remained in sight of the coast, and more small islands appeared. At 5 p.m. we sighted a number of fantastic icebergs, amongst which I saw many transitional forms between the table-bergs and the peaked arctic forms. I made drawings of four of them (Fig. 14). The sea was rough, and the breakers dashed against the shore and the icebergs. About 8.30 p.m. we were in the midst of a labyrinth of rocks, and there were also several low snow-covered islands in sight. At 10 p.m. the *Belgica* was in a very uncomfortable situation, threading her way between rocks on every side, on which a heavy sea was breaking: the position was about $65^{\circ} 10' S.$, $64^{\circ} 50' W.$

On Monday, February 14, the sea was free from ice, except for bergs, many of which were in sight. We steered south-west, in the direction of a strong ice-blink; a less marked ice-blink appeared also

in the east. During the day we designedly sailed over the position assigned to the Biscoe islands in the Admiralty Charts, which seem to have adopted a position so far from Graham Land by making an error of one degree in each co-ordinate; thus Pitt island is shown in $65^{\circ} 20' S.$ and $65^{\circ} 40' W.$, while Biscoe gave its position * as $66^{\circ} 20'$ and $66^{\circ} 38' W.$

On Tuesday, February 15, continuing her south-westerly course, the *Belgica* crossed the antarctic circle. During Wednesday, February 16, we tried to approach Alexander Land, which, however, proved to

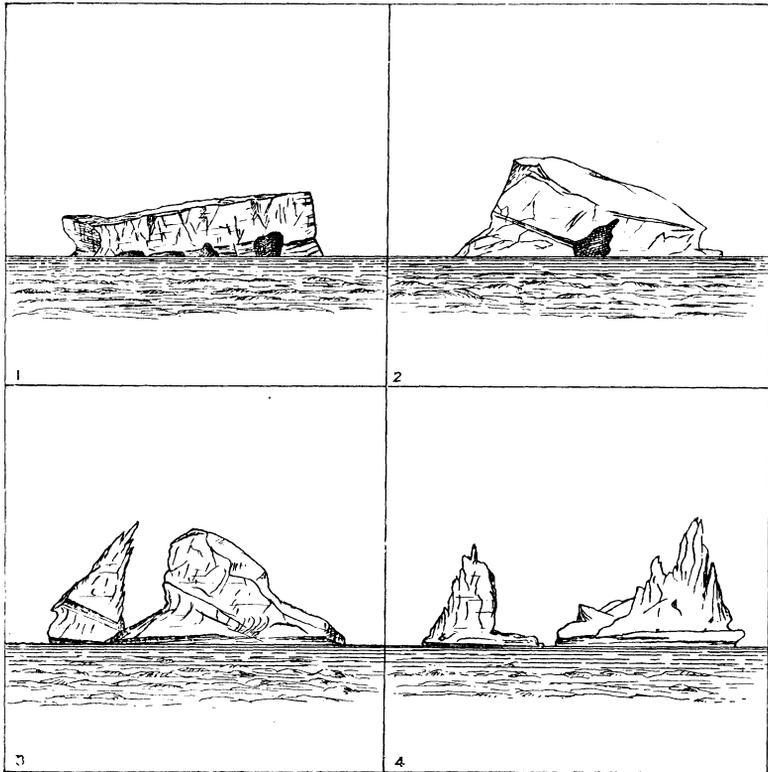


FIG. 14.—ANTARCTIC ICEBERGS, SHOWING TRANSITIONAL FORMS.

be inaccessible on account of the pack. At a distance of at least 20 miles from the land we obtained a sounding of 74 fathoms, with a rocky bottom, doubtless the shoal formed by the destruction of some former island by marine and glacial erosion. In the evening the sky became quite clear, and we were able to see a large island in the east, and the extremity of Alexander Land. The island seemed to

* *Journal Royal Geographical Society*, February 11, 1833. The position as given in Biscoe's MS. log-book is, however, $65^{\circ} 20' S.$ and $66^{\circ} 38' W.$

mark the termination of Graham Land, for the coast beyond it seemed to turn towards the east. It may be, therefore, that there is a strait, or at least a gulf, between the two lands. We could not say positively that we saw the south coast of Graham Land, because the distance was too great. The island formed a mountain chain with many valleys entirely filled with glaciers, but the forms of the mountains were not those of the north. I saw no sharp crests; there were rather great pyramidal masses, their lower slopes having the appearance of terraces, no doubt hills buried in snow. All round the island a great plain of ice sloped outwards, and merged into the surrounding pack. Alexander Land, in the south, was a mountainous aggregate over which very lofty peaks rose majestically; it tended north and south, and was lost to view vaguely on the horizon. A cape was seen in the north of this land, which formed the extremity of an east-and-west chain, though how far it ran to the east we could not see, nor could we be sure that it did not terminate in a great mountainous mass which rose beyond it, and of which the chain might only be a branch. In fact, two or three other lines of mountains seemed to run parallel to each other, unless, indeed, these lines are only those of important valleys; anyhow, there is a great mass of high land in the south-east. Towards the south the mountains seem to become lower and of more gentle outline. It is worthy of notice that here also a plain of ice of gentle slope lies at the base of the mountains, the glaciers merging into it from above, the plain itself merging into the sea-ice studded with imprisoned icebergs. In Alexander Land the glaciers thus fail to reach the sea, for they coalesce together into one great ice-foot, the existence of which fully explains the numerous tabular bergs which we encountered during the last two days. The great difference in the configuration of Alexander Land and the land we had seen further north may very probably be accounted for by the fact that Alexander Land lies outside the region of subsidence. Alexander Land has a wider basis than the Palmer archipelago or the northern part of Graham Land; it possesses a continuous coast-line in place of mountains, plunging perpendicularly into the sea. The continuous coast-line seen from a distance may indeed be broken into bays and capes in detail, but, even if so, all these irregularities are buried under the uniform plain of the ice-foot. But, on the other hand, we do not know what the scenery of the lands discovered by the *Belgica* would be like if they were restored to their aspect of the glacial epoch under a burden of ice as heavy as that which bears upon the remote antarctic solitudes of Alexander Land.*

* There is a very noticeable difference between my description of Alexander Land and that given by Dr. Cook in his work, 'Through the First Antarctic Night.' I cannot discuss the question from memory, and the only thing that I can say is that all my notes were written on the spot from day to day; that I have always made a point of