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MACQUARIE ISLAND
ITS
GEOGRAPHY AND GEOLOGY

BY
DOUGLAS MAWSON
BASED MAINLY ON THE RECORDS OF
LESLIE RUSSEL BLAKE

GOVERNMENT PRINTING OFFICE, SYDNEY.

1943.

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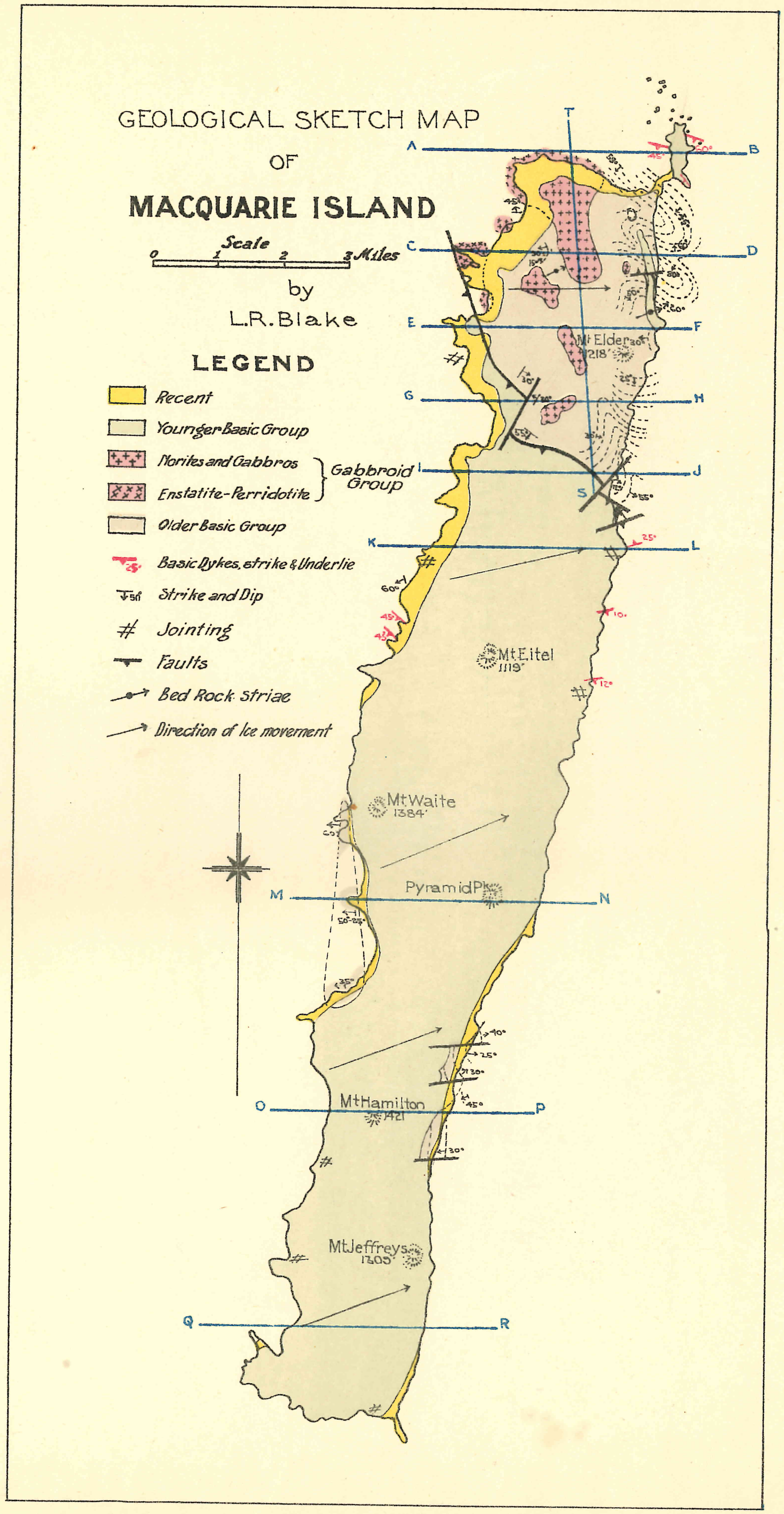

GEOLOGICAL SKETCH MAP
OF
MACQUARIE ISLAND
Scale
0 1 2 3 Miles
by
L.R. Blake
LEGEND
Recent
Younger Basic Group
Norites and Gabbros
Enstatite-Perridotite
Gabbroid Group
Older Basic Group
Basic Dykes, strike & Underlie
Strike and Dip
Jointing
Faults
Bed Rock Striae
Direction of Ice movement
Mt Elder
1218'
Mt Eitel
1119'
Mt Waite
1384'
Pyramid Pk
Mt Hamilton
1421
Mt Jeffreys
1305'
A
B
C
D
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PREFACE

The basis of all that appears in this volume is the excellent geographical and extensive field geological work executed by L. R. Blake during his two years of residence on Macquarie Island.

Throughout that extended period he was busily engaged surveying the island in great topographical detail and in developing a broad classification of the rock formations represented, as well as defining their locations in the field. As a topographical surveyor he was well qualified, for, prior to joining the Expedition, he had been a junior field officer of the Queensland Geological Survey, and, as such, had been mainly engaged in the preparation of topographical field maps in preparation for detailed geological survey. Thus, he had all the necessary training required to execute the unusually complete and accurate map of the Island reproduced in this volume.

His geological notes are not very extensive, but are illustrated by many sketches and an excellent series of photographs, also by a large collection of rock specimens from all parts of the Island. After so creditably acquitting himself during those two years of arduous field work in that bleak southern outpost, the tragedy is that he was not to experience the consummation of his labours in the publication of this volume.

Within a short time after return to Australia, in 1914, he volunteered for war service and spent several years in France, where he gained unusual distinction and promotion. But, alas! on almost the last day of active hostilities, he was killed in action.

Fortunately for the appearance of this volume, when he joined up for active service, he handed over to me all his specimens and photographs, with a summary of his geological observations.

It has been my work to compile the present volume, based mainly on Blake's records and collections, to which have been added my own observations during two short visits to the Island. There are included, also, certain data collected by Capt. J. K. Davis in sounding operations around the Island during his several visits on board the "Aurora"; also additional sounding from our visit in the "Discovery" in the year 1930.

I am gratified that this volume shall remain mainly a memorial to Leslie Russell Blake, whose labours in the cause of science, and good service in advancing the Expedition's programme was, in its measure, no less meritorious than his devotion to duty and supreme sacrifice to his country's need in 1918.

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MACQUARIE ISLAND

By
DOUGLAS MAWSON
Based mainly on the Records of
LESLIE RUSSEL BLAKE

GEOGRAPHY

HISTORICAL SUMMARY.

Macquarie Island* was discovered on 10th April, 1810, by Captain Fred Hasselborough[1] of the brig "Perseverance," a vessel of 136 tons, when cruising to the south of New Zealand in search of new sealing grounds.† Campbell Island was discovered on that same voyage. The latter was thus named to commemorate the firm of Messrs. Campbell & Co. of Sydney, the owners of the vessel. Macquarie Island received its name in honour of the then Governor of New South Wales. On discovering these islands, Hasselborough left sealing parties on them and returned to Sydney, arriving unostentatiously on 17th August. The discoveries were not reported at the time and before the news could leak out, an effort was made by Messrs. Campbell & Co. to get fully equipped vessels away to reap the harvest of skins and oil.

After refitting, the "Perseverance" departed from Sydney on the return voyage to the Islands. She was followed by five other vessels, thus bringing to six in all the number of the first sealing fleet to Macquarie Island. An unfortunate circumstance of the voyage was the accidental drowning of Captain Hasselborough when operating at Campbell Island.‡

Of the vessels which followed the "Perseverance" south in 1810, the "Aurora" of 180 tons was the first to arrive back, but was quickly followed by others, all heavily laden with skins of the valuable fur seal. One vessel alone brought back a cargo of 35,000 skins.

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* In old records often referred to as "The Macquaries," having regard to the fact that several small islets lie a few miles to the south and others a few miles to the north of the main island.

† For the early historical record of Macquarie Island we owe most to Robert McNab[1]. The history of the Scientific Investigation of the Subantarctic Islands to the south of New Zealand has been dealt with by Dr. Charles Chilton.[2]

‡ It is interesting to note that some years later, in 1828, the "Perseverance" was itself wrecked at Campbell Island,

Though the "Perseverance" was the first vessel to report the existence of Macquarie Island, she was not the first to reach its shores, for the sealing gang left ashore by Hasselborough found portions of wreckage of a large vessel of ancient design, and apparently long cast up, high amongst the tussock-grass above the shore on the west coast. No clue was obtained as to the origin of the vessel, nor was there found any indication of former human occupation of the Island.

From an early date Macquarie Island was placed under the control of the Government of Tasmania and has so remained ever since. It is thus under a different administration from all the other Subantarctic islands in the seas to the south of New Zealand which are grouped under the Dominion of New Zealand. In the year 1890, the transference of Macquarie Island from the jurisdiction of Tasmania to that of New Zealand was attempted[3] but was not effected.

After an orgy of killing during the first three years, the reduction in the annual volume of the spoil resulted in a falling off in the trade with Macquarie Island. By 1820 the Fur Seals were so depleted that the trade was then almost entirely concerned in the production of Sea-elephant oil. Finally, the slaughter of Sea-elephants went on without limit until, in the year 1834, even they had almost deserted the shores. From that time on to the date of our arrival in 1911, the blubber-oil trade continued in a desultory fashion, though seldom a year passed without a visit by one sealing craft or another in search of Sea-elephant or Penguin oil. Little has been recorded* of those visits except on occasions when exploring vessels have touched on its shores or when scientists have accompanied sealers for the purpose of recording features of the extraordinary abundant life attracted to that densely populated resort.

The Russian Expedition,[4] commanded by Captain Thaddeus von Bellingshausen paid a visit to the Island, arriving on 17th November, 1821, and remained for two days off its shores. An English translation of Bellingshausen's report dealing with that visit to the Island is published by McNab.[1]

On 10th January, 1840, the "Peacock" of the American Exploring Expedition[5] commanded by Lieut. Charles Wilkes, made a landing of a few hours' duration at the south-west extremity of the Island.

Messrs. Elder and Nichols of New Zealand were conducting sealing operations at the Island about the year 1880. Professor J. H. Scott of the University of Otago, New Zealand, secured a passage to the Island on the schooner "Jessie Nichol," one of their vessels, and made botanical and zoological observations.[6]

In the year 1894, A. Hamilton of New Zealand (subsequently Director of the Dominion Museum, Wellington) spent a short period on Macquarie Island engaged on scientific observations.[7] The journey down and back was made in the "Gratitude" by arrangement with Mr. Hatch of Invercargill who was then engaged in the blubber-oil trade at the Island.

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* Owing to war emergency I have not been able to consult a manuscript journal relating to life on the Island by John Cook who was shipwrecked there in 1852. This MS. has recently been acquired by the Central Public Library, Auckland.

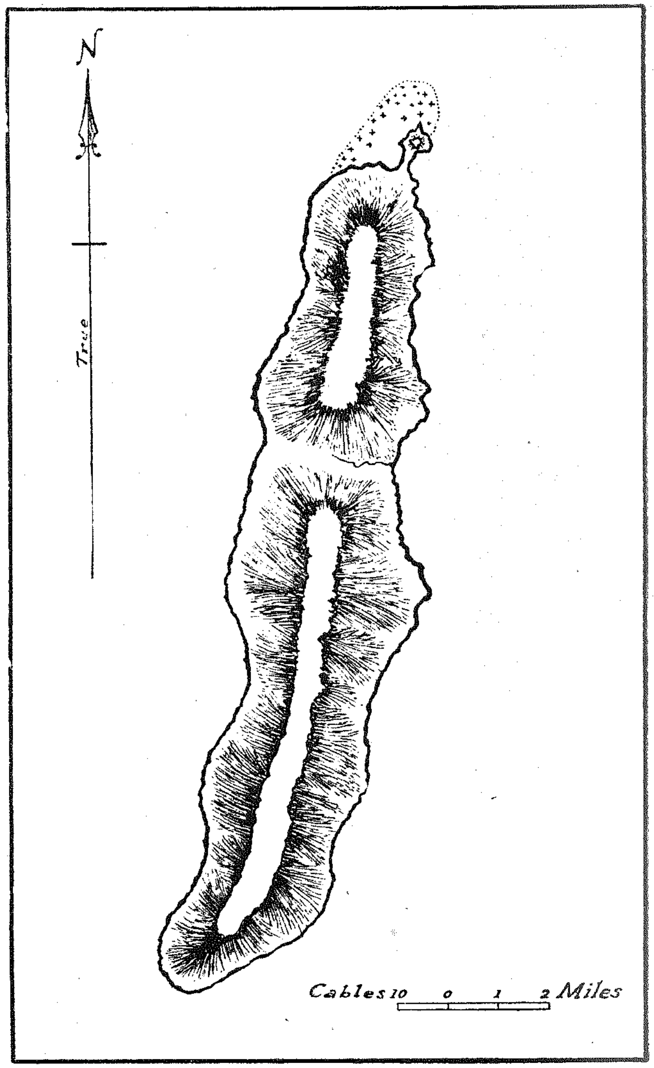


FIG. 3. Bellingshausen's Map of Macquarie Island: year 1824.

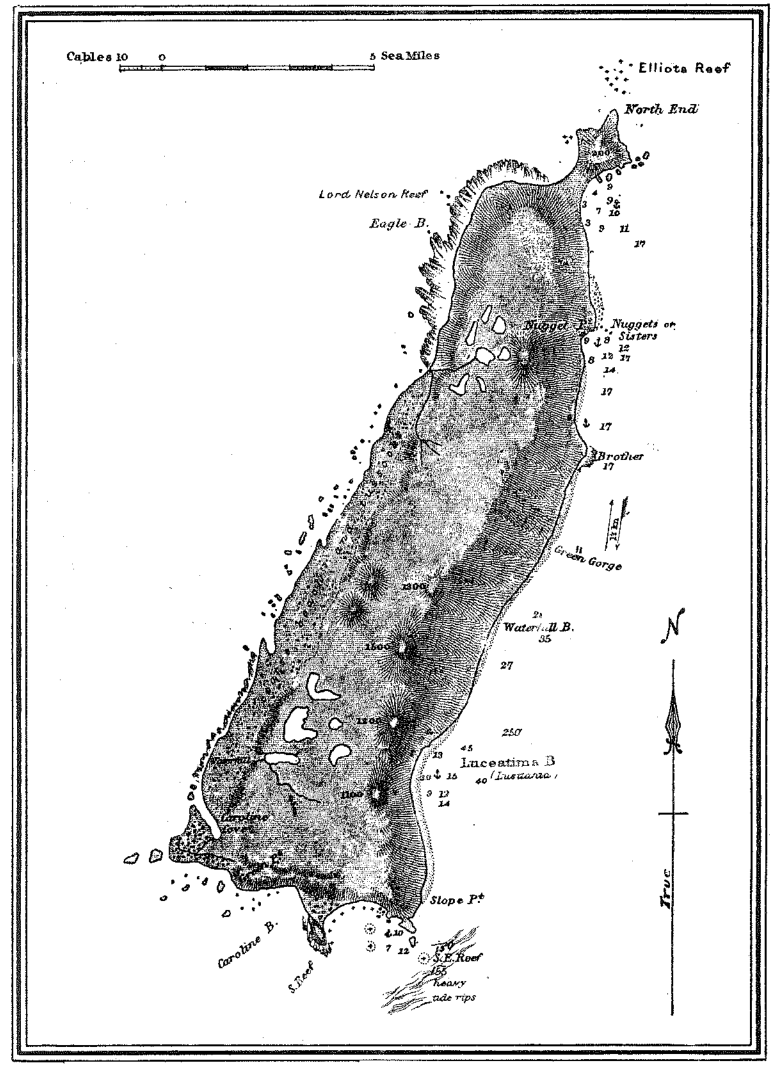


FIG. 4. Admiralty Chart of Macquarie Island of 1887.

The " Discovery " commanded by Captain R. F. Scott[8] put into Lusitania Bay for a few hours on 22nd November, 1901.

Captain J. K. Davis,[9] master of the " Nimrod " whilst on the return voyage to England at the conclusion of Shackleton's Antarctic Expedition, paid a visit to the Island spending several days at anchorages on the east coast.

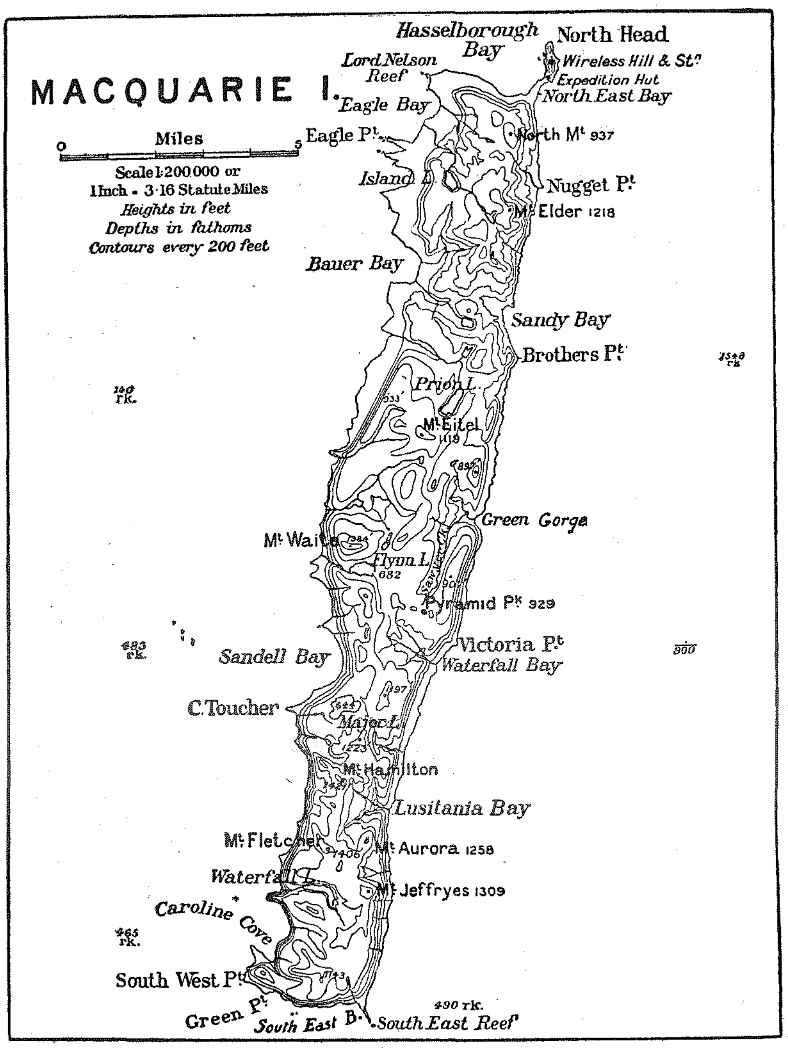


FIG. 5. Macquarie Island as charted by L. R. BLAKE and published in 1914.

Our own Australasian Antarctic Expedition[10] of 1911–14, occupied the Island during two years,[11] after which the meteorological and wireless stations were manned and carried on during 1914 and 1915 by a party provided by the Commonwealth Government Meteorological Bureau. War conditions then prevailing determined the temporary closing of the weather station and it has not since been re-established.

For many years prior to our occupation in 1911, Mr. Joseph Hatch of Invercargill, New Zealand, operating a blubber-oil business had despatched a party annually to Macquarie Island for the collection of Sea-elephant and Penguin oil. Their operations continued until 1919 when the Tasmanian Government terminated the lease of the Island which had allowed unrestricted slaughter of the animal population.

The Island was visited by our B.A.N.Z.A.R. Expedition[12] in the "Discovery" during November, 1930, for magnetic determinations and for the purpose of observing the state of the animal population as a result of the respite afforded since killing had been suspended in 1919.

The absence of good harbours and the stormy latitudes in which Macquarie Island is placed have exacted a heavy toll upon shipping visiting its shores. Some of the more notable disasters of which we have record are the following.

The "Campbell Macquarie" wrecked on the Island in 1813; the "Betsey" abandoned at sea after leaving the Island 1815; the "Caroline" wrecked at Caroline Cove in 1825; The "Lord Nelson" wrecked on the Nelson Reef in 1830; the "Countess Cimento" wrecked 3 miles down the east coast from the north end in 1849; the "Eagle" wrecked at Eagle Point about 1879; the "Kakanui" lost on the return voyage to New Zealand in 1890. In the first few years of this century, the "Gratitude" was wrecked on Nuggets Beach, then the "Jessie Nichol" went ashore to the south of the Nuggets in 1910, and the "Clyde" was wrecked in the North East Bay in 1911. Finally, the "Endeavour" was lost on the return voyage to Hobart in 1915.

Summarising the story of events at Macquarie Island during the first 100 years (to the time of the arrival of the "Aurora" in 1911), it is a tale of uncontrolled exploitation of the Island's creatures on the one hand and of tragedy and hardship for the exploiters.

CARTOGRAPHY.

The earliest recorded position assigned to Macquarie Island is that reported in 1811 by Captain O. F. Scott of the sealing vessel "Aurora" who stated that it was situated in lat. 54° 40′ S., long. 159° 45′ E. He did not, however, indicate the definite position on the Island to which his observation refers.

Bellingshausen's Expedition[4] on its visit of 1820, by carefully conducted astronomical observations, fixed the middle of the Island as lat. 54° 38′ 40″ S., long. 158° 40′ 50″ E.

The "Peacock" of the United States Exploring Expedition[5], on its visit of January 1840, placed the south end of Macquarie Island in lat. 54° 44′ S., long. 159° 49′ E.

Though Bellingshausen's position was a good determination for his day, yet it was not until recent years that the longitude of the Island was determined with approximate accuracy. Thus Captain Davis,[9] when at the Lusitania Bay anchorage in the "Nimrod" in 1909, recorded his position as lat. 54° 43½′ S., long. 158° 54′ E.

When our expedition on board the "S.Y. Aurora" visited the Island in December, 1911, the location of the magnetic station on the Isthmus at the north end of the Island was carefully determined by Eric Webb, the magnetician.[13] That position, lat. 54° 30·7′ S., long. 158° 57′ E., is accepted by us as the datum point for fixing the location of Macquarie Island.

Prior to the issue of the Admiralty chart of 1887, maps of the Island were extremely crude, and it was not until the surveys conducted by our Expedition that the Island was correctly delineated.

Some early sketch maps executed by sealers had been filed at the Admiralty. Then the Russian Expedition of 1820 published a map (Fig. 3), a copy of which appears on page 13. In the year 1887 the Admiralty published a chart (1022) of the Island based on the information at that time available. Subsequently this was corrected to the year 1911; a reproduction (Fig. 4) of it appears in this volume on page 13.

After the return of the A.A.E., the Admiralty adopted Blake's plan of the Island and in 1917 published a revision of chart number 1022, a small reproduction (Fig. 6) of which is given on page 17. In this the outline and detail are as plotted by L. R. Blake, but several of the place names adopted were not taken either from our map or from the earlier Admiralty chart.

Blake's Map.

During residence on the Island for the period of two years, as cartographer and field geologist of the Macquarie Island party, L. R. Blake devoted a large proportion of his time to mapping the Island. This was executed as a theodolite triangulation from a measured base line. Sighting poles were erected on all the main features of the land, and these were then plotted systematically. From these established stations* the minor detail and contours were plotted. The finished map as reproduced in this volume (see folding map and other sectional maps) is thus of a high order of accuracy and presents much topographical detail. In the preparation of this map all data have been carefully checked and names reconsidered. The folding map now published is intended to supersede previous issues of Blake's map appearing in the official and unofficial reports of the A.A.E. 1911–14.

We now know that the main island is 21 miles in length with the major axis bearing N. 14° E. Its breadth varies between 1½ and 3 miles and its area is 46 square miles. In the year 1911 the compass variation taken at 20 feet above sea-level at the Magnetic station on the Isthmus at the North End of the Island was 18° 22′ 30″ E.

* Many of Blake's rock specimens are referred for locality of origin to these Stations, each of which was distinguished by a serial number. Unfortunately, neither Blake's field note books nor any map recording the location of these Stations have been found among his papers. However, the positions of some of these Stations have been ascertained by cross references appearing in his list of photographic negatives and bearings to Stations given from the ship's position when sounding around the Island.

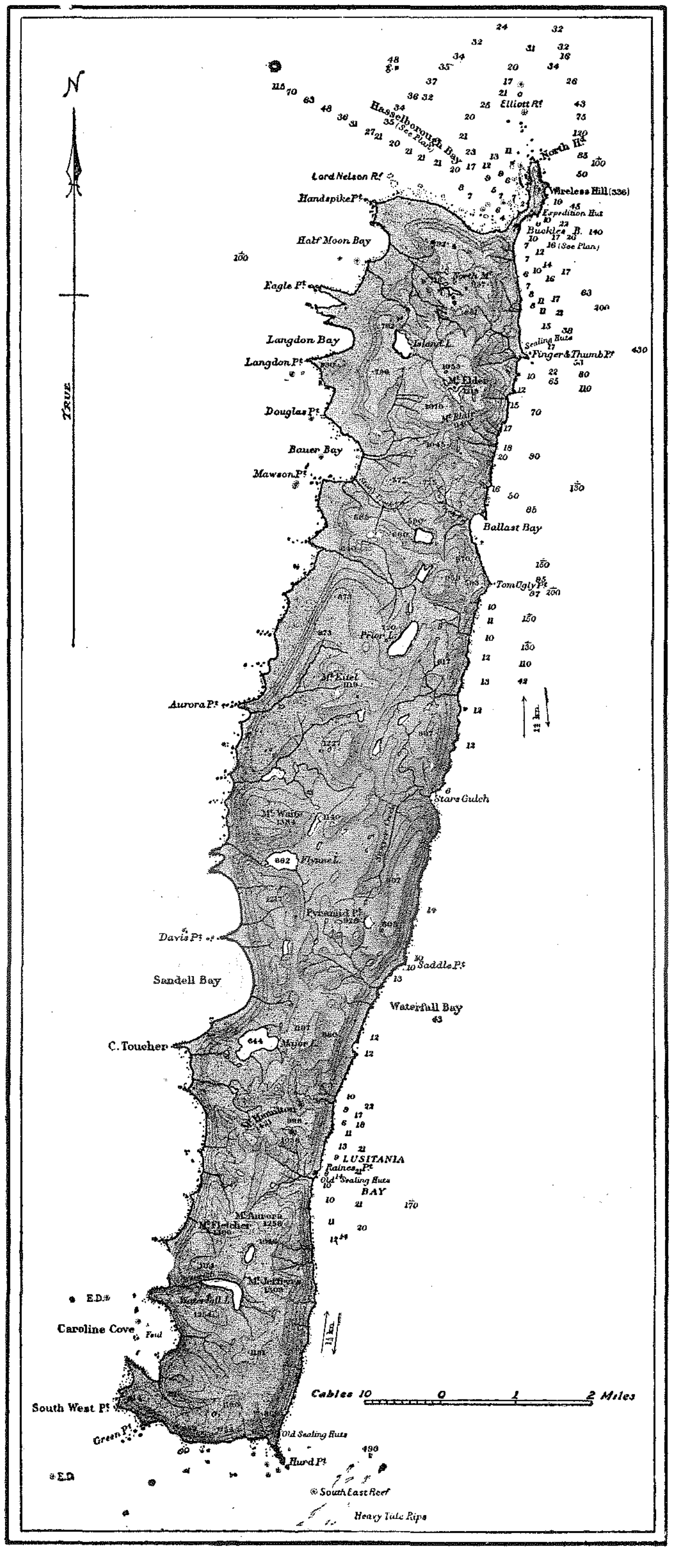


Fig. 6. Reduced reproduction of the Admiralty Chart published 1917.

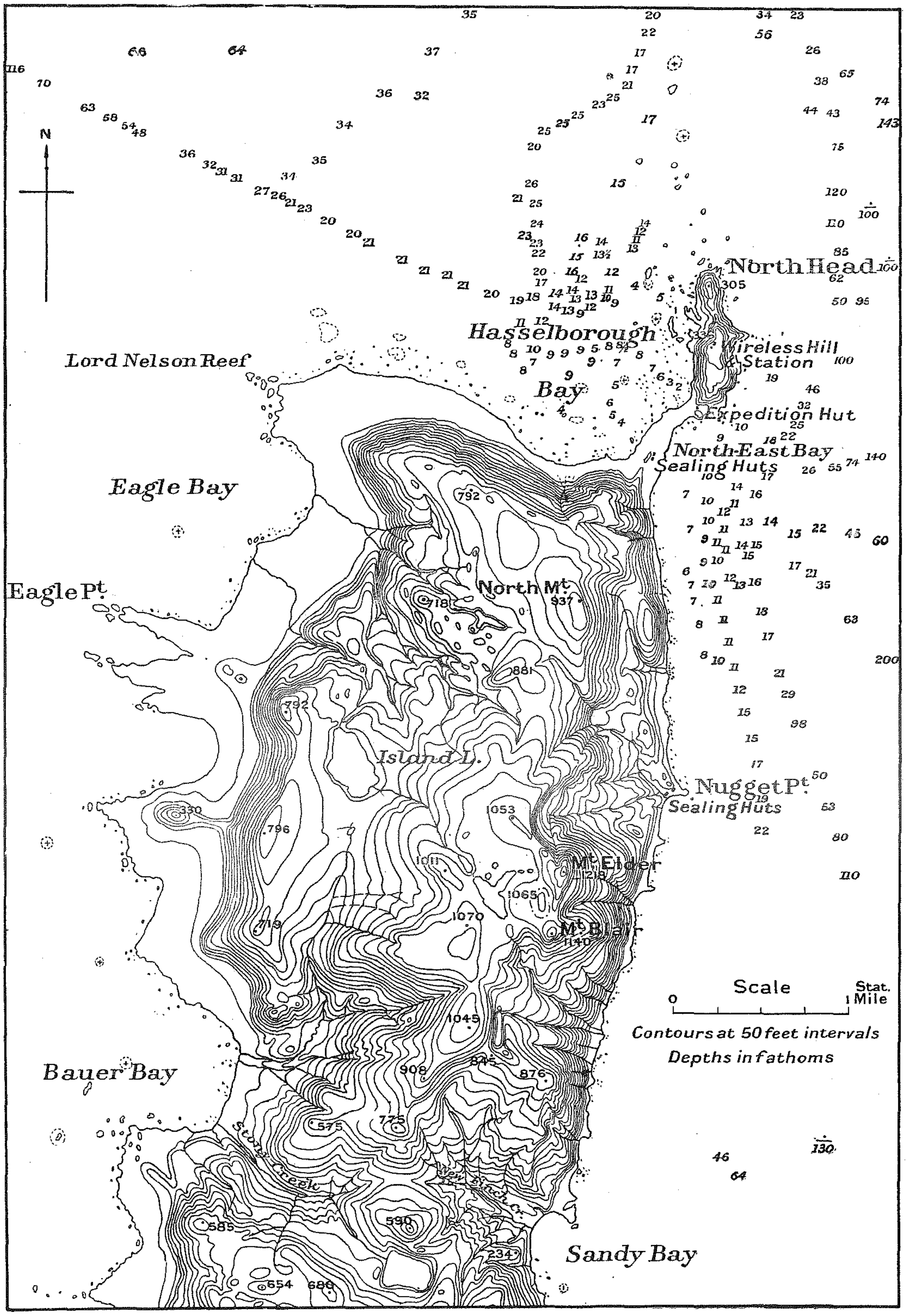


FIG. 7. The Northern end of Macquarie Island with 50-feet contours; by L. R. BLAKE, published 1914.

The Judge and Clerk Islets lying to the north have been fixed accurately in position by sights from the land. The more distant Bishop and Clerk Islets beyond the south-end of Macquarie Island were only approximately located by Blake, but further check was made from the " Discovery " in 1930.

Even the small rocks and islets along the coast have been entered in Blake's map. Consequently, as the years pass by, data will become available for estimates of the rate of marine planation. The accuracy and detail of his mapping also presents a sound basis upon which to establish future observations concerning the rise and fall of the land in relation to sea-level. For this purpose Blake established a bench-mark on the shore of Garden Bay (Fig. 16) in the neighbourhood of the Expedition hut. This record is in the form of a metal ring-bolt cemented into the rock at 8·96 feet above mean sea-level (Plate XVIII, Fig. 2).

Upon the completion of his triangulation survey of the Island, Blake then undertook a contoured plan of the land surface. This was achieved with a satisfactory degree of accuracy and thus the relief of the land is well illustrated. He ran contour lines at 200-feet intervals over the entire Island, but over a considerable area at the North End contours are plotted at 50-feet intervals.

The Rock Fringed Coast.

The island is completely fringed with rocky ledges and reefs which make landing from boats difficult, and the coast dangerous for shipping. With two or three exceptions, all the reefs on the east coast are merely narrow rocky fringes immediately skirting the land forming a belt not more than 200 yards in width. The points known as the Nuggets and Brothers are two of these exceptions, inasmuch they have rocky reefs running seaward for some little distance which represent the remnant of short spurs that formerly existed there. The reefs on the western coast (Plate VIII, Fig. 2) all extend seaward from low rocky capes and headlands for some considerable distance.

Anchorages.

Macquarie Island possesses no well defined bays or even safe anchorages; but several open roadsteads, where shelter may be obtained under the lee of the hills, have been designated bays. The most important of these anchorages for shipping purposes are Hasselborough Bay and Buckles Bay (Fig. 8). The advantage possessed by these two anchorages is in their nearness to each other, and in their occurrence on opposite sides of the Isthmus, so that in the event of a complete change of wind, shelter may be obtained by steaming around the northern promontory. Useful anchorages are indicated in the maps by anchor symbols. Other anchorages on the east coast named in order from north to south are at Nuggets Point, Sandy Bay, Green Valley, Waterfall Bay and Lusitania Bay. Plans of some of these appear as text-figure 9. Landings may be made from all anchorages during calm weather but the rocky fringing reefs make it a dangerous task with a rough or even moderate sea running. Freshwater streams enter the sea at these landing places, but with the exception of Green Valley,

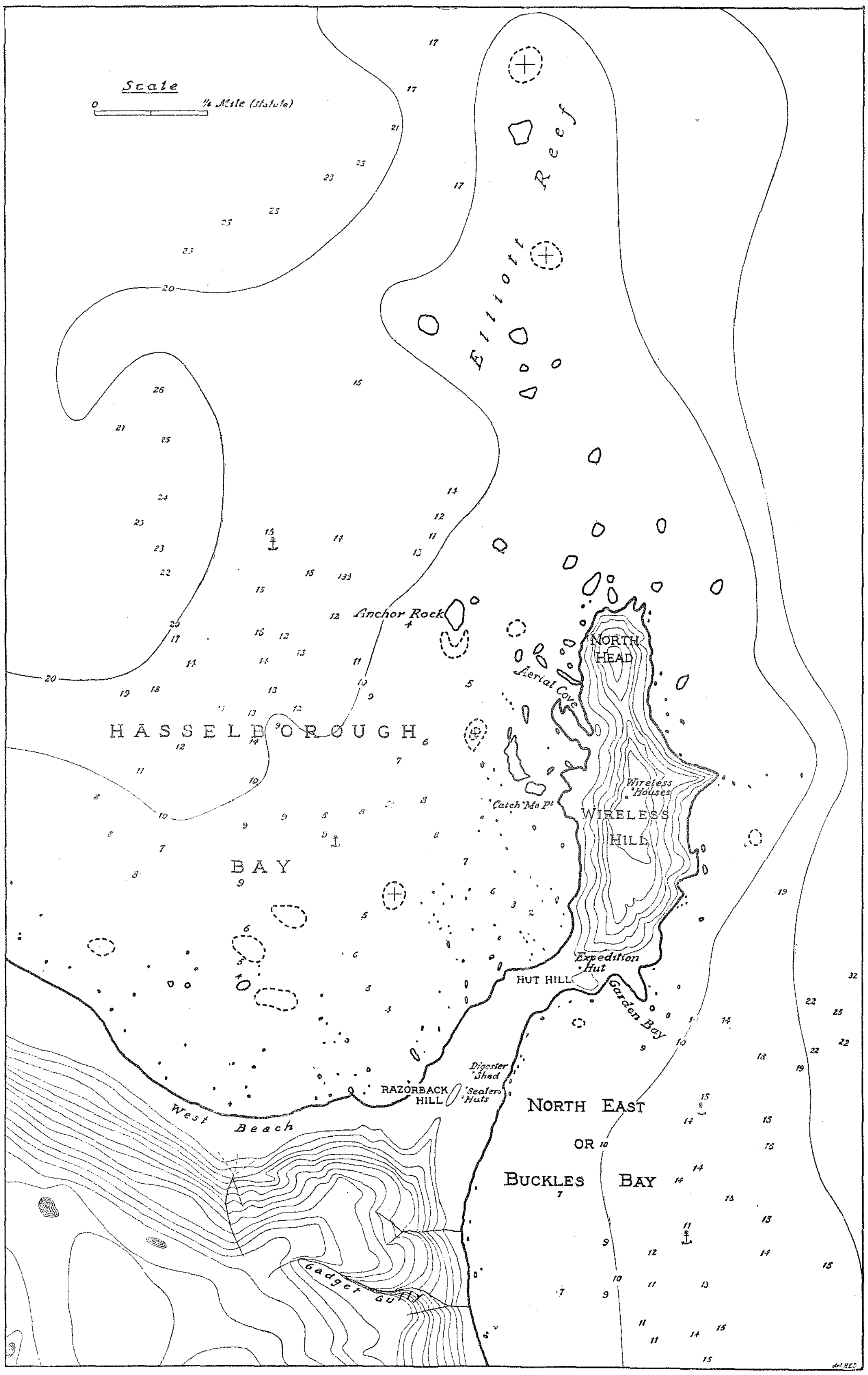


FIG. 8. The anchorages at Hasselborough Bay and Buckles Bay.

they are all polluted by penguins and the water is unfit for use for six months of the year. Green Valley, with its good landing place and clean fresh water, makes a most suitable anchorage for a visiting ship.

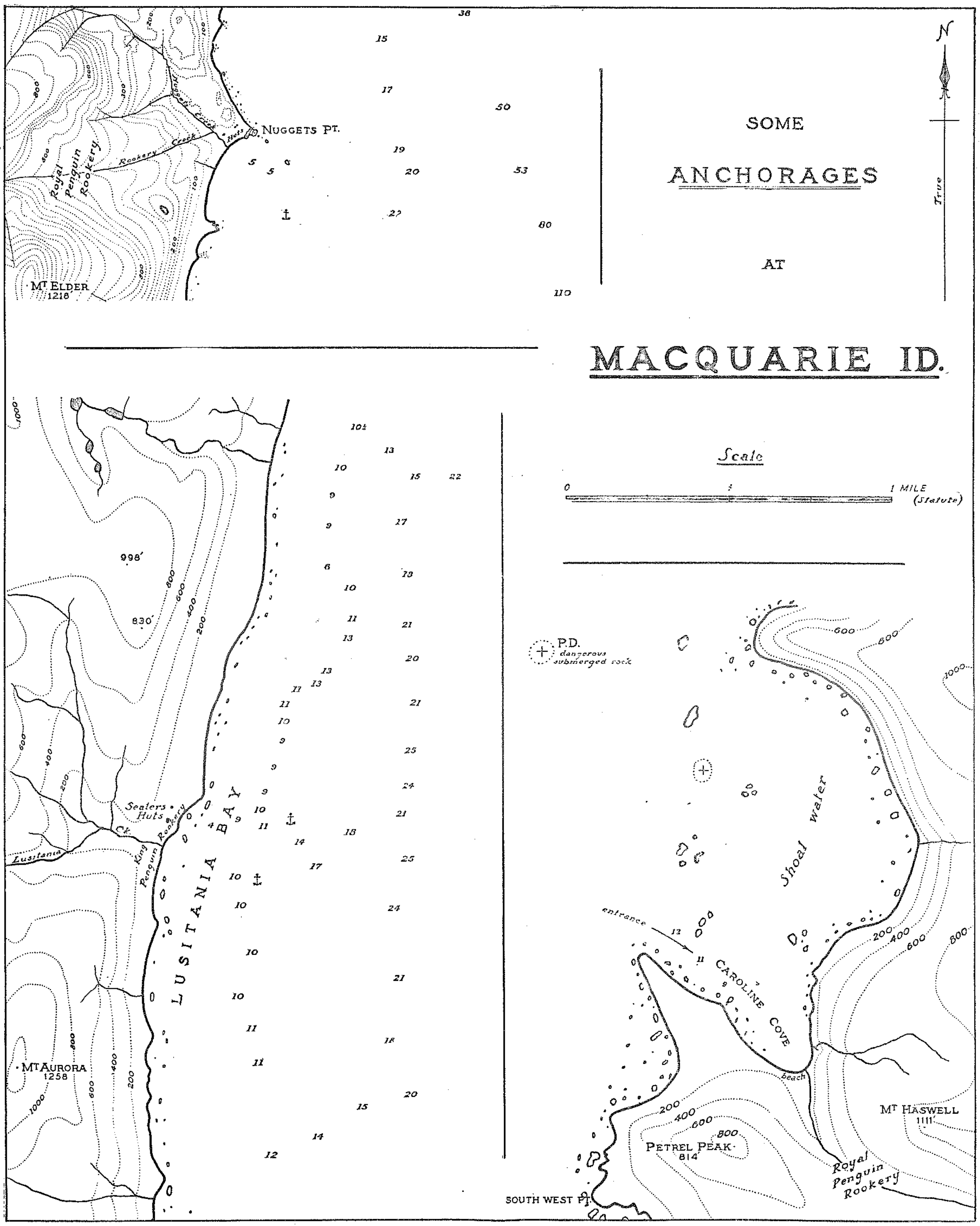


FIG. 9. The Anchorages at Nuggets Point, Lusitania Bay, and Caroline Cove.

On the south coast, South-East and Caroline Bays are rock-strewn and useless as anchorages, but a good landing may be made at the former place in a calm sea during northerly weather. Caroline Cove (Fig. 9) is situated on the west coast near the southern end of the Island. Good shelter is afforded here for small craft during easterly weather, but as it is open to the west, or towards the direction from which the prevailing wind blows, it is seldom that it can be used as an anchorage.

At the time of Blake's survey old huts in various stages of dilapidation existed at the North End Isthmus, Nuggets Beach, Sandy Bay, Lusitania Bay and South-East Bay. Practically all of these including the Expedition Hut must now be rotted away and of no further use as habitations. A detailed plan of the Isthmus and location of hutments thereon is submitted as text-figure 16.

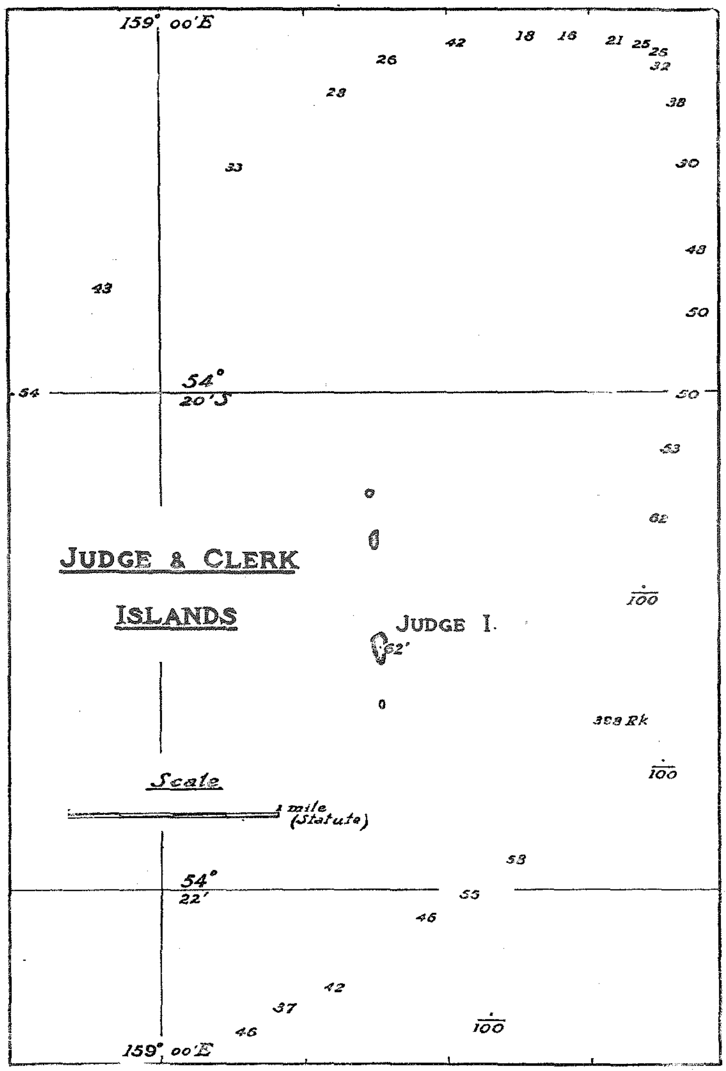


FIG. 10. Map of Distribution and Location of the Judge and Clerk Islets.

JUDGE AND CLERK ISLETS.

The Judge and Clerk Islets are a number of small barren rocks, the largest of which, the Judge, reaches a height of only 62 feet above sea-level. The Judge

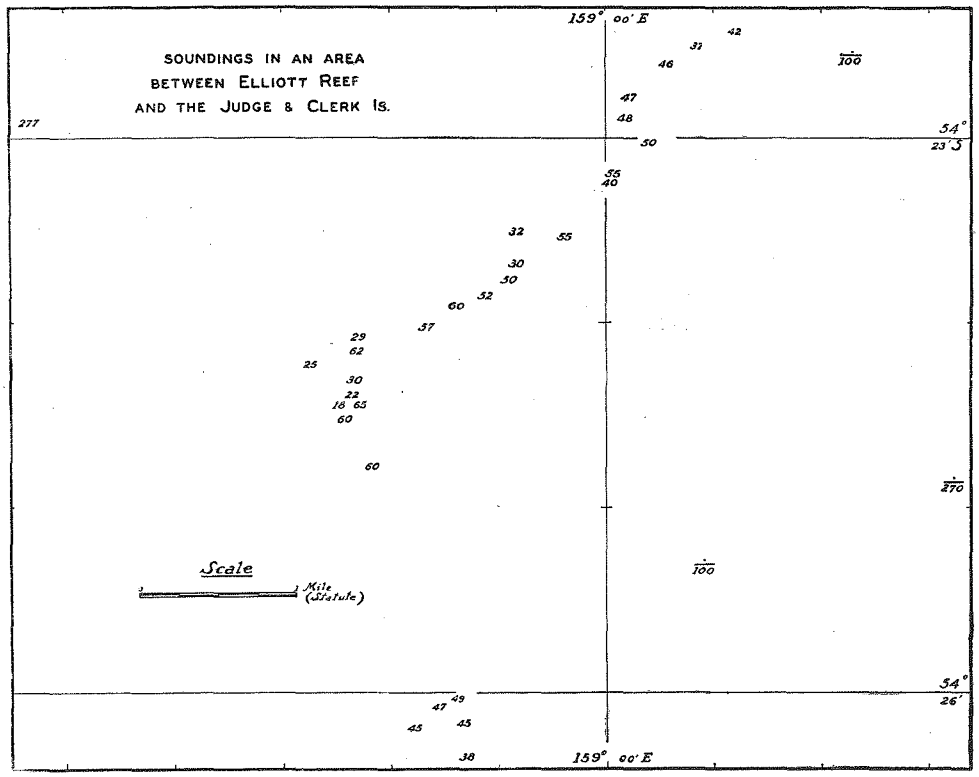


FIG. 11. Soundings north of the Elliott Reef.

lies 9 statute miles from North Head on a bearing 14° 15′ E. of N. (true). Their appearance when observed at a distance is illustrated in text-figure 12, and their distribution is shown in text-figure 10.

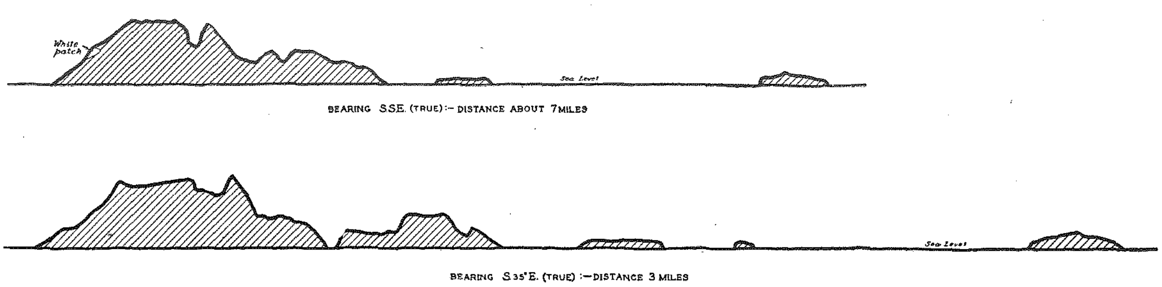


FIG. 12. Aspects of the Judge and Clerk Rocks, by J. K. DAVIS.

BISHOP AND CLERK ISLETS.

The Bishop and Clerk Islets are a chain of barren rocks located somewhat over 20 statute miles from South-West Point on a bearing (according to Blake) 7° 15′ W. of S. (true). Their appearance seen from the deck of the "Aurora" at a distance of about 4½ nautical miles is reproduced in text-figure 14. In November, 1930, on board the "Discovery" we approached these rocks from a different direction as shown on the map, text-figure 13. There was a fog haze at the time, probably obscuring the more distant rocks. However, the vessel approached within about one-third of a mile to the N.N.E. of the Bishop, and Lieut. Oom's sketch is reproduced in text-figure 14. The height of the Bishop above sea-level was found to be 140 feet. The white patches indicated in the sketch are accumulations of penguin guano.

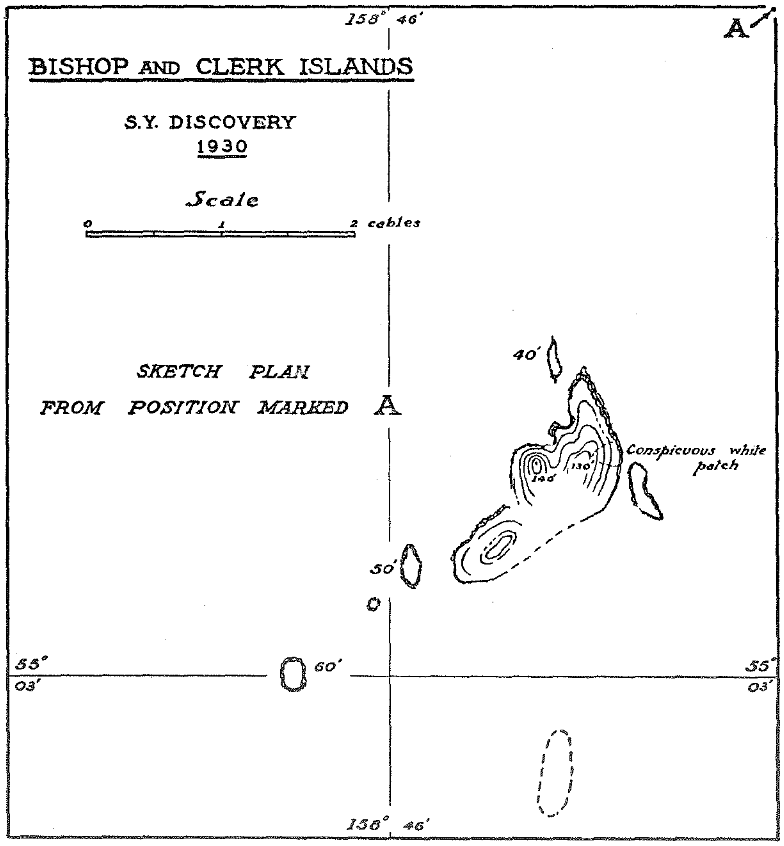
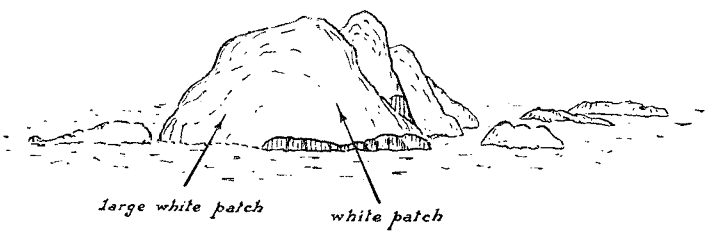


FIG. 13. Map of the Bishop and Clerk Islets.

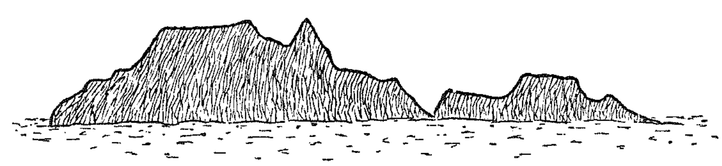
An accurate and complete survey of the Bishop and Clerk group of islets has not yet been achieved. They were too far distant from Macquarie Island for Blake to see any but the highest rocks. On no occasion did the " Aurora " find time to examine and map the group in detail. On the occasion of our visit on the " Discovery " visibility was limited as mentioned above. On that occasion a latitude observation made when close to the Bishop gave its position as lat. 55° 03′ S., which is a little south of Blake's approximate position. The longitude of the Bishop obtained on the " Discovery," observed under favourable conditions, was 158° 46′ E., whereas Blake's sight from the south end of Macquarie Island placed it in about longitude 158° 44½′ E. It seems probable that the correct longitude lies between these two limits.

SOUNDINGS.

From the " Aurora " Captain Davis conducted a programme of sounding around the entire Island. On these occasions Blake accompanied the vessel to assist in fixing the position of such soundings in relation to his new chart of the land. Soundings in greater detail were executed at each of the main anchorages; part of this work was done by Blake operating from a small boat borrowed from the sealers, but much of it was the result of Captain Davis's operations from the "Aurora" or from the ship's motor-launch. Thus from a region almost devoid of all soundings in 1911, the broader features of the sea-floor around the Island were known by the end of the two years of the A.A.E. operations.



OOM'S SKETCH FROM THE "DISCOVERY" AT ½ MILE TO N.N.E.



HODGEMAN'S SKETCH FROM THE "AURORA" AT 3½ MILES TO N.W.

FIG. 14. Aspects of the Bishop and Clerk Islets.

Later, when visiting the Island in the "Discovery" in 1930, we secured additional data by use of the echo-sounder. In the maps submitted in this volume these soundings are included with those made by the A.A.E. of 1911–14. On board the "Discovery" we carried a line of close soundings southward beyond the Bishop and Clerk Islets illustrating that they stand on the same submarine ridge as does Macquarie Island itself. This feature of the ocean floor, though less marked, was traced still further south. In lat. 56° 40′ S., long. 158° 39′ E., a notable shallowing of the sea was located, a minimum depth of only 754 fathoms being recorded (see map on page 26). This feature of the sea-floor we have named the Hjort Rise. Unfortunately, time did not permit further searching investigation as to the ultimate southward extension of this submarine ridge. It intrigued us at the time to observe that the charted position of Emerald Island (see map on page 26) is no great distance to the east of the Hjort Rise. However, so many vessels have searched in vain for this reputed Island since it was reported by the sealing vessel "Emerald" in December, 1821, that its non-existence has long been confirmed.

More soundings are needed to the west of Macquarie Island to define better the limits of the ridge in that direction.

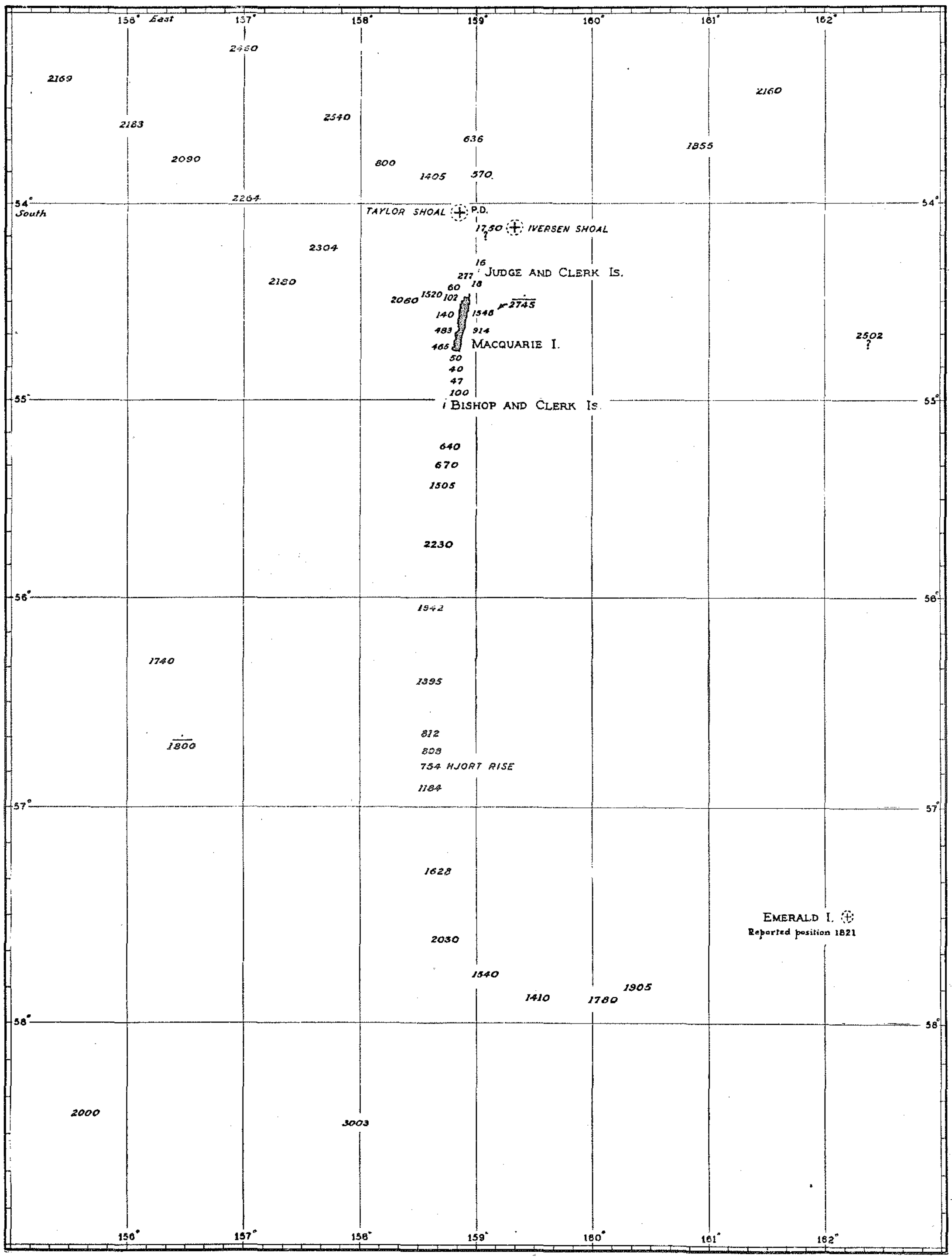


FIG. 15. The Macquarie Island Submarine Ridge and surrounding ocean depths,

To the north of Macquarie Island, Captain Davis was able to secure additional evidence of the existence of deep water isolating the Macquarie Ridge from the submarine platform upon which stand the Auckland Islands and other sub-antarctic extensions of New Zealand.

However, far more information is still required as to the contour of the sea-floor in the region to the north of the Judge and Clerk Islets. The need for further information concerning this area is evident in view of two independent reports of shoal areas (see text-figure 15) in that neighbourhood.

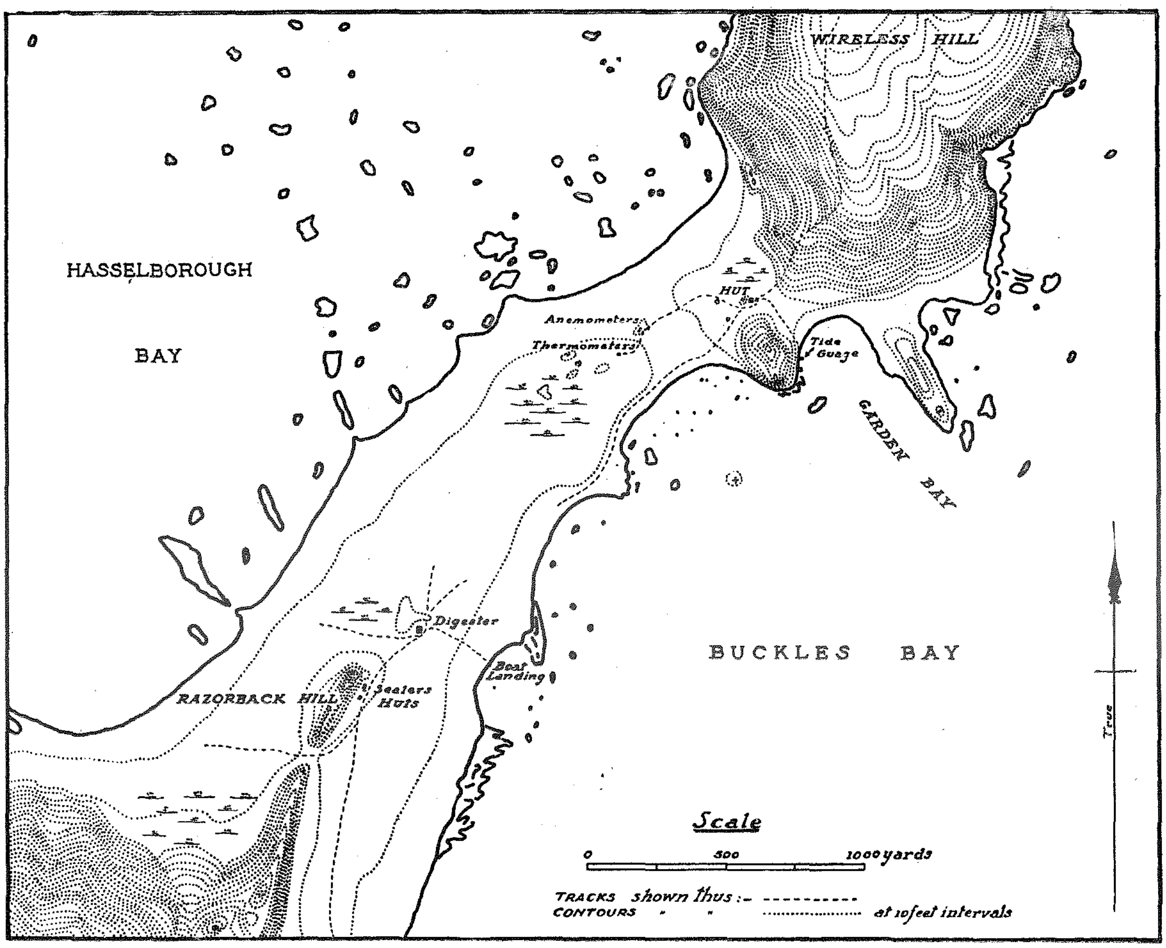


FIG. 16. Detailed plan of the Isthmus and location of Hutments.

The first of these dates back to 1824, when Captain D. Taylor of the vessel "Caroline" of Hobart reported[1] as follows :—

"Caution to Mariners. N.W. by N. (by compass) six leagues from the northernmost breakers and the Judge's Clerk, lays a very dangerous reef of rocks under water. The sea broke very heavy on two different parts. I passed close to it with the ship. It was seen by myself, my officers, and whole crew."

As near as it can be placed today Taylor's shoal should be in about lat. 54° 3′ S., long. 158° 52′ E.

In the year 1923, just 100 years later than Taylor's discovery, Mr. Iversen, Master of a steam whaler reported[14] shoal water of a depth estimated at only 5 fathoms in approximately lat. 54° 7′ S., long. 159° 22′ E.

It has been suggested that the shoal reported by Taylor may be identical with the discovery of Iversen, the assumption being that Taylor made an error in his bearing from the Judge and Clerk. However, it may be that both shoals exist, for comparatively shallow soundings have been recorded to the north and north-west of Taylor's position. The deep sounding of 1,750 fathoms recorded from the " Aurora " in 1912 at a position intermediate between Taylor's Shoal and Iversen's Shoal, may possibly be in error, for on that occasion the wire parted when winding up, which suggests the possibility that, in paying-out, the bottom was overshot.

There appears also to be some doubt concerning the sounding made to the east of Brothers Point where no bottom at 2,750 fathoms was recorded. This depth is in excess of what might be inferred from comparison with soundings still further to the east. Here again the wire was lost so that there was no possibility of checking whether bottom had been reached.

CLIMATE.

As the result of a full program of meteorological observations extending over four years, good climatic data are available[15]. Mean figures* which I have calculated for each month and for the full year based on the hourly observational records of the years 1912, 1913 and 1915, are presented herewith in tabular form. In computing these mean figures, I have not been able to include the year 1914, for the complete records of that year were on board the relieving vessel " Endeavour " when she foundered on the return voyage to Hobart in December, 1914. Copies of the general daily weather summaries only were left on the Island, and hourly data are therefore not available for that year.

The years 1912 and 1913 were rather similar as regards weather at Macquarie Island, but 1915, which marked the advent of a new climatic cycle in the Australasian region was noticeably different from the previous years, particularly in the matter of wind data. Thus the effect of including the year 1915 with the earlier years is to secure a better climatic mean than would result if only the years 1912 and 1913 are considered. In the case of the month of December, however, no data for 1915 is available, and the average hourly values quoted are for a period of two years only.

* Loewe[46] has also published a summary of weather data for Macquarie Island based on the A.A.E. records.

MEAN CLIMATOLOGICAL STATISTICS FOR MACQUARIE ISLAND—YEARS 1912, 1913, 1915.
(Calculated from Records in Series A, Vol. III of this Publication.)

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Full Year.
Atmospheric Pressure (inches of mercury)	29·322	29·500	29·510	29·564	29·598	29·548	29·620	29·627	29·388	29·313	29·387	29·421	29·483
Wind Velocity (miles per hour)...........	13·7	12·4	13·8	13·4	13·6	14·5	17·0	14·6	14·9	19·0	13·1	18·1	14·9
Hours of Sunshine...	2·7	2·1	1·4	0·8	0·3	0·0	0·2	0·4	0·7	1·1	2·1	1·9	1·1
Air Temperature (degrees Fahrenheit)	43·1	42·5	42·1	40·3	38·8	37·2	37·6	38·1	38·2	38·7	40·2	41·8	39·9
Solar Maximum Temperature (degrees Fahrenheit)	114·0	105·1	95·7	82·8	61·6	52·4	61·6	70·6	79·8	97·9	108·7	112·8	86·9
Terrestrial Minimum Temperature (degrees Fahrenheit)	36·6	37·0	36·8	34·6	31·6*	31·3†	31·7‡	32·0	32·5	32·6	34·8	37·0	34·0
Sea-water Temperature (degrees Fahrenheit)	43·4	42·0	41·1	40·6	38·6	38·3	37·6	38·2	38·6	39·0	41·0	43·0	40·1
Earth Temperature (degrees Fahrenheit)	47·0	46·2	44·7	41·9	39·1	37·6	37·2	37·6	38·8	40·3	43·7	45·6	41·6
Relative Humidity (percentage of saturation)	90	94	93	93	93	92	90	92	93	91	92	91	92
Precipitation (inches of water)	5·15	3·22	4·53	4·44	3·95	3·44	3·93	3·73	3·29	3·24	3·36	3·58	45·86

* This figure is the average of twice the 1915 figures, plus the 1913 figure; procedure adopted because the 1912 data are missing and because May, 1913, was exceptionally cold for that month.

† Average for June, 1913, is 30·3, not 33·1 as given in Vol. III.

‡ Average for July, 1913, is 31·7, not 35·9 as given in Vol. III.

Atmospheric Pressure.—The mean taken over the period of three years and reduced to standard gravity, mean sea-level and 32° F., amounted to 29·483 inches of mercury. The absolute maximum barometric pressure recorded was 30·531 inches and the absolute minimum 28·015. August is the month of highest average pressure, October that of lowest.

Wind Direction.—The wind is mainly from the north-west to west. Very little comes in from the north-east to east-south-east. This means that for most of the year the east side of the Island is a sheltered coast. The percentage frequency for the whole year for each direction of the compass as deduced from the tabular records of 1912, 1913 and 1915 computed as averages for the whole year is as follows: N. 4·3, N.N.E. 1·0, N.E. 0·6, E.N.E. 0·6, E. 1·1, E.S.E. 0·7, S.E. 2·0, S.S.E. 1·8, S. 2·6, S.S.W. 1·6, S.W. 4·9, W.S.W. 7·4, W. 14·7, W.N.W. 16·9, N.W. 22·1, N.N.W. 7·1, calm 10·6.

These data are graphically represented in the wind-rose diagram, text figure 17.

Wind Velocity.—The windiest month is October. In the year 1915, December was an unusually windy period, so much so that it greatly increased the average for the month as compared with the more normal years. January, February, March and April are the least windy months. The highest hourly wind velocity to be recorded was 52 miles, occurring in the month of July, but puff velocities up to 75 miles per hour were experienced.

During 1915 the Robinson Cup Anemometer gave an average for the year of 18·1 miles per hour, but the average for the anemobiagraph record for the three years was 14·9 miles per hour. It is well known that the cup type of anemometer is apt to give rather a high reading under gusty conditions. Consequently it may be expected that the weighted mean for the three years of hourly observations was about 16 miles per hour. These wind values were obtained on the North End Isthmus at a point about 8 feet above the ground, that is, about 28 feet above sea-level.

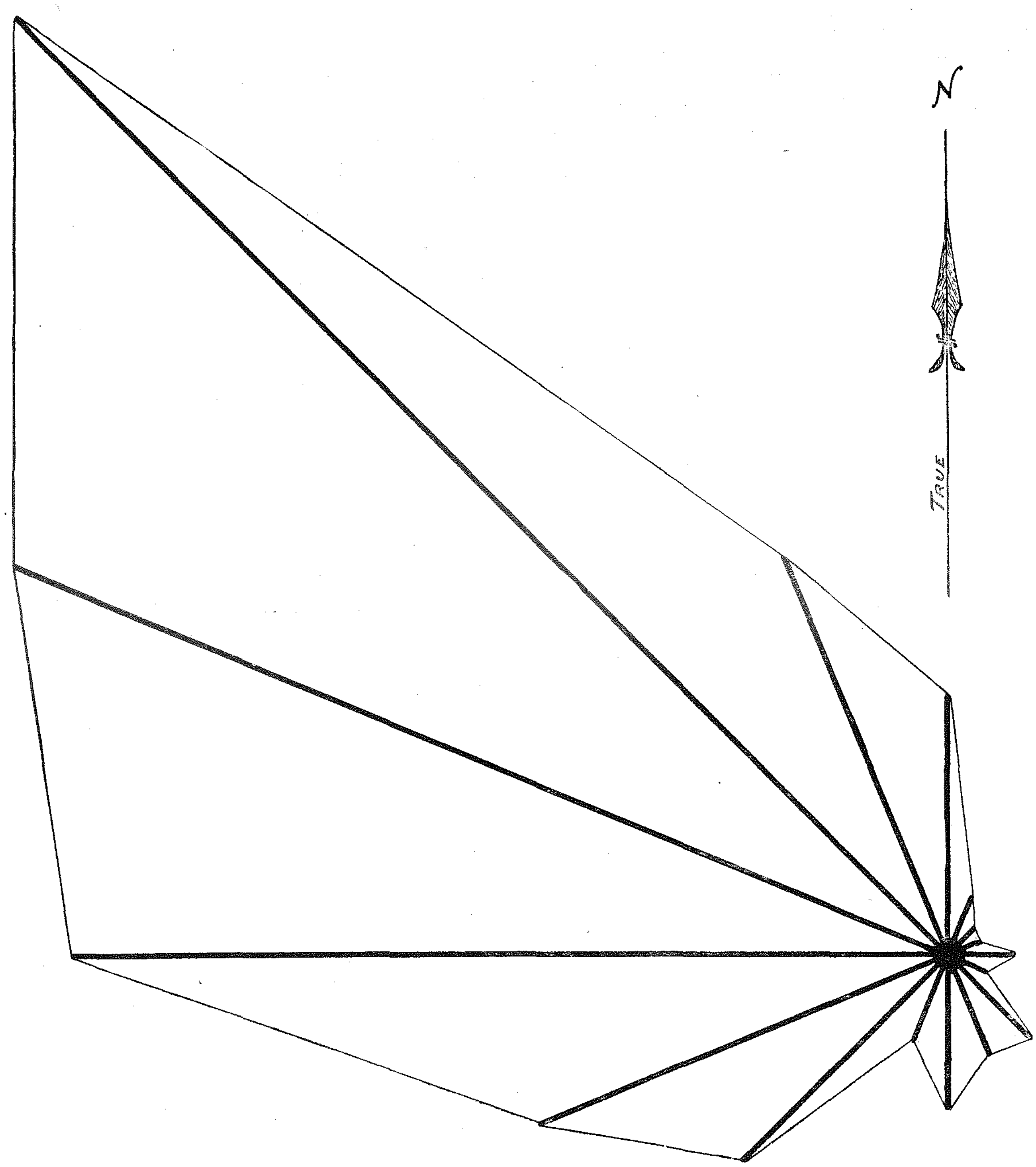


FIG. 17. Wind-Rose for Macquarie Island: the Prevalence of Winds in relation to Compass Directions.

Sunshine.—The hours of sunshine recorded on a Campbell-Stokes sunshine recorder averaged 1·1 per day for the whole three-year period.

Air Temperature.—The mean as determined in a standard meteorological screen and at a height of 25 feet above sea-level was found to be 39·9° F. An absolute maximum of 51·8° F. was recorded in December and absolute minimum of 22·7° F. in July. The amount of heat received from the latent heat of aqueous vapour is very noticeable, especially during the winter months.

Solar Maximum Temperature as recorded by a black bulb thermometer yielded a mean annual figure of 86·9° F., with a monthly maximum in January of 114° F. and a minimum of 52·4° F. in June.

Terrestrial Minimum Temperature ascertained by a thermometer laid on the grass was lowest in August. The annual mean is 34·5° F.

Sea-water Temperature.—The mean surface water temperature for the whole year was ascertained to be 40·1° F., with a minimum monthly value of 37·6° F. in July.

Earth Temperature.—The annual mean as deduced from the 9 a.m. readings of a thermometer stationed in a tube 2 feet below the ground surface was 41·6° F. The minimum monthly figure is 37·2° F. in July and the maximum monthly value was 47·0° F. in January.

Humidity is high at all times of the year. Expressed in percentage of saturation, the hourly average for the year is 93%.

Fogs are frequent throughout the year. For instance, in 1915 there were 166 foggy days. The monthly maximum fogginess is usually in May and the minimum in October.

Rainfall.—Only during the year 1915 was the precipitation in the form of rain and snow quantitatively measured. In earlier years no satisfactory gauge had been provided giving reliable figures under the prevailing windy conditions. The total precipitation during 1915, including both rain and snow, amounted to 45·96 inches. This was spread over 339 rainy days. It is mostly in the nature of light misty rain with cold snow showers during winter months. The rain-winds come usually from the north, gradually backing from west to north as the storms approach, and then veering to north-west and west as they pass.

As regards the incidence of snowfalls, such usually occur during every month in the year, but the heaviest take place in July. The total snowfall recorded in 1915 amounted in all to 9 feet, equivalent to 901 points of rain. During that year the greatest depth of snow lying on flat ground at sea-level at any one time was 6 inches. Clouds of snow are to be seen blowing from the land into the sea on occasions during gales. Owing mainly to the agency of rain and wind, snow never remains long on the ground, especially near sea-level. Although the elevated plateau is often snow-capped for weeks at a time during the winter, there exist no permanent snow-drifts or ice masses.

Thunderstorms.—Thunder and lightning are rarely experienced at Macquarie Island. One such storm of a cyclonic nature which approached from the east to north-east was experienced in March, 1915. Apart from this, lightning was observed only on two other occasions during the whole three-year period.

Aurora Polaris.—The auroral maximum zone lies to the south of Macquarie Island. Manifestations are of great frequency, appearing mostly in the quarter of the sky between south-east and south-west. Usually the displays commence in the southern skies and gradually work up towards the zenith, and on occasions continue past the zenith well into the northern sky.

OCEAN SURFACE DRIFT AND SEA CURRENTS.

One important factor affecting the climate of Macquarie Island is the fact that it lies within the northern limit of the region of Antarctic surface waters. Small icebergs are occasionally within sight from its shores. When we called there in November, 1931, there were several icebergs aground near the south-west corner of the Island and on the Bishop and Clerk rocks.

For its latitude (55° S.), however, the climate is milder than that of some other sections of the Subantarctic, such, for instance, as the locality of Heard Island. This is, no doubt, due in part to the modifying influence of the large body of warm surface water, which, after streaming southward down the east coast of Australia, then trails away to the south-east into the Southern Ocean beyond Tasmania.

In part, also, some amelioration of the climate in the Subantarctic to the south of the Western Pacific Ocean is to be expected as a result of the southward recession of the coast of Antarctica in longitudes to the east of Adelie Land. Thus a wider belt of ocean insulates Macquarie Island from the Antarctic ice mass than is the case with Heard Island.

Under the influence of the westerly gales, the surface waters drift from west to east past the Island at the average rate of a few miles per day. The drift of messenger bottles released from the " Discovery "[16] and the recorded[17] movement of icebergs indicates a north-easterly trend in the surface drift in the region between Macquarie Island and New Zealand.

On 6th March, 1915, Tullock picked up on West Beach, Macquarie Island, a sealed bottle containing a letter stating that it had been dropped into the sea in North-East Harbour, Campbell Island, in January, 1911, and requesting the finder to forward it to H. Booth of the s.s. " Hananui," of Auckland. The explanation of the appearance of this bottle on the coast of Macquarie Island appears to be that it first drifted north up the coast of New Zealand, eventually arriving in the east to west South Pacific drift which carried it to the Australian coast, down which it would proceed in the comparatively fast-moving warm current until to the south of Tasmania it would be carried to the south-east, then east by the Southern Ocean drift. The interval of over 4 years would give more than sufficient time for this journey.

The survivors of the wrecked "Bencleugh" reported[18] that on visiting Eagle Cove on the west coast "we found hereabouts a ship's figurehead (a large eagle), and quite a number of logs of what we supposed to be Australian red cedar." If the logs found were of Australian red cedar, they may have drifted down the east coast of Australia and arrived at the Island by a similar course as that probably pursued by Booth's bottle.

However, when visiting Heard Island, to the south of Kerguelen Island, in 1929, I found cast up on the beach a splendid milling log of large girth, hewn square, and which also resembled Australian red cedar. I concluded at the time that it was more likely to be mahogany from the Atlantic seaboard. If drifting in the Atlantic, whether from Nigeria or from South America, it would eventually travel southward along the coast of South America until delivered in far southern latitudes into the Southern Ocean drift and thence to Heard Island.

A feature which is doubtless of great importance in the maintenance of the large seal and bird population of Macquarie Island is the fact that the extensive submarine ridge from which it rises lies astride the ocean currents of that neighbourhood, and thus must tend to bring to the surface the more highly nitrated and phosphatic waters of the deeper zone. This is a necessary condition for the growth of increased micro-flora which, in its turn, gives rise to increased marine fauna. Consequently the waters around Macquarie Island and to the east of it should be rich feeding grounds for penguins and seals. In fact, here there appears to be rather similar conditions to what have been shown to exist around the island of South Georgia.

FLORA.

The Island is devoid of anything in the nature of trees. Indeed, it is without any form of obvious ligneous growth. Nevertheless, from the beach to several hundred feet above sea-level the ground, except where it is just massive rock, is more or less completely clothed in vegetation.

The rankest growths are on the boggy flats and low raised-terraces marginal to the coast. In the latter localities and in sheltered valleys tussock-grass (*Poa foliosa*) is the dominant vegetation. On the more exposed and swampy flats, meadows of *Pleurophyllum Hookeri* make their appearance. With increasing elevation on the hill slopes the tussock-grass dwindles in luxuriance and size, gradually giving way to a hardier and scantier growth of a cold and wind resistant community in which moss and cushions of *Azorella Selago* (Plate XVIII, fig. 3) are the principal members. Thus the vegetation of the highlands may be described as that of a wind desert. There the plants usually appear in linear arrangement related to the direction of the prevailing wind. Such wind rows of Pleurophyllum are illustrated in Plate XV, fig. 2.

As ascertained by Harold Hamilton of the Expedition's Macquarie Island Party, a census of the vascular flora, that is, all plants other than the very lowest forms, such as algae, lichens and mosses, comprise[19] in all thirty-four species, of which three are endemic. All, with the exception of the three endemic grasses, are New Zealand or Fuegan forms. Fifteen are circumpolar, and have a wide distribution in the islands of the Southern Ocean.

Apart from tussock-grass and Azorella, only two other members of the plant community are so conspicuous as to warrant special reference here. The first of these is *Pleurophyllum Hookeri* (Plate XVIII, fig. 4), which grows as broad-leaved rossettes of silvery sage-coloured foliage which, in the appropriate season, run up a conspicuous purple flowering head. It is widely distributed, but thrives best on swampy flats.

The other rather remarkable plant is *Stilbocarpa polaris* (Plate XVIII, fig. 4), popularly designated Macquarie Island Cabbage. This has broad, rhubarb-like foliage, and develops large umbels of waxy flowers. It grows best on the well-drained lower slopes and flats. In former days it constituted an important item of diet* among the sealers, who valued it for its antiscorbutic properties.

Around the shores of the Island there is a prodigious growth of the giant seaweed *Durvillaea antarctica.* Extremely thick and long swathes of it are attached to all the rocks and submerged reefs to a depth of quite 5 fathoms. So dense is this growth in the shore waters in many places that it is quite an obstacle to landing parties. This remarkable marine alga is illustrated in Plate CXIV, fig. 1, of Vol. I of this Series of Reports, where it is seen lying about amongst the rocks on the shore line.

FAUNA.

The conspicuous faunal elements existing on the land are the seals and birds. The invertebrate land life is limited, amounting to only very few species. Apart from parasitic ticks and earth-worms, the invertebrates are chiefly represented by insects. The latter embrace the following varieties : 3 collembola, 1 hymenoptera, 1 coleoptera, 1 lepidoptera and more than 6 distinct varieties of diptera. Amongst the latter are interesting wingless forms and kelp-eating flies.

It is the abundance of seal life thronging its shores in the breeding season that has been chiefly responsible for directing public attention to Macquarie Island. When man first broke in upon that ocean sanctuary the Southern Fur Seal (*Arctocephalus forsteri*) was there in vast numbers but the depredations of the sealers soon reduced them to negligible quantities and eventually resulted in their extinction.

* Bellingshausen's account of the island makes special reference to " an excellent remedy against scurvy in the shape of a certain wild cabbage, which is found in great abundance on the island. The stalks are about a foot long, and the leaves are rough; the colour of the central stalk is white like that of a cauliflower. The taste of the root is something like that of a cabbage stump. The traders scrape the roots and the stalks, cut them up very thinly and boil them for soup. We collected a great quantity of that cabbage, stocking ourselves with it for our servants, whilst for the officers' table pickles were made from the roots. We prepared some tasty cabbage soup out of the preserved pieces and regretted we had not obtained more."

Sea-elephants (*Morunga elephantina*) are now the only really abundant representatives of the seal family visiting those shores (Plate VI). Though never entirely absent from the beaches they arrive in numbers for the breeding season about August and, except for odd stragglers, both young and old have again quitted the Island by March.

Sea-leopards (*Stenorhynchus leptonyx*) are plentiful to the degree to which such predatory animals ever do occur. In actual numbers they are very few indeed in comparison with the sea-elephants. Unlike the latter, however, they remain in the immediate coastal waters all the year round, preying upon the penguins. They are seldom seen ashore except during the late winter months.

The variety and abundance of bird life existing on Macquarie Island has always been a matter for special remark. When the "Peacock" of Wilkes's squadron called there in 1840, Mr. Eld, a member of the ship's company who landed wrote: "Although I had heard so often of the great quantity of birds on the uninhabited islands, I was not prepared to see them in such myriads as here. The whole sides of the rugged hills were literally covered with them." It is difficult to imagine that there is any other island sanctuary so remarkable in this regard. In the main, of course, the bird population is seasonal. Many of the species inhabit the Island only during the breeding season. For a systematic record of these Subantarctic birds, see R. A. Falla's[20] account.

The vast numbers of penguins crowded into single rookeries make these remarkable creatures the most conspicuous of the bird population. Four species are represented amongst those regularly breeding on the Island.

The King Penguin (*Aptenodytes patagonica*) (Plate XII, fig. 1) is the most striking member of this group. There now exists only one rookery located at Lusitania Bay. They have been exterminated from other areas as a result of uncontrolled exploitation for blubber oil.

The Royal Penguin (*Eudyptes* (*Catadyptes*) *schlegeli*) (Plate V and Plate XII, fig. 2) is a species based solely on Macquarie Island. In numbers it far exceeds any of the others. The rookeries are scattered at many points on the east and west coasts. The largest occupying 16 acres with a population of about 600,000 birds is at the south end. On the hills above the beach at the Nuggets there is another rookery occupying about 10 acres which was estimated by Blake (1912) to contain about 500,000 birds. These birds remain at sea during the winter months. The vanguard of the returning horde appears about the middle of September, and all have departed by the last week in the following April.

Rockhopper Penguins* (*Eudyptes cristatus*) (Plate XI, fig. 2) are distributed in small rookeries around the entire coastline. They are to be found on rocky slopes adjacent to the sea. These are a migrating species departing early in May, to return for breeding purposes in the middle of October.

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* In some reports these have been referred to, in error, as Victoria Penguins. See B.A.N.Z.A.R. Expedition Reports Series B, Vol. II. Falla's nomenclature is adopted here.

Gentoo Penguins (*Pygoscelis papua*) nest amongst the tussock-grass on the beach terraces. They are never found in very large congregations in any of the breeding areas. South-East Harbour, Sandy Bay and Aerial Cove are locations of rookeries. This species remains at the Island throughout the whole year.

Though not so conspicuous as the massed population of penguins other forms of bird life that have come under notice of our Expedition observers are as follows :—

The Snowy or Wandering Albatross (*Diomedea exulans chionoptera*) found nesting on the hills above Caroline Cove and on the highland slopes facing the sea north-west of Mt. Waite.

The Grey-headed Mollymawk (*Thalassarche chrysostoma*) nests on the steep cliffs at the south-west corner of the Island.

The Black-browed Albatross (*Thalassarche melanophris*) is a common bird of the adjacent seas and almost certainly nests on the Island.

The Light-mantled Sooty Albatross (*Phoebetria palpebrata*) nests in several localities on the steep sea-cliff faces.

The Giant Petrel (*Macronectes giganteus*) is an all-the-year-round resident. In the spring these birds assemble in large rookeries, some on the flats near the sea, others on high terraces. The largest rookery observed, said to contain several thousand nests, overlooks Caroline Cove.

The Sooty Shearwater (*Puffinus griseus*), one of the burrowing sea birds, is to be found at North Head, Lusitania Bay, etc., nesting during the summer season.

The White-headed Petrel (*Pterodroma lessoni*), another of the burrowing forms, nests in several localities.

The Grey Petrel (*Procellaria cinerea*) nests at North Head and other localities. This and the Lesson Petrel were known to the sealers as the "larger night birds."

The Dove Prion (*Pachyptila desolata*) is seen on the coast in summer but is absent in winter. In association with the larger prions they nest in thousands on the higher portions of the land both on hillsides and on flats. Their burrows are numerous on the hills above Lusitania Bay. These are the "lesser night birds" of the sealers.

The Cape Pigeon (*Daption capense*) known to the Macquarie Island sealers as the "ice bird" is a visitor but has not been observed to nest at Macquarie Island.

The Macquarie Island Wreathed Tern (*Sterna vittata macquariensis*) is distinctive of this locality.

The Southern Skua (*Catharacta skua lonnbergi*) is a resident during the larger part of the year, but departs north in winter absenting itself for several months.

The Southern Black-back Gull (*Larus dominicanus*) frequents the Island all the year round. It inhabits the shoreline but is occasionally found swimming on the lakes of the highlands.

The Macquarie Island Shag (*Phalacrocorax* (*Leucocarbo*) *albiventer purpurascens*) is specific of the Island. The largest rookery is at West Point where there are 200 nests. There is a small rookery at Aerial Cove.

A Ground Parakeet existed on the Island in great numbers in the days of the early sealers. Their extermination was completed about the year 1890.

The Grey Duck (*Anas superciliosa*) is met with in moderate numbers, usually feeding on the swampy raised terraces of the West Coast.

There are now on the Island great numbers of the Stewart Island Wood Hen or Weka, descendants of some birds introduced by the sealers. Occasionally examples of land birds from New Zealand and elsewhere have been sighted on Macquarie Island, these are over-carried migrants or accidental refugees. Amongst those recorded by Falla are the Redpoll, Godwit, Knot, and Starling.

This list of major forms of the faunal population would not be complete without mention of the existence of rabbits, rats and cats introduced by sealers. At the present time rabbits are numerous only near Lusitania Bay. Rats are troublesome only in the neighbourhood of the old sealers huts at the north end. Cats are few but widely distributed. The introduction of all these creatures is most unfortunate in their destructive effect upon the natural fauna and flora.

THE ROLE OF MACQUARIE ISLAND IN RELATION TO HUMAN ECONOMY: RETROSPECTIVE AND PROSPECTIVE.

Oceanic birds and seals, though living a truly pelagic existence during most of the year, must have recourse to *terra firma* during the breeding season. Actually a very small land area may suffice for all the feathered and furred creatures that can be supported by the produce of a wide range of ocean. Thus it is that for long ages past Macquarie Island, as a speck of land set in the midst of a vast expanse of sea has been a vital factor in the stocking of a great area of the Southern Ocean with bird and seal life.

It is so placed as to constitute the metropolis for such life existing throughout an oceanic region far larger than, say, the United States. At this key point a vast throng of creatures is entirely at the mercy of man.

The complete extermination of this congregation, a community resulting from millions of years of evolutional development under the conditions of a specialised local environment, would be no great task. But as nothing so valuable to human economy could be substituted, there is no justification even on the most material grounds for such slaughter. Furthermore, on every other ground, it is surely the duty of civilisation to conserve for all time the peculiar fauna and flora of so extensive a region of the Earth's surface. Having this object in view, there certainly is no more suitable sanctuary for the preservation of a wide range of the bird and seal life of the Southern Ocean than Macquarie Island.

The Extinction of the Fur-Seals.

Unfortunately the depredations of the sealers, during the hundred years following the discovery of the Island to the time of our arrival on the scene, have been most disastrous to the animal population, resulting in the extermination of some species and disturbance in the balance of life among those remaining. Within a few years of the discovery of the Island, unbridled and unregulated slaughter of the Fur Seals had reduced a great asset to almost negligible proportions. That this was so is recorded in an article which appeared in the *Sydney Gazette*[1] of 1815, as follows :—

"Between three and four years ago Macquarie Island was discovered to abound in seals, and above 100,000 skins were procured there in the season. The case, however, is now very different, as the whole number collected there by several gangs this season does not exceed five or six thousand. The decrease of the amphibious brood may be very naturally accounted for from the practice adhered to of killing promiscuously all the seal that offer, of which the Clap Match or female seal, furnish great proportion. The pups or young seal were also indiscriminately slaughtered, so that the means of increase were totally annihilated unless from the solitary few which escaped the vigilance of the hunters, and which would require to enjoy length of undisturbed security and repose before their numbers were sufficiently recruited to afford a competent allurement to renew hostility. These causes were sufficient to counteract the prospect of benefiting from a fitting out hither for seal for many years to come, but it might have been looked forward to as an advantageous scene of adventure at a future period. This prospect is, however, totally obliterated by the ravages committed on the younger seal by innumerable wild dogs bred from those unthinkingly left on the island by the first gangs employed upon it. The birds, which were formerly numerous, and were found capable of subsisting a number of men without any other provision, have also disappeared from the same cause. Their nests, which were mostly in inaccessible situations, have been despoiled of their young, and the older birds themselves surprised and devoured by these canine rovers, which as they multiply must every day diminish the value of one of the most productive places our sealers were ever stationed at."

For many years after the first great onslaught, fur seals continued to be taken at Macquarie Island in small but gradually decreasing numbers. Even after they were thought to be extinct, a few would reappear, following intervals during which the ravages of sealers had been suspended. This restocking came from other, then existing, sanctuaries in the Southern Ocean. We were informed by the headsman of the sealing gang operating in 1911 that, in his experience of the Island which extended over eleven years, odd fur seals had appeared on the beaches on a number of occasions. Of course, needless to say, they were killed forthwith. With the slaughter in recent years of the small colony of Fur

Seals, until then protected, on the neighbouring Auckland Islands,[22] the extinction of this creature in the Subantarctic Islands lying southward of New Zealand may be considered now complete. Fortunately, the Southern Fur Seal still exists in small numbers at Bouvet Island, in the region to the south of the Atlantic Ocean. These survivors should be rigidly protected to ensure their increase, in order that some day other Subantarctic Islands, including Macquarie Island, may be restocked with these valuable creatures.

The Extinction of the Ground Parakeet.

Another interesting member of the original fauna of Macquarie Island, though now extinct, is an endemic ground parakeet. The sealers are reputed to have held these birds in greater esteem as food than any other creatures on the Island. Bellingshausen, on his visit of November, 1820, recorded:[1] "To our great surprise we saw a number of medium-sized parrots, all belonging to the same species . . . . at five o'clock we returned to our vessels with our booty, which consisted of two albatrosses and twenty dead and one live parrot; the last one the traders sold me for three bottles of rum."

Twenty years later the "Peacock" of Wilkes's squadron called there. Two men, Mr. Eld and the quartermaster, made a difficult landing at the south end of the Island, and collected penguins and eggs. It is recorded[5] that the quartermaster saw "some green paroquets with a small red spot on the head, and an oblong, slaty or purple spot at the root of the bill, and with a straight beak."

These birds were still existing in considerable numbers when Thomson spent some months there ship-wrecked about 1878. He wrote[18]: "I shot some paroquets, and occasionally we were successful in knocking them over with stones. . . . . There appeared to be great numbers of them. We roasted them on sticks in our fire of driftwood and found them delicious."

Professor Scott,[6] visiting the island in 1880, reported their existence in considerable numbers. He stated that their principal food was the pupae of the kelp-fly, and that they nested in the tussock-grass. In 1894, when A. Hamilton[7] spent about a month on the Island, the parakeet were extinct. One of the sealers, who had been operating on the Island for some years, told Hamilton that the birds had been seen up to the year 1890. That appears to be the date of their extinction, and the factor chiefly responsible was no doubt the wild cats, which A. Hamilton stated were plentiful at that time.

The Fate of the King Penguin.

The ultimate fate of the King Penguin, one of the more remarkable elements of the Island population, is still in the balance. The rookery at Lusitania Bay is the only community of these birds existing within the great sweep of Southern Ocean between Heard Island and Tierra del Fuego It now comprises about 5,000 birds,[20] a mere shadow of its former population.

When the Island was discovered there were in existence at least two very large breeding communities. That at Lusitania Bay was vastly greater than it is to-day, and at the North-End Isthmus there was a second, probably still greater, congregation of birds. Actually the Isthmus at the North End offers for these permanently resident penguins, geographical advantages over any other site on the Island, owing to the fact that the sea on both sides of the land is equally accessible. This same geographical feature has determined the Isthmus to be the chief base for all exploiters of the Island. This led to the early extermination of the entire community of King Penguins there located.

A. Hamilton, in his account[7] of life on the Island, states that a large King Penguin rookery was reported at the North End by Bennett in 1815. In 1820 Bellingshausen, who called at the North End but did not visit Lusitania Bay, describes landing amongst a dense population of King Penguins.

A. Hamilton, in 1894, and H. Hamilton, in 1911, both found masses of King Penguin bones buried under drifted sand on the Isthmus, supplying evidence consistent with the former existence of this King Penguin rookery. Probably within thirty years of Bellingshausen's visit, this entire community has been wiped out, for by the year 1820 fur seals were so scarce that the energies of the sealers were mainly devoted to the production of blubber-oil. Production of this oil, apart from that proceeding from the whale fisheries, was firstly obtained by the slaughter of sea-elephants, and secondly from the wholesale destruction of penguins. On account of its size, and because it is available in its haunts at all seasons of the year, the King, above all other species of penguin, has always been the first choice of the blubber-oil gangs. Consequently it is indeed fortunate that the bird has not been entirely exterminated.

At the time of Professor Scott's visit (1880) the rookery at Lusitania Bay was still on a grand scale. It was even so when A. Hamilton (1894) reached the Island. He stated that when anchored in 15 fathoms off Lusitania Bay, thousands of King penguins played around the ship. On shore nearly the whole of the Lusitania Beach, over 1½ miles in length,* and from the crown of the beach to the hills, was occupied with Kings packed so closely that there remained unoccupied only a space of about 1¼ feet in width† surrounding each bird. The total area of the rookery he estimated at 30 to 40 acres. At the time of that visit the blubber-oil gang was busy operating on Royal penguins, but there was observed a great heap of King penguin remains attesting their recent slaughter.

In 1895, when Bickerton[24] spent a short time with the sealers, there was still a very large King penguin population at Lusitania Bay, for he wrote of them: "When we reached the rookery the penguins were there in countless numbers." Bickerton's photograph looking inland across portion of the rookery shows a vastly greater concourse of birds than remained in 1911.

It must have been soon after Bickerton's visit that a great assault was made upon them, leaving only a remnant, which has been and still is in danger of

* The real Lusitania Bay Beach is nearer half-a-mile in length.

† This implies about 400 birds to the square chain, or 110,000 birds in the 30 acres.

complete extinction. Owing to the fact that only one egg is laid each year, this bird is very slow to increase its numbers. (See Falla's statement.[20]) Their rate of increase is also controlled by the sea-leopards and other enemies taking a constant toll of them.

At the time of our occupation (1911) the sealers had ceased to operate at Lusitania Bay, presumably because the number of penguins had been reduced to the point at which the further operation of the boiling-down plant ceased to pay. The attention of the blubber-oil gangs had then been turned to the hordes of Royal Penguins at the Nuggets Rookery. This, however, did not mean that the King penguins were to receive complete respite, for the sealers operating at the Nuggets continued to visit Lusitania Bay annually to collect and store for food large quantities of the eggs of the King penguin.

Taking Toll of the Royal Penguins.

Having slaughtered the King penguins to the stage when they were too few for further economic exploitation, the penguin oil industry at the Island then relied solely upon the smaller but very abundant Royal penguins, the centre of operations being at the Nuggets. There the gang operating for some years prior to 1911, and thereafter until 1919, levied an annual toll upon these birds of, say, 150,000 birds as a conservative estimate.[10 and 22] In 1912 Blake estimated the population of that rookery at 500,000 birds.[10] The numbers must have been reduced during succeeding years until the industry ceased, for in 1931 the population of the Nuggets Rookery was estimated by Falla[20] as only about 338,800 birds actually engaged in nesting.

Sea-Elephants and the Blubber-Oil Trade.

Though vast numbers of penguins have been slaughtered for their oil at Macquarie Island, yet the sea-elephant has always been the main base of the Island's blubber-oil industry.

Giving evidence in Sydney in 1821 before an official commission of inquiry into the southern sealing industry, Mr. Edward Riley stated that Macquarie Island was the greatest centre for sea-elephants in the Australasian region.

Periodically since then, as a result of over-slaughter, the sea-elephants have dwindled to small numbers. Doubtless these creatures would be extinct already at Macquarie Island but for the fact that they roam widely over the Southern Ocean, allowing replenishment from other distant Subantarctic islands, such as Kerguelen and Heard Island. Their severely reduced numbers of twenty-five years ago have been greatly augmented since the blubber-oil industry at the Island was terminated in 1919. This was apparent on the occasion of the visit of the "Discovery" in 1930, when we were delighted to find them again abundant.

Destructive Activities of Introduced Creatures.

Very serious agents in the destruction of the native fauna and flora have been certain creatures introduced by the sealers, the most devastating of which are cats and dogs. Bellingshausen referred to the destruction wrought by wild cats and dogs. Fortunately, the dogs died out in course of time, but a few wild cats are still to be found seeking cover in the petrel burrows. The rat is another introduced animal which must be responsible for considerable destruction among the eggs and young of the smaller birds. This pest exists in considerable numbers in the neighbourhood of old habitations of the sealers.

Rabbits are another very unnecessary and unfortunate introduction. They were brought there by Messrs. Elder and Nichol about the year 1880, being let loose at Lusitania Bay. As the climate is not well suited for them, they have not, thus far, overwhelmed the Island, though existing in considerable numbers on the east coast to the north of Lusitania Bay. In 1911–14 they were not seen on the west coast. Their depredations are mainly concerned with the extermination of Macquarie Island Cabbage and interference with the burrows of the petrels.

An introduction which has, to some extent, taken the place of the parakeets is the Weka or bush hen of New Zealand, These are now found in numbers in all the coastal areas, feeding largely on the pupae of the kelp-fly. They were already well established on the Island in the year 1890, but were not recorded by Inches Thompson[18] in 1878. Unlike the other introduced creatures, their continued existence on the Island does not appear to affect materially the welfare of the endemic life.

Pastoral and Agricultural Investigations.

With a view to ascertaining the further economic possibilities, experiments on the suitability of the Island for sheep, fowls, ducks and certain plants were made by Tullock during the year 1915. At the end of the year he submitted a report[25] on the results of these experiments. The results arrived at by Tullock considered in conjunction with our own experiments in 1911–14, indicate that sheep, if of suitable breed, such as Romney Marsh, can be acclimatised, and will grow good wool, lamb satisfactorily, and fatten on the tussock-grass and cabbage. The hens and ducks both laid reasonably well, the latter proving the better foragers so far as the native food is concerned. A few chickens were reared which in every case proved better fitted for life in the Island than the original stock. Also the island-born hens were the more prolific layers.

The Director of Agriculture, Hobart, supplied seeds and plants for experimental cultivation, but though no measure of success was recorded, I am of the opinion that certain useful domestic vegetables could be grown there if properly treated in well-sheltered areas. It is important, however, that if further experiments of this nature be prosecuted, the greatest care shall be taken to safeguard the Island from the introduction of parasites detrimental to the native flora.

Steps taken towards Conservation of the Island's Resources.

The first step taken towards regulating the killing of the animal population of Macquarie Island was contained in the Tasmanian Government's Fisheries Act of 1889. This prohibited the taking of seals of any kind without licence from the Tasmanian Government. Under this control, licensees under the Crown Lands Act occupied the Island for some years, killing without limitation any of the animals and in such numbers as they desired.

From 1915 onwards efforts were made by individuals[21] and organizations to put an end to such unregulated slaughter.

In 1918 the lease of the Island was cancelled by the Tasmanian Government and further exploitation of the animal population suspended.

About 1920 Sir Ronald Munro Ferguson (Lord Novar) interested himself in efforts to secure the transfer of the Island from Tasmanian to Commonwealth Government control, whereby it was anticipated greater facilities could be provided for maintaining it and policing it as an animal sanctuary.

About that time Sir William Allardyce, Governor of Tasmania, and later Sir Ernest Clark, Governor subsequent to 1932, actively investigated the problems of the Island and its welfare and submitted memoranda thereon to the Government.

In 1933 the weight of public opinion in Tasmania caused the Government to declare Macquarie Island a sanctuary for native animal life.

Conservational Suggestions for the Future.

Now for a policy in regard to the future administration of the Island. Already I have dealt with this matter in earlier publications[21, 22 and 23]. It has also been the subject of much consideration by Sir William Allardyce[27] and Sir Ernest Clark,[28] respectively in their official capacity as Governor of Tasmania. The more recent suggestions of Sir Ernest Clark are, in my opinion, a sound basis for the final implementation of a policy directed at the maintenance of the Island as a sanctuary for its endemic life and for the prosecution of scientific observations.

Whatever system of administration is adopted, it should provide not only for the complete protection of the native fauna and flora but all possible steps should be taken to repair the ravages of the past and to eliminate all introduced creatures except perhaps the Weka. There should also be considered the question of some reduction in the numbers of Skua Gulls, and Sea-leopards, both of which are predatory on the other creatures and whose numbers have, in the past, by the operations of the sealers, doubtless been unduly increased in proportion to the other elements of the community.

I am now of the opinion that both sheep-farming and the breeding of introduced fur-bearing animals would be a risky proceeding so far as the maintenance of the endemic fauna and flora is concerned. The breeding of fur foxes in effective enclosures, utilizing penguin and sea-elephant meat as food, is not unfeasible but it is well known that in a wet climate, the fur deteriorates and hair develops. A few sheep maintained in an enclosed area to serve the needs of an official resident party should be permissible.

To be sure to check all poaching there should be a resident officer at the Island, and it is suggested that he could be one of the party conducting scientific observations and communicating daily weather reports to Australia and New Zealand. Without jeopardizing the existence of the Sea-elephants, immediate revenue could be forthcoming from the slaughter of the surplus bulls for their oil; also the numbers of the Royal Penguins are such that some toll could be taken, either of the birds or of their eggs. Such exploitation as annually decided upon by the Board of Control could be executed either by members of the official party or by tributors operating, subject to royalty, under the direct supervision of the Resident Officer.

Future conservational developments on the Island will doubtless require power for heating, lighting, etc. For this need, cheap hydro-electric power could be provided in several localities utilizing the overflow from the more suitable lakes of the highland. From such, the existing rainfall would maintain a supply of about 75 H.P. (continuous) per square mile of suitable catchment at greater elevation than 550 feet above sea-level. Unfortunately the North-End, which is the best locality for a permanent station, is distant from locations where hydro-electric power can be cheaply harnessed.

PHYSIOGRAPHY

TOPOGRAPHY.

Macquarie Island may be conveniently described as a mountain range rising abruptly in cliffs directly from the sea or from narrow low-lying beaches (Plates VI & IX). These cliffs are partly, at least, the result of marine erosion, which has developed a marked wave-cut platform around the island. They vary in height up to 900 feet, but those of the western coast are much higher on the average than those of the eastern, and they also differ considerably in degree of slope, some of them being precipices and others just steep declivities. Those cliffs that have been protected from further marine erosion by the presence of raised beaches, have been reduced to the condition of steep slopes by the attacks of sub-aerial denuding agencies, and are now clothed by long rank tussock grass (*Poa foliosa*). The faces of these steep slopes are scarred by innumerable steep gullies which also are over-grown by this tussock-grass. In several localities there are waterfalls and cascades, some of which are 500 to 600 feet in height, precipitating streams over the cliffs on to the beach below.

As the result of a recent positive movement of the land in relation to the sea, portion of the wave-cut platform has been raised above sea-level.

As viewed from the sea, the sky-line of the land is so generally uniform as to be strongly suggestive of former planation, probably marine planation prior to the period of glaciation.

THE COAST TERRACE.

Thus a strip of beach, elevated above the sea, occurs on both sides of the island, and has its greatest development at Handspike Point, where it is a half-mile in width and has a maximum height of about 40 feet (Plate IV, fig. 2 and Plate XV, fig. 2). Commencing at the southern base of the North-End hill (Wireless Hill), this raised beach extends southwards for about one-third of a mile as an Isthmus joining the headland to the main portion of the Island (Plate I). From the southern end of the Isthmus it extends north-westerly around Hasselborough Bay to Handspike Point, and then trends due south down the west coast (Plate VIII, fig. 2) for a distance of 8 miles where it disappears, and only occurs in very small patches in two or three other localities on this coast. On the east coast this elevated beach occurs intermittently in narrow strips which do not exceed one hundred yards in width.

Blake remarked that its comparative absence on the south and south-west coasts may not indicate, as might be inferred, that the elevation is due to a

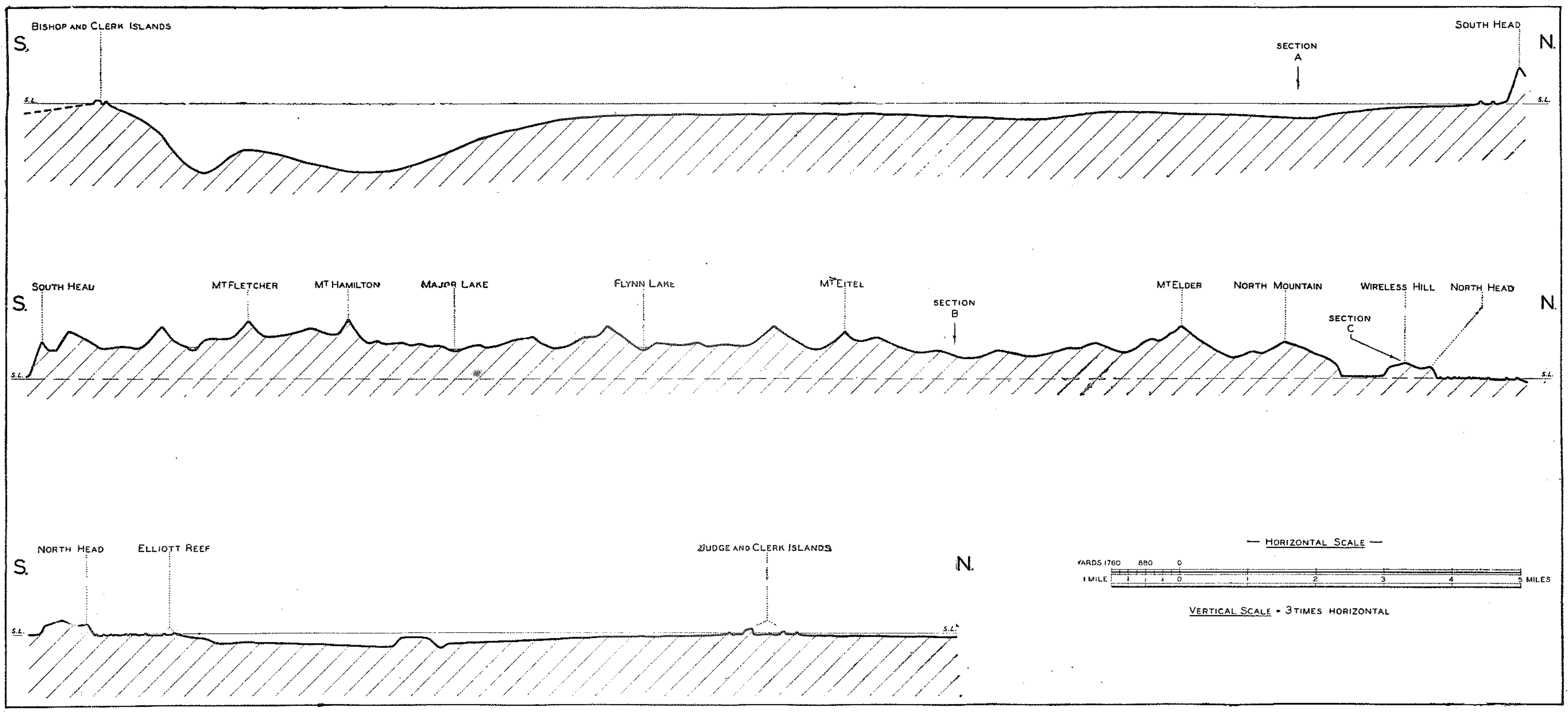

Fig. 18. Profile of the Macquarie Island Ridge from the Bishop and Clerk to the Judge and Clerk.

differential movement which has been considerably greater at the northern end, but is, possibly, to be explained by a more effective marine erosion in the south and south-west which could have caused the rapid removal of the beach terrace after elevation.

These raised beaches have everywhere become overgrown by peat-forming plants, and are now, for the most part, swampy morasses. In certain localities water has collected under this peaty covering, which is generally six to twelve inches in thickness, and walking upon it, imparts to the surface an undulatory movement which has earned for such occurrences the name of "Feather-Bed Swamp." Though the greatest elevation above sea-level of the old wave-cut terrace is about 40 feet, the height of the terrace has, since its elevation, been supplemented by debris washed down from the coastal cliffs during their disintegration and now reaches in many places on the west coast, a height of 50 feet. Sections cut into this elevated beach show layers of sand, pebbles, and cobble stones heaped together in hopeless confusion, and overlain by peat and tussock grass.

Several marine-eroded caves occur in the coastal cliffs around the Island. Their floors are from 10 to 15 feet above sea-level.

Blake's observations suggest that the rate of elevation of this beach terrace has been extremely rapid, so much so, that "had bench-marks been fixed by preceeding expeditions, a considerable increase might now have been registered." Evidence of rapid elevation exists in numerous places on the west coast, where wreckage covered by peat and overgrown by grass is to be found high and dry, as far as 300 yards from the water's edge, "and in such a position as to preclude the possibility of it having been washed there by heavy storms."

A bench-mark, in the form of a ring-bolt, was cemented into the face of the rock in Garden Bay, 8·96 feet above mean sea-level. This rock is situated on the beach. A reference plate, bearing the inscription B.M. over A.A.E. was also cemented into the rock (text-fig. 16) near the ringbolt and faces to the south-west (Plate XVIII, fig. 2).

Off-shore Sub-marine Profile.

Soundings made (see page 26) in the sea around Macquarie Island have demonstrated that both it and outlying rocks to the north and south are the exposed cap of an extended but narrow sub-marine ridge trending in a general north and south direction. Between North Head and the Judge and Clerk Rocks the crest of the ridge is nowhere greater than 30 fathoms below sea-level.

Looking north from North Head the ridge may be traced for a distance of 1 mile as a line of exposed and sunken rocks, known as Elliott Reef, at which point it disappears beneath the surface and is not again seen until at one half mile south of the Judge Islet where there is a submerged reef and an occasional exposed rock. In rough weather, the sea may also be seen breaking on a submerged reef to the north of the Clerk Islet and soundings obtained when crossing the ridge at $2\frac{1}{2}$ miles north of this Islet, showed a depth of only $16\frac{1}{2}$ fathoms. The Taylor and Iversen Shoals were reported still further north.

Beyond the southern extremity of Macquarie Island the crest of the submerged ridge continues through the Bishop and Clerk Rocks, beyond which, though still defined, it descends to greater depths. The Hjort Rise, distant 140 statute miles from Macquarie Island appears to be a feature definitely associated with the Macquarie Island sub-marine ridge.

The profile section (text-fig. 18) illustrates, by heights above and depths below sea-level, the crest line of the ridge between the Judge and Clerk and the Bishop and Clerk. It is probable that had the line of soundings between Macquarie Island and the Bishop and Clerk Islets been run a mile or two further to the west, the deepening of the crest line just north of the Bishop and Clerk would not have been encountered.

Cross-sections of the ridge illustrated in text-figure 19, show the sea-floor slope to be steeper on the east side, than on the west. It is to be observed that on the east side of the Island there is in general, a gradual slope from the shore to the 100 fathom contour, from where the grade rather suddenly steepens to a regular descent of about 1 in 2 and continues thus for about 10 miles or more to seaward. At $4\frac{3}{4}$ miles from the shore a depth of 1,548 fathoms was obtained.

Soundings off the west coast, except at the north end, are not sufficiently numerous to obtain a clear picture of the bottom contour adjacent to the Island. The soundings taken on that side of the Island do, however, demonstrate that the ocean bottom there lacks the regularity of the eastern side, and shallow water extends over a wider area. Blake believed that the latter is well accounted for by the power of the westerly seas to erode a wide wave-cut platform on that side of the Island. From the shallow coastal waters at the north-west corner of the Island the sea floor descends steeply to 1,520 fathoms.

As the main rock formations of Macquarie Island are overwhelmingly of an igneous nature it is possible that this sub-marine ridge is, in fact, fundamentally an igneous accumulation rising above the general floor of the sea. However, there is evidence, for instance the folding of rocks of the Older Basic Group, that the structure is not so simple. Because of the regularity and steepness of the adjacent sea floor, illustrated in the cross-section of the ridge, and in view of the linear regularity of the ridge it may be and probably is orogenically of the nature of a horst block. This matter will be dealt with more fully at a later stage.

The Highlands.

The upland surface of the Island consists of flats and low rounded spurs and hills, studded with innumerable lakes and tarns, the whole drained by numerous well-defined streams (Plate II). At an early stage of his investigation, Blake found evidence that the highlands had, in recent times, been capped with ice, glacial erosion being evidenced everywhere.

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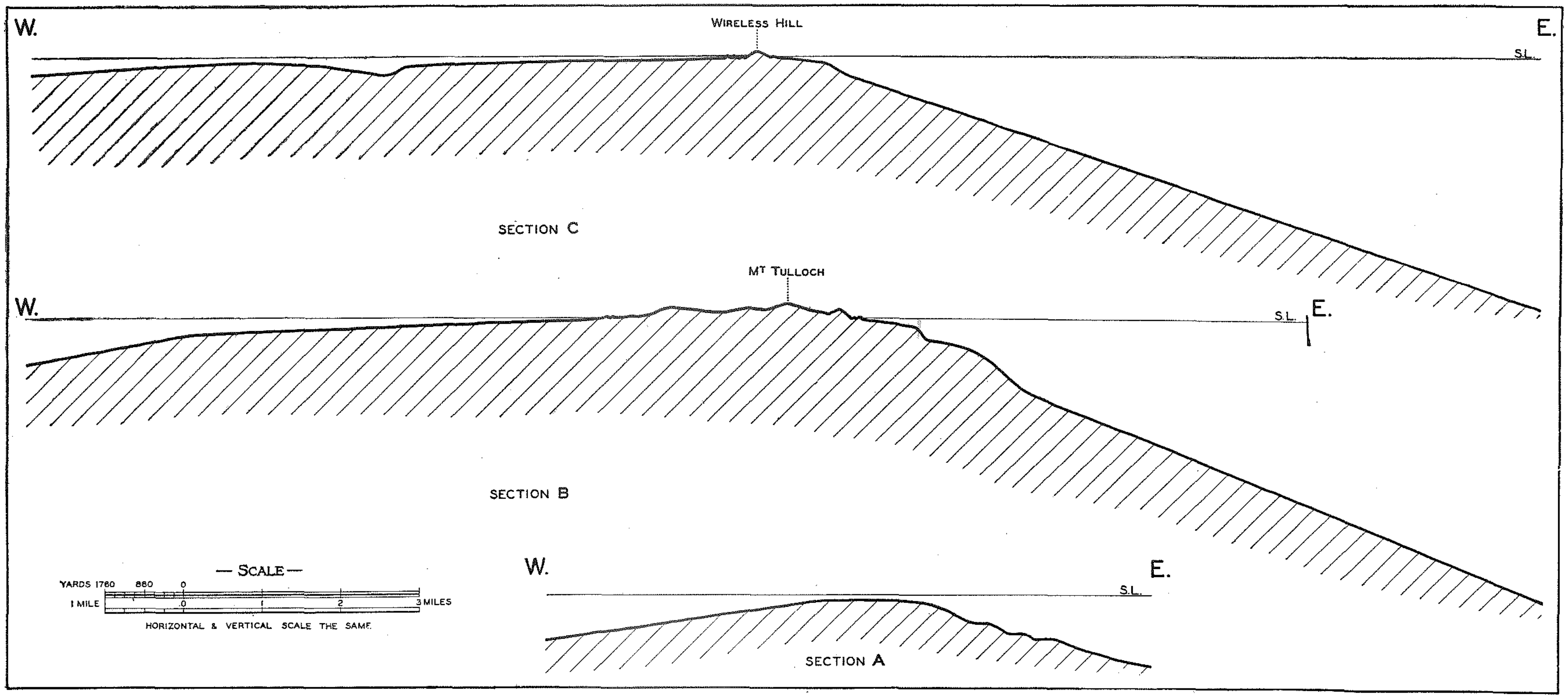


FIG. 19. Profile Sections across the Macquarie Island Ridge.

Pre-Glacial Features.

Blake also reported traces of pre-glacial* topography visible in the form of wide, flat-bottomed valleys which drained easterly and westerly from a low watershed that occupied the same site as the existing one. He held that evidence showing that these pre-glacial valleys reached a fairly mature stage is found in the flat grades of valleys and the low elevation of the watershed above them. The beds of these old valleys which occur at elevations ranging from 50 to 400 feet, would not, in most cases, if they be continued at the same grades, reach the present sea-level for some considerable distance from the shore.

Blake's report further states that " this evidence lends colour to the theory that the island was much more extensive in pre-glacial times. On the west coast, a restoration of some of the topographic features of this old land may be made with little difficulty. A careful survey of the slopes on that side of the watershed reveals the fact that the spurs running westward are all heading towards the rocky capes and reefs which form such a notable feature on that coast. These spurs, which now stop short at the cliff edges, originally continued in a westerly direction as long sloping ridges and their remnants may now be seen as rocky reefs extending seawards and as high upraised sea-stacks on the elevated beaches between the cliffs and the sea. The old valleys draining westward are apparently related to the openings occurring between these rocky capes and reefs."

" No similar evidence can be seen on the eastern coast except in the two spurs at Nuggets and Brothers Points. If the beds of the old valleys on this side of the island be produced at the same grades, several of them will not reach sea-level on the marine bench and certainly will not intersect the steep, sloping, off-shore sea-floor. This fact supports the suggestion that the steep slope off the eastern coast of Macquarie Island is in all probability a fault scarp."

Whilst Blake's argument is sound for the east coast there is nothing contravening the probable existence of faults marginal to the land on the west side of the Island though the throw has probably not been so great there.

Glacial Features.

Abundant evidence is presented later in this volume demonstrating that the Island has been overridden by a not inconsiderable ice-sheet in comparatively recent times. In addition to an almost ubiquitous covering of boulder clay the highlands exhibit all the usual topographical features of glaciation. (Plate III.)

In the case of certain wide-bottomed valleys, Blake held that their history was that of mature pre-glacial valleys subsequently modified by glaciation. He states that these have rock terraces running parallel to their length, carved by ice out of the higher levels, giving the valleys a distinctive cross-section profile. Such terraces are usually one or two in number, possibly suggesting the work of successive glaciations.

* It is doubtful whether any trace of pre-glacial topography remains except, perhaps, evidence of former peneplanation.—D.M.

Some cirque-like features are clearly defined in Blake's topographical map, and he reported that in the vicinity of Island Lake there are several cases of streams issuing by falls from hanging valleys. A case in point is located on the western highlands opposite Nuggets Point. There a creek commences near Island Lake, and flows southwards in an old valley at a grade of 1 in 16 for a distance of three-fifths of a mile, at which point it suddenly plunges in waterfalls and cascades for a depth of 260 feet through a narrow V-shaped gorge. After flowing through this gorge for 600 yards, it reaches an open flat, where it is joined by its main tributary. Originally this stream joined what is now its main tributary by a sheer fall situated at the lower end of the present gorge, which latter has been all carved out by headward erosion of the stream since the disappearance of the ice. (Fig. 20.)

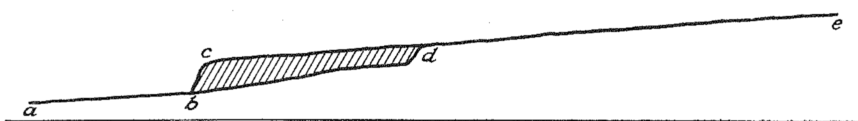


FIG. 20. Illustrating the recession of a hanging valley to the west of Mt. Elder. (*a–b*) Grade of lower valley; (*b–c*) Original position of waterfall; (*d–e*) Grade of Upper valley; (*d–b*) Grade of falls and rapids between upper and lower valleys.

BED-ROCK STRIAE

The greater portion of the surface of Macquarie Island being covered either by Till or peat, evidence of glaciation in the form of bed-rock striae is of rare occurrence.

A small area of volcanic breccia, only a few square yards in extent, is exposed below the Till near Nuggets Point, and well-defined striae, striking E. 5° N., are exposed; the rock showed signs of having been well polished prior to weathering.

The small roche moutonnée of dolerite half a mile north of Island Lake was also observed to be scored with striae, which were seen as faint scratches directed towards E. 10° N.

One mile north-north-east of the same lake, bed-rock striae were seen on a small area of gabbro exposed below boulder clay. Here the striae have a direction of almost due north, this departure from the easterly direction apparently having been caused by local topographical considerations. In this locality a mass of rock, having an area of about 100 square feet, was observed in the bed of a V-shaped gorge having fallen, after being undermined, from the top of the cliffs above. The surface of the rock, which is harzburgite, was observed to be well polished and marked with very fine striae.

Though outcropping rock faces showing glacial striae are infrequent, yet all the hills of the highland show unmistakable evidence of having been overridden by ice, for they almost all present long gradual slopes to the west-south-west and steep faces to the east-north-east, the result of erosion by an ice sheet advancing from the west-south-west. (Plate XIX, fig. 2.)

ROCHES MOUTONNÉES.

Characteristic round-backed, ice-worn rises are to be observed in a number of localities in the highland area. In all cases the surface of these rocks is much weathered owing to the coarse texture of the rock, consequently striae have, with few exceptions, disappeared.

This feature of glaciation may be seen at its best in the gabbro outcrops immediately north of Island Lake (Plate XXVI, fig. 3). The rock is reported by Blake to be a coarse crystalline norite, and although it has lost its polished surface through weathering, it still retains the characteristic ice-worn form, from which the direction of the movement of the ice was determined to be about E. 20° N.

At half a mile north of the same lake a single roche moutonnée of dolerite occurs, and has on its surface striae bearing in a direction of E. 18° N. On the northern slopes of a valley one-third of a mile north of Mt. Hamilton there are several ice-worn hummocks whose appearance indicates that the ice-sheet had also an easterly movement in this locality. Near the margin of a small rock basin between Mt. Hamilton and Mt. Aurora, there are several roches moutonnées which have also an easterly trend. (Plate XIII.) Several small rock hummocks occur in the highlands west-north-west of Green Valley, and though weathered considerably are undoubtable roches moutonnées.

LAKES AND TARNS.

Numerous lakes and rock basins whose origin is intimately associated with glaciation were found by Blake to occur throughout the Island. In aggregate surface area these are approximately 1 square mile. They vary from mere shallow tarns filling moraine-dammed depressions in the Till to deep rock basins of some considerable size.

The largest of the rock basins is Major Lake (Plate XVI, fig. 4). It is located at a height of 644 feet above sea-level, and extends in an irregular shape over an area of 113 acres. Its longitudinal axis is parallel to the direction of ice movement, which was here E. 30° N. Blake reported that: "This lake has no visible outlet, its surplus waters being drained off at its south-western end by soakage through peat covering a flat which is on the same plane as the normal level of the lake. The west coast cliffs have been cut back to within 5 chains of this lake. The eastern and northern sides are bounded by steep slopes and ridges from which a prominent ice-worn bluff or headland stands out into the lake. At its extreme northern corner a stream enters, which brings the water from another small rock basin situated at an elevation of 50 feet above Major Lake. The occurrence of the steep ice-worn headland, and general appearance, suggest that Major Lake is of some considerable depth."

"The next lake in point of size is Flynn Lake, covering an area of 72 acres, situated at an elevation of 682 feet above sea-level, $2\frac{1}{2}$ miles west-south-west of Green Valley. It is of no definite shape, and it is almost entirely surrounded by steep ridges which culminate in a bold ice-worn hill, Mt. Waite. An outlet occurs at the western end, from which a shallow creek flows for a short distance before plunging as a waterfall over the precipitous cliffs of the west coast."

" Island Lake, although covering an area of 67 acres, is a shallow depression in the glacial drift which occupies the head of an old valley that formerly drained in a southerly direction. The drainage from the western and south-western slopes of Mt. Elder, as well as that of the intervening country, flows as a well-defined creek into the south-east side of the lake. Its outlet is from the extreme northern end, where a channel has been cut through the low ridge, which originally formed the old divide. A section, 10 to 20 feet in height, exposed in the southern bank of the lake, is composed solely of horizontally stratified fine sand and silt. A narrow sandy spit or bar completely bridges the lake towards its eastern or lee side. This bar (Plate XXVI, fig. 2) has been formed by the deposition of sediments from the inflowing waters assisted by the dredging action of drifted ice during the winter season."

" Waterfall Lake is situated $2\frac{1}{4}$ miles south-south-west of the landing-place in Lusitania Bay, at an elevation of 570 feet above sea-level (Plate III, fig. 2). It covers an area of 62 acres, and has an elongated form concave to the south-south-west, which appears to be due to gouging by the ice-sheet along two joint planes intersecting at a wide angle. The ice-worn rock banks of this lake are very steep, and give it the appearance of having great depth. It has an outlet at its western end in a small creek which flows over a precipitous cliff 570 feet in height. A large glaciated dome, 100 feet in height, occurs on the southern bank of the lake near its outlet."

" Prion Lake (Plate XVI, fig. 2) has an elongated form which lies approximately at right angles to the direction of the former ice movement, and has originated by plucking along a joint plane of the underlying rock formation. It is situated $1\frac{1}{2}$ miles south-west of Brothers Point at an elevation of 560 feet, and covers a surface area of 67 acres. The banks are very steep, rocky and ice-worn. This lake has no present outlet, but an old water channel occurs at the northern end about 15 feet above its present water-level, through which the waters formerly drained into Flat Creek."

A typical example of a small rock-basin is illustrated in Plate XIX, fig.1. This lake is situated about half-way between Mt. Hamilton and Mt. Aurora, at an elevation of about 1,000 feet. Roches moutonnée are developed on its edge, and a stepping-down in topography of 80 feet occurs on its eastern side.

The commonest form of rock basin is stated by Blake to be that of Prion Lake, which has its longitudinal axis approximately perpendicular to the direction of ice movement. This form of lake has been caused by the overriding ice-sheet plucking the rock material away on the lee side of the numerous joints which traverse the rocks of the Younger Basic Group. (Fig. 21.)

The shallower lakes are merely depression in the Till (Plate III, fig. 1). Such generally occur as tarns and small shallow lakes, which are often overgrown by peat-forming plants, so that their former sites are now marked only by swampy morasses through which the streams meander. Island Lake, which is the second largest lake on the Island. is in point of size a notable exception among moraine-dammed lakes.

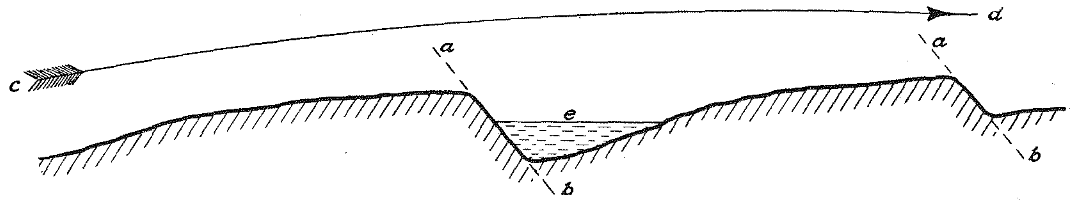


FIG. 21. Section illustrating the formation of certain of the lakes through "plucking" at joints. The lines *a–b* mark joint planes; *c–d* is the direction of ice movement; *e* is the resultant lake.

Blake's report states that "The majority of the lakes are drained by gullies and creeks, but several exist which have no surface outlet, and apparently lose their surplus water by evaporation and underground soakage. This type of lake has small strand lines or elevated beaches up to 15 feet above present water-level, which rather suggests that the annual rainfall was much greater in former times than at present. Major and Prion Lakes have these lines of higher water-level, and an old channel about 15 feet above the present water-level may be seen leading from the latter lake into Flat Creek."

It was found impossible to make a bathymetrical survey of any of the deeper lakes, or even to obtain any soundings, for an ice covering sufficiently thick to bear weight was not formed on any of them during the Expedition's sojourn on the Island.

EROSION.

MARINE EROSION.

Macquarie Island must suffer marine erosion to an intense degree. This has resulted in a well-developed wave-cut bench. Owing to the recent uplifting movement, the attack of the waves is now mainly confined to reducing the shore terrace and further recession of the cliff faces is in progress only in unprotected areas.

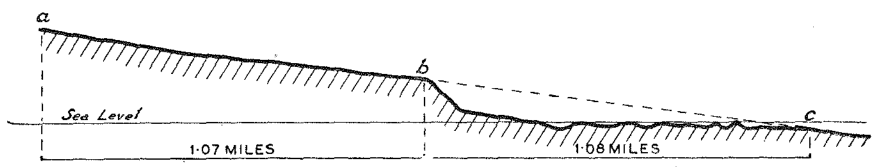


FIG. 22. Section according to Blake along the grade of Flat Creek (*a–b*), and showing its probable former extension seawards (*b–c*), and also indicating the amount of marine erosion in that locality.

In this matter of marine erosion, Blake wrote: "The wave-cut bench extends seawards on the eastern side of the Island to about the 25 fathom contour, but no depth has been ascertained regarding its limit on the western side. With the erosion of this bench, shore cliffs were developed; these are often as much as 800 or 900 feet in height. In certain localities tillite is exposed in the cliff faces, which fact indicates that the culmination of the cliff-cutting process was in late-glacial or post-glacial times. That the wave cutting of the terrace was comparatively rapid is attested by the size and abundance of sea-stacks scattered over it." (Plate IV, fig. 2.)

"Those cliffs which are flanked by the elevated portions of the marine bench have been reduced to steep slopes by sub-aerial denuding agencies; in those which have not been reduced in this manner, numerous small caverns are to be observed. The encroachment of the sea is greater opposite those lower portions of the land which represent, in most cases, the sites of old pre-glacial valleys, while the high-projecting bluffs or headlands represent the old divides between those valleys. The erosion of the cliffs by wave action still occurs in a few localities confined to the southern and south-western coasts. The highly-jointed rocks composing the main mass of the Island are suitable materials for speedy erosion by wave-action."

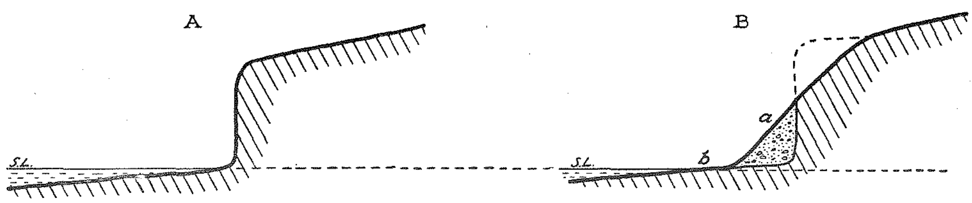


FIG. 23. Blake's sketch section of the west coast cliffs illustrating the reduction of precipices to steep slopes by sub-aerial denudation after elevation which developed the raised beach.

A.—Before elevation: B.—After elevation. (*a*) talus; (*b*) raised beach; S.L. indicates sea level.

In his notes Blake does not consider the possibility that faulting has contributed to the development of some of the steep faces bounding the Island. Nevertheless, this appears to be a distinct possibility in view of the remarkably linear character of the coast line on both the east and west sides. Further, in support of this probability is the fact that the rock collection contains slickensided crush-breccias from localities on both the east and west coasts. Such fault lines may traverse portion of the rock-cut platform, or may be entirely beneath the sea in the marginal waters.

FROST ACTION.

On this subject Blake wrote as follows: "Of the subaerial weathering agents now in operation, frost is perhaps the most important factor. The steep shore cliffs, of highly-jointed rocks have suffered very severely by the attacks of this agent, but its effects are not so noticeable on those still subject to wave action as on those protected by raised beaches. In the latter case the rock material quarried from the face of the cliff forms a talus cone, resting on the raised beach below, and there acts as protection against further sapping of the foot of the cliff. These cones grow continually as the head of the cliff recedes, and when they have reached the same angle of slope as that of the cliff above, the downhill movement of the debris becomes sufficiently reduced to allow the coarse peat-forming tussock-grass to take root. This grass grows with great rapidity, and soon covers such slopes with a protective covering of peat which thereafter reduces the rate of erosion."

"The coarser material from the Till which has been exposed at the surface by the action of running water, has also been attacked by frost and reduced to the state of fine chips. The narrow V-shaped gorges cut in the cliffs near the mouths of the various streams are being continually widened by frost action."

Solifluction.

Blake remarks as follows: "The continuous precipitation of moisture, in the form of mist, rain and snow, to which the island is subjected, keeps the surface soils in an almost complete state of saturation. This saturated soil, especially under the influence of repeated freezing and thawing, has a tendency to creep downhill, even on low grades, and by this means it is carried to the valley bottoms, where streams then transport it to the sea. The mantle of recent Till which covered the upland region has been considerably reduced in volume by this process of solifluction (Plate XIX, fig. 2). More especially have its finer constituents been removed for some depth, leaving the coarser material exposed to the action of other denuding agents. The upland surface of the island, especially after a long continued period of mist and rain, presents the appearance of a ploughed field viewed from a distance. This phenomenon is due to the grit and other fine material from the disintegrated till, being drawn out by the action of this surface flowage into long straight lines or furrows parallel to the slope of the ridge on which it is resting. In a few localities the finer material has not completely disappeared, and when saturated it forms a pasty mud incapable of supporting vegetation. This mud is of such density that it will easily carry on its surface boulders of three and four inches in diameter. Though still influencing the denudation of the surface of the island, solifluction cannot be regarded as so important in this respect at the present day, as most of the fine material in the surface soil has been transported to the coast."

Wind Action.

During heavy westerly gales, the wind carries sand and small pebbles from the beach up the steep slopes and cliffs. This windborne sand and gravel abrades the peat, and undermines and finally strips off the covering of tussock-grass near the cliff edges (Plate XX, fig. 1). Once this is accomplished, the underlying boulder-clay and soft rocks are rapidly denuded.

Blake mentions that in some exposed localities the windward faces of large boulders lying on the upland surface have been carved by this agent into fantastic shapes (Plate XXIX, fig. 4).

The Activities of Birds as Denuding Agents.

Birds on Subantarctic islands where vegetation is limited must be considered denuding agents of no mean importance. The vast throngs of penguins at their breeding-grounds destroy the herbage and expose the underlying peat and soft rock material which is quickly swept away. These exposed areas occur from sea-level to a height of 600 feet. One of these rookeries covers an area of 16½ acres, and the combined area of hundreds of such places, both large and small, represents a considerable extent of ground. On Rookery Creek, near Nuggets Point, tracks leading from one rookery to another across a small valley moraine, have in places been cut down to a depth of 5 feet below the surface.

A peculiar and somewhat unique feature was observed on the faces of a number of moraine boulders found in penguin rookeries, and along their lines of march. The Royal penguin rookery at the Nuggets is a case in point. There birds form a continuous procession, moving in both directions between the rookery areas and the sea for about six months of the year. The effect of the ceaseless passing of millions of their feet over a period of at least hundreds of years has resulted in polishing the exposed face of boulders lying along these tracks and in the rookeries. In the case of large erratics of partly-serpentinized harzburgite set in consolidated boulder-clay, where the rock faces present a fairly high angle to the progress of birds marching to the rookery the rock face is also deeply scored with polished grooves (Plate XXVIII, fig. 1). These are cut in the softer serpentine by the claws of the penguins scrambling up the polished face.

Vast numbers of burrowing petrels of many species breed at Macquarie Island. In some areas, acres of ground are riddled with their burrows, resulting in the destruction of much of the turf. This allows the high winds in exposed places to undermine the rest of the herbage, eventually removing it and the soft underlying weathered rock matter.

Running Streams.

The numerous streams which drain the Island are permanently flowing, but, owing to their small volume and through the lack of material sufficiently fine for transportation, they have no great erosive powers, except where the grade is steep in the final fall to the sea.

Blake states: "The waterfalls at the cliff edges are gradually receding inland, and in so doing are being reduced to cascades (Plate XVI). Those streams that are no great height above the sea have completely regraded their beds, and in others the waterfalls have given place to steep cascades, which plunge downwards through narrow gorges. The water in these streams is generally crystal clear, only becoming turbid after unusually heavy rain. On the beach below the mouths of numbers of the streams large, flat, deltaic talus cones occur containing material which, in size and weight, is far above the present transporting powers of these streams. This material consists of large angular blocks of rocks, with striated boulders and other finer debris. The large blocks of rock have been quarried off the face of the steep gorges through which the streams flow, and the striated boulders have been transported from the uplands. The occurrence of this heavy material suggests that the streams had a larger volume in comparatively recent times."

However, this effect could be produced by rare and quite exceptional events, such as catastrophic rains, or the temporary damming of the upper courses of the streams by winter freezing and subsequent release.

Rejuvenation of Streams.

The recent rejuvenation of existing streams is attributable to two distinct agencies. The first and more marked stage of this process was consequent upon either the recession of the coastal cliffs as the result of marine erosion, or cliff face development by faulting and block uplift. The truncated creeks were thus rendered precipitate at the seaward end of their courses. The second stage of rejuvenation is the recent uplift of the land, which developed the raised beach terrace.

The streams are now busily engaged in regrading their beds. As the waterfalls recede inland, steep V-shaped gorges are being cut through the coastal cliffs and the courses of the streams degenerate into cascades. Between their sources and the sea, the streams flow over various grades which are separated by numerous topographic unconformities.

Blake supplies a description of the bed of Nuggets Creek, serving as a type to illustrate the diverse grades of these young streams. "This stream has its source on the slopes of a hill 881 feet in height, and commences to fall at a grade of 1 in 5. It is gradually reduced to 1 in 15 as it approaches a glacially eroded flat. After flowing for a distance of 500 yards over this flat at the same slope, it suddenly plunges through a steep narrow V-shaped gorge at a grade of 1 in $2\frac{1}{2}$, and continuing thus for a distance of 265 yards; it then debouches on the flat of an old valley, choked with glacial Till. The stream has cut a channel through this Till, and after flowing at a grade of 1 in 12 for a short distance, gradually flattens as the sea is approached."

GEOLOGY

BLAKE'S GEOLOGICAL MAP.

Prior to the operations of the A.A.E. (1911) very little was known of the geology of Macquarie Island. The only record from a visiting geologist is that of H. T. Ferrar[32] who, as a member of the British National Antarctic Expedition, landed at Lusitania Bay for several hours in 1901. He collected specimens of basalt and dolerite, which were described[32] by G. T. Prior. Dr. Prior's report concerning the several specimens examined states : " The basalts from Macquarie Island . . . . are much more altered than the rocks of the Auckland Islands, and appear to be of a greater age. The more coarse-grained rocks are diabasic in character, and consist of a medium-grained aggregate of feldspar laths, colourless augite (sub-ophitic), large magnetite grains, sparingly distributed, and interstitial green chlorite and hornblendic alteration products. The rock from 100 yards up the stream shows large phenocrysts of labradorite and a few chloritic pseudomorphs after olivine. The " crushed rock " is a much-altered andesitic basalt showing large phenocrysts of labradorite in a very fine-grained altered base."

Odd specimens collected by visitors[31] had all proved to be igneous. It developed upon Blake, therefore, to prepare a geological map of what was really a virgin field. In this he has achieved a large measure of success, but, in the almost complete absence of fossiliferous strata, the job must have been rather unattractive to one not specialising in igneous petrology.

The broader features of Blake's field observations are incorporated in his geological map. He distinguishes three divisions of igneous rocks, so divided on the basis of relative age. The only sediments indicated on the map are recent (post-glacial) accumulations on the raised-beach terrace. It is a good feature that in this small-scale map he has ignored the widely distributed veneer of glacial and fluvio-glacial deposits and the bog peat occupying some of the depressions of the highlands.

The rock collections are mainly from the north end of the Island, with a small group from the neighbourhood of Lusitania Bay. Thus a large region south of Brothers Point is but sparsely represented by specimens available for microscopic study. That this is so is partly owing to the fact that a considerable collection made in the central areas of the Island, which was labelled and stored at the Sandy Bay Hut, was destroyed when the hut was accidentally reduced to ashes by a fire which occurred during Blake's absence late in the second year of occupation. However, notwithstanding that loss, it is unlikely that any important petrological novelties are unrepresented in the collection for, had such been met, Blake would almost certainly have commented upon them in his notes.

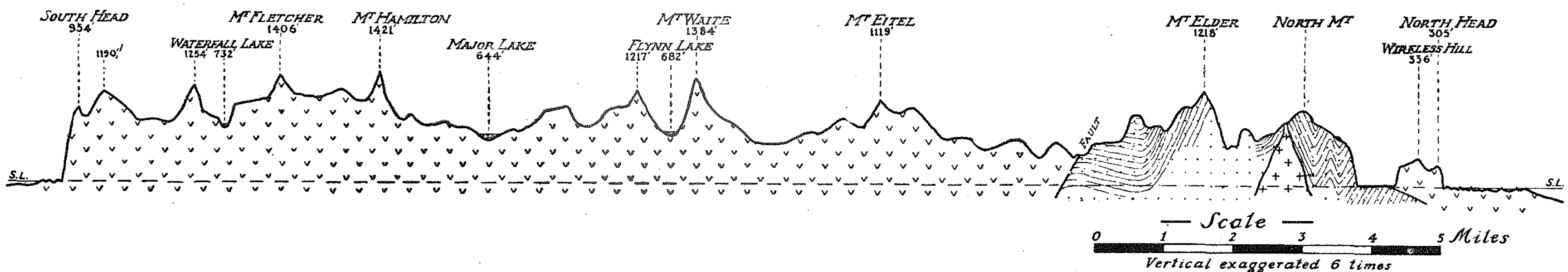


Fig. 24. Longitudinal Geological Section through Macquarie Island.

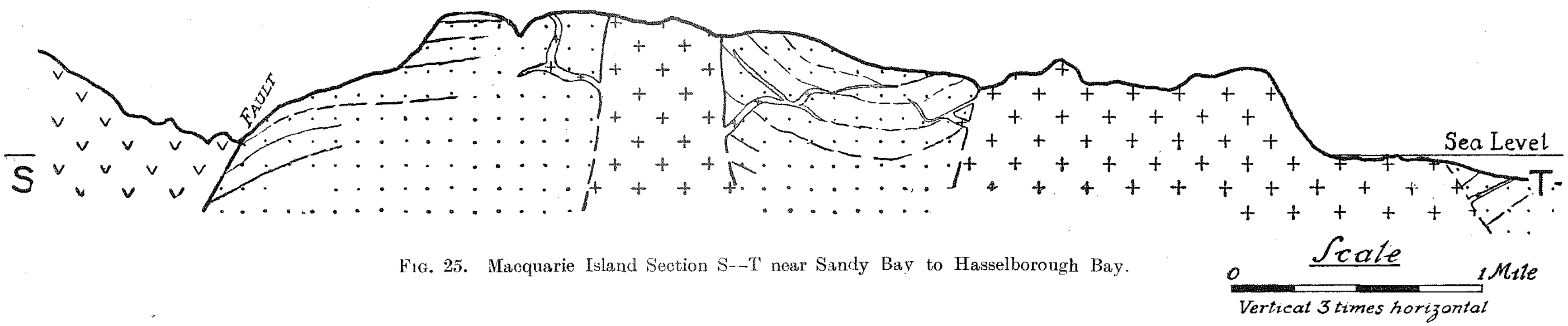
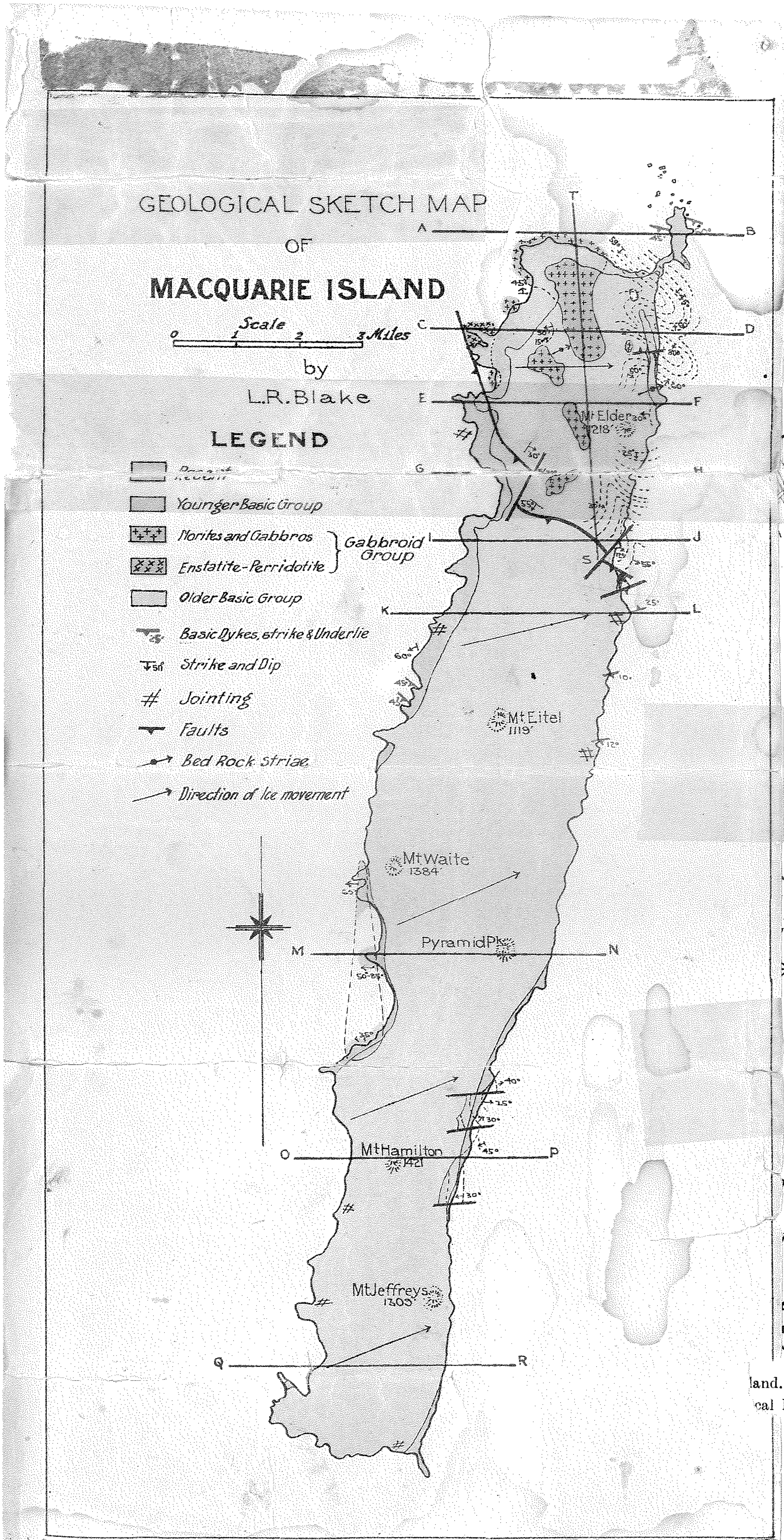
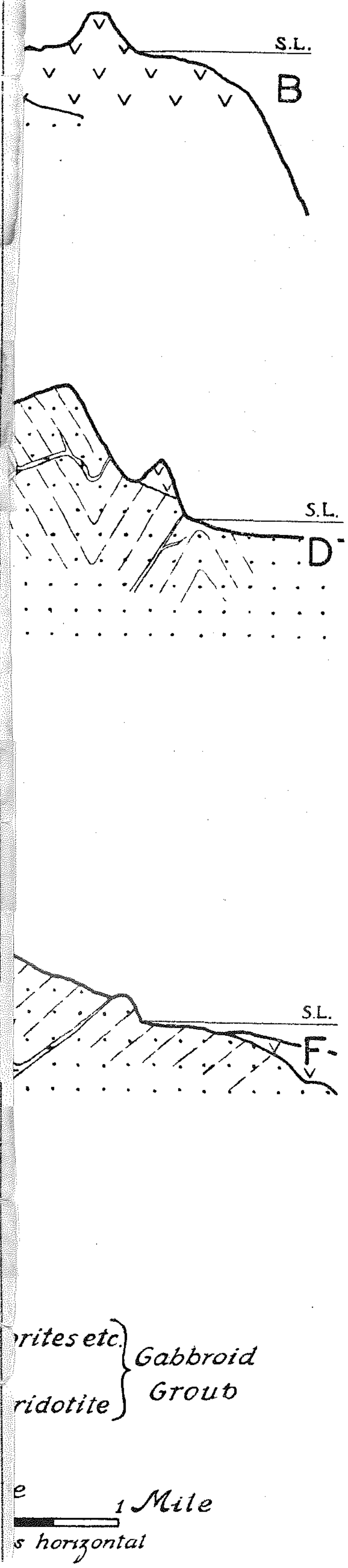


Fig. 25. Macquarie Island Section S--T near Sandy Bay to Hasselborough Bay.

Figs. 24 & 25. Geological Sections through Macquarie Island. (Location of Lines of Section shown in Geological Map) (Frontispiece).


GEOLOGICAL SKETCH MAP
OF
MACQUARIE ISLAND
Scale
0 1 2 3 Miles
by
L.R. Blake
LEGEND
Recent
Younger Basic Group
Norites and Gabbros
Enstatite-Perridotite
Gabbroid Group
Older Basic Group
Basic Dykes, strike & Underlie
Strike and Dip
Jointing
Faults
Bed Rock Striae
Direction of Ice movement
Mt Elder 1218
Mt Eitel 1119
Mt Waite 1384
Pyramid Pk
Mt Hamilton 1421
Mt Jeffreys 1305


S.L.
B
S.L.
D
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F
rites etc.
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Gabbroid Group
1 Mile
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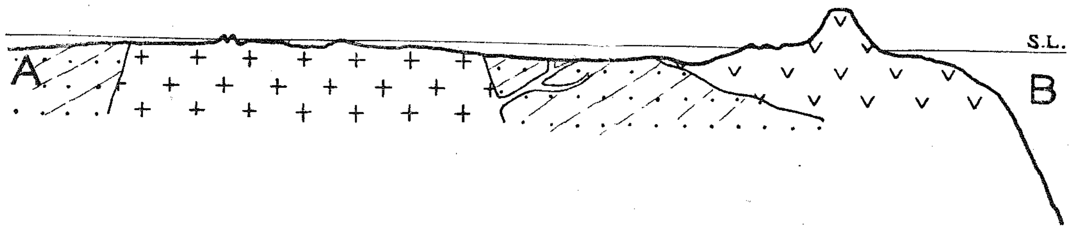


FIG. 26. Section A—B.

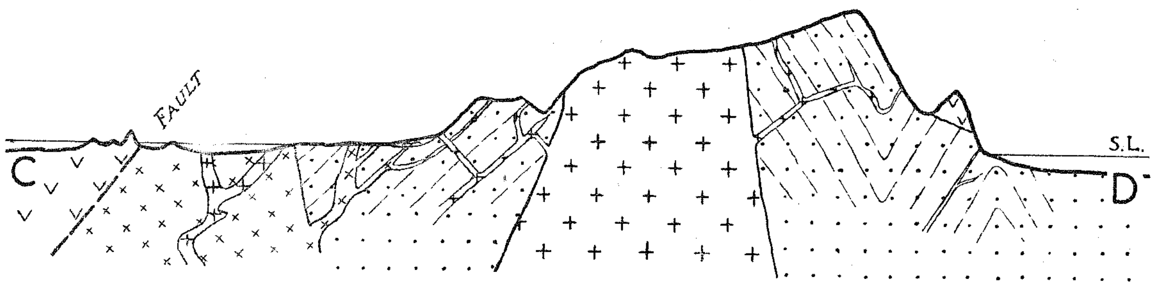


FIG. 27. Section C—D.

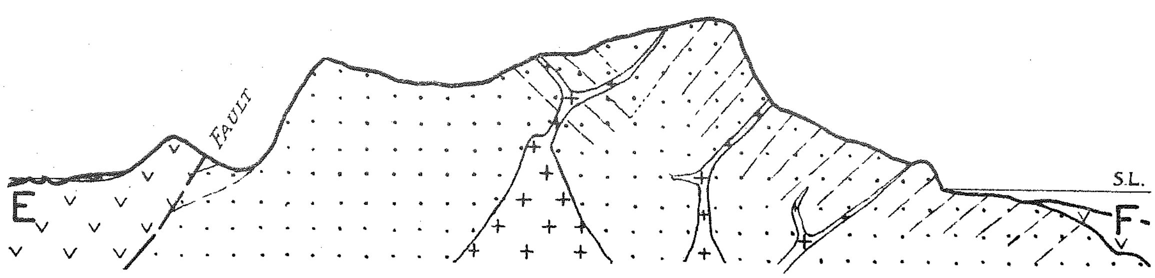
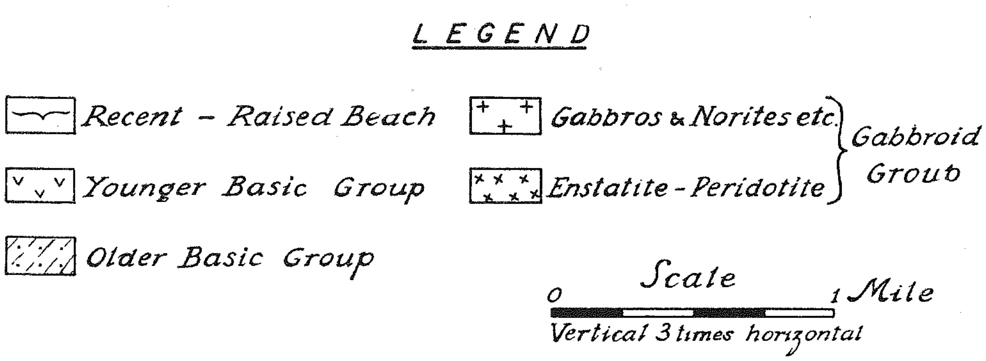


FIG. 28. Section E—E.



Geological Sections through Macquarie Island.
(Location of Lines of Section shown in Geological Map.)

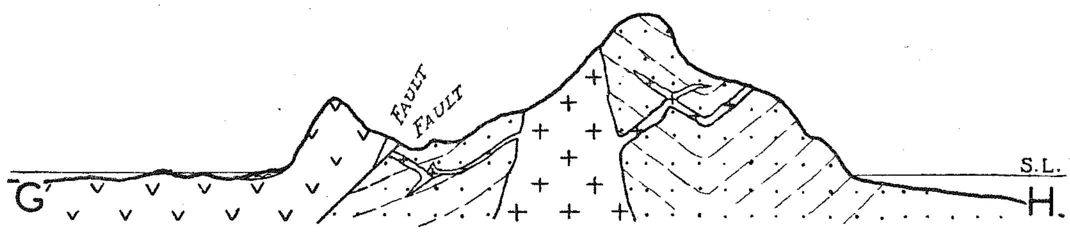


FIG. 29. Section G—H.

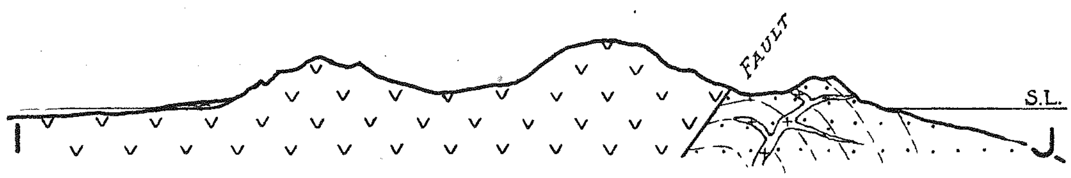


FIG. 30. Section I—J.

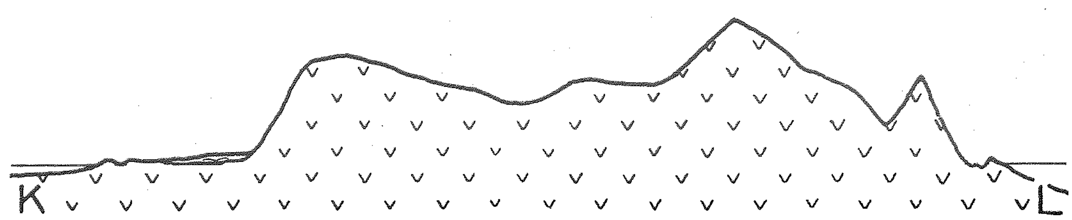
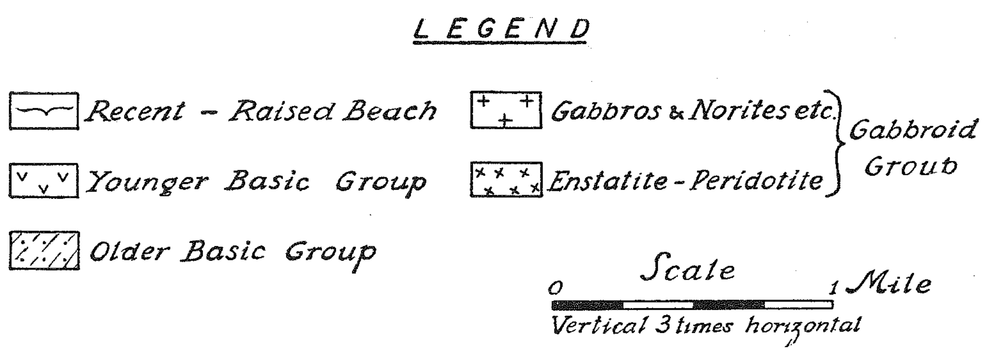


FIG. 31. Section K—L.



Geological Sections through Macquarie Island.
(Location of Lines of Section shown in Geological Map.)

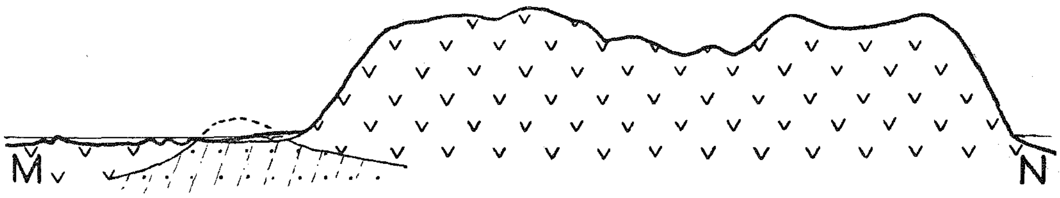


FIG. 32. Section M—N.

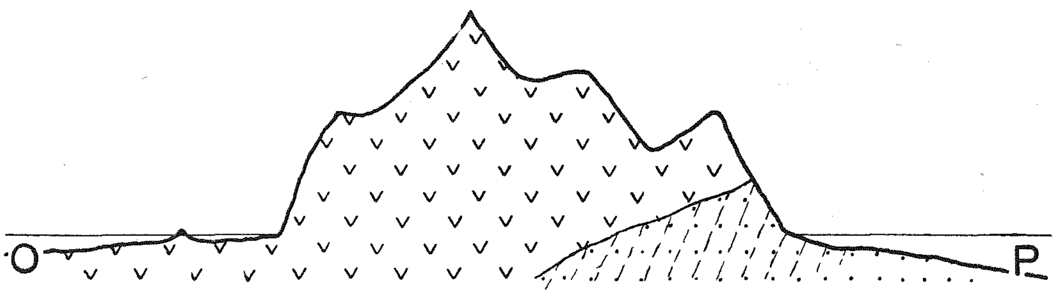


FIG. 33. Section O—P.

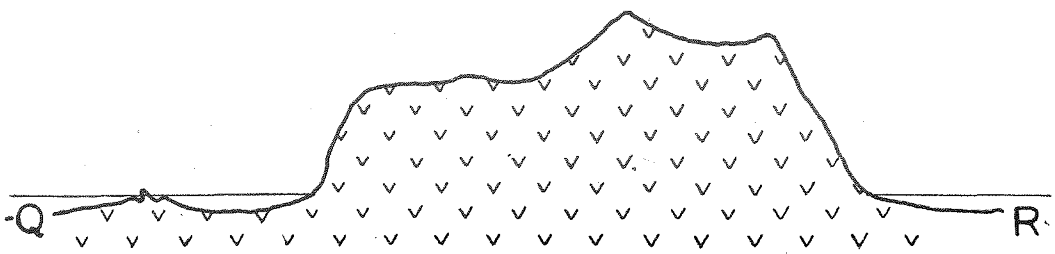
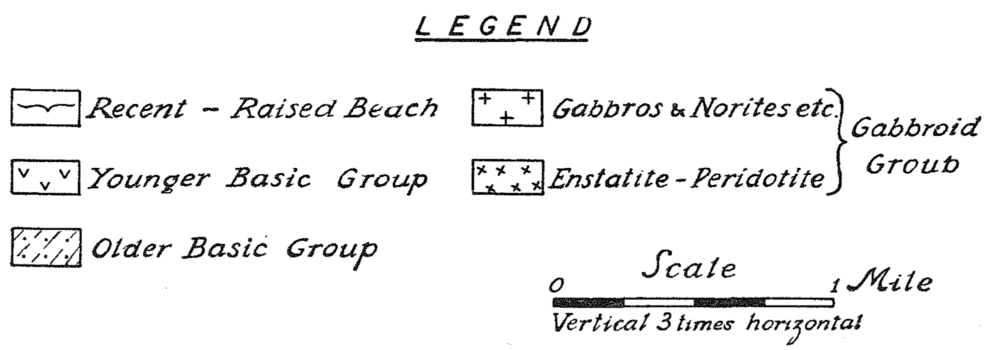


FIG. 34. Section Q—R.



Geological Sections through Macquarie Island.
(Location of Lines of Section shown in Geological Map.)

OROGENY.

Soundings have shown that the Macquarie Island Ridge is a major feature of the submerged lithosphere in the region between the New Zealand platform and South Victoria Land in Antarctica. It has now been traced, though broken, for a length of about 250 miles. When more is known of the ocean floor in that region it may be found to extend further.

There is no evidence of volcanic effusions in the geologically recent past, though in earlier times it was the locus of marked volcanic activity. Nevertheless, crustal movements are in progress there to-day on a really notable scale, for it has been found to be a region of great earthquake frequency and intensity. During the occupation of the Island by the Expedition, though no seismological instruments were provided for recording weaker tremors, there were felt and recorded a number of earthquakes each year. On searching old records it was discovered that the period of our occupation was not at all exceptional in the matter of earthquakes.

Here is a list of earthquakes culled from the log-books of the Expedition's Macquarie Island Party.

1911—

22nd December. A light earthquake at 10·15 p.m.

1912—

28th April. A tremor at 9·15 p.m. Blake recorded that it appeared to travel from S. to N.

10th May. A tremor at 3·15 a.m.

5th September. An earthquake at 7·05 a.m.

28th October. Shocks at 1·35 a.m. and 9·35 a.m.

1913—

19th January. Earthquake at 11·17 a.m.

3rd May. Earth tremors at 1 a.m. and at 4·56 a.m.

9th September. Earthquake at 2·37 a.m. lasting 2 seconds.

9th November. A rather severe earthquake at 9·45 a.m. caused the hut to agitate violently for 2 seconds, temporarily putting the wireless out of action. Tremors continued for 30 seconds. The direction the shock appeared to take was S.S.W. to N.N.E.

17th November. A tremor at 1·39 a.m. lasted 1 second.

On looking up old records, we find that other visitors to the Island have had a similar experience. For instance, in a day-by-day log (a copy of which was made by Ainsworth) kept by Otto Bauér, headsman of the sealing party residing on Macquarie Island during part of the years 1909 and 1910, we find the following entries :—

1909—

3rd November. A heavy earthquake at 5·30 p.m.; a light one at 5·45 p.m.; a severe shock at 9·58 p.m.; a heavy shock at 11 p.m.

4th November. Light earthquake shocks at 10 a.m.; 10.45 a.m.; 6.45 p.m.; 10·15 p.m. and 10·30 p.m.

21st December. Earthquake at 1·30 p.m.

1910—

6th February. Earthquake at 11·45 p.m.

23rd July. A heavy earthquake shock at 11·45 a.m.

Earthquakes were also experienced by the early sealers. We find[1] that the headsman of a sealing party landed from the vessel "Betsy" recorded a series of earthquakes between October, 1815, and May, 1816. "The first which took place on the 31st October, 1815, at one o'clock in the afternoon, overthrew rocks, and gave to the ground the motion of a wave for several seconds. Several men were thrown off their legs, and one was considerably hurt by his fall, but soon recovered. At two o'clock the same afternoon another earthquake was felt, another at four o'clock, and ten shocks during the night, all of which were accompanied with a noise in the earth like that of distant thunder. On the 1st of November another shock was felt; and as the people were employed in distant divisions, their observations of the effects produced by the phenomena were most general. An overseer of a gang states that he witnessed the falling of several mountains, and the rocking of others which appeared to have separated from the summit to the base. On the 3rd of November, hard frost and heavy snow, two very severe shocks were felt. The 5th, 9th, and 11th were attended with some alarming phenomena. On the 7th, 8th and 9th of December, one was felt each day; and also on the 16th of January and 1st of April."

When Bellingshausen's vessels paid a visit in November, 1820, though in the vicinity of the Island for only two days, a sharp earthquake shock was felt on board both vessels, which at the time were sailing off the coast in a considerable depth of water. The sealers operating ashore recorded the same earthquake.

Crustal disturbance on a considerable scale still continues for seismic phenomena from that region are recorded from time to time at the Riverview Observatory at Sydney. An unusually violent disturbance was recorded* at Riverview on 26th June, 1924, the epicentre of which was placed in latitude 57° S. and longituded 159° E., which is approximately the location of the Hjort Rise.

Thus it is clear that faulting and other crustal deformations are in progress there to-day. Also it is equally certain that large-scale vertical movements have operated in the not very distant (geologically) past, for such are necessary to account for a sea-floor deposit of typical Globigerina ooze involved in submarine tachylite outpourings to have been brought above the surface of the sea. Chapman's suggestion is that the type of ooze represented is such as usually characterises deposits in depths of between 1,000 and 2,000 fathoms.

However, Blake records in his map only one really large-scale fault, that running north-west from Brothers Creek. His remarks on the subject of faulting are: "Numerous small faults traverse the rocks of the Younger Basic

* Personal communications from the Director of Riverview College Observatory.

Group and the other series, and a large fault exists between the rocks of the Older Basic and Gabbroid Groups on the one hand and those of the Younger Basic Group on the other. This fault commences on the coast near the mouth of Brothers Creek, and may be traced in a north-westerly direction to Eagle Point, a distance of five miles. The maximum vertical displacement of the rocks along this fault is not ascertainable, but it is known to exceed 600 feet. This fault has in turn been faulted by several smaller fissures which strike across it at a high angle."

Blake reasoned that to account for the steep sea-floor gradient off the east coast there must be a fault or possibly a series of parallel faults beneath the sea. He does not, however, appear to have contemplated the existence of faults along the west coast.

However, he has shown that in the process of glaciation the main gathering ground for the ice was west of the present Island boundary. The trend of glacial striae throughout the island demonstrates this. Also there are boulders in the Till which, while related to the local igneous rocks, are not known to occur *in situ* on the present land area. Finally Blake satisfied himself that the very abundant erratics of serpentinized harzburgite in the Till near the north end of the Island all originated from the mass *in situ* near Handspike Point. He presumed that, at the time of glaciation, the west coast of the Island was further west than Handspike Point, and that a glacier proceeding from it to the east had deposited the trail of harzburgite erratics which extend across to Nuggets Point. To arrive at the present situation he then assumed that all the land that lay to the west of Handspike Point and the half mile from there to the present west coast was planated by the sea in post-glacial time.

However, there are grounds for believing that the close of the glacial epoch on the Island has been very recent, leaving insufficient time for so great a width of marine planation. Consequently, though Blake's assumption is not impossible, it is far more likely that faulting has played a part in arriving at the present topography.

To the west, north-west and north there is a considerable area of undulating sea-floor at no very great depth which, in former times, may quite well have formed part of the land, but subsequently became submerged. Also it has been argued that certain peculiar elements of the fauna and flora are best accounted for as remnants of the population of a much larger land area.

The sea floor to the north-west is undulating, not planated as it would be the case if accepted as a former extension of the land, now submerged by marine planation. So there are many grounds for postulating the existence of longitudinal faults on the west side of the Island as well as on the east; thus the elongated, rectangular land mass is to be regarded as a horst. This, of course, does not mean that marine planation has not played a part in carving the present coast line; it certainly has, but to what extent cannot be demonstrated without a critical examination of the shore line itself.

In view of the fact that slickensided faces and crush-breccias have been collected from the shore platform, both on the east and the west side of the Island, it is probable that the lines of faulting are not entirely out of sight beneath the sea.

There is also some evidence of cross-faulting within the system of more recent earth movements. This appears to be well exemplified at North Head. The summit of North Head is a glaciated plane about 330 feet above sea level, tilted slightly towards the main mass of the Island. The latter at its north end is also a very flat glaciated surface, mainly between 800 and 900 feet above sea level. This marked difference in level between these two surfaces, which in glacial times were obviously coextensive, indicates a fault zone between the two masses which prepared the way for the development of Hasselborough Bay, Buckles Bay, and the low Isthmus area.

The frequency of earthquakes in that region, already demonstrated, is clear evidence that fault movements are still in progress.

The main fault shown on Blake's map appears to predate the system of faulting just discussed, for it occurred prior to the period of general planation which was responsible for the notable degree of accordance of summit-level in the crest line of the Island.

This explanation of the structure of the Island is in accord with that of New Zealand, which has been described by Professor C. A. Cotton as " a concourse of earth blocks."

STRATIGRAPHY.

THE OLDER BASIC GROUP.

According to Blake, " The oldest rocks met with on Macquarie Island are a series of basic lavas of some considerable thickness. In the main, these lavas have the nature and fabric of fine-grained dolerites. In some areas the presence of pyrite in amounts obvious to the naked eye is a common feature. The flows or sheets are each 2 or 3 feet in thickness and their great regularity suggests the appearance, when viewed from a distance, of stratified deposits. The maximum thickness of this series where it could be ascertained with any degree of accuracy, is not less than 650 feet, but may be very much more. For the most part, they are highly jointed, and on weathering break up into small cube-shaped blocks."

" At the northern end of the Island these rocks have been subjected to intense folding, the axes of these folds strike north-west to south-east, the dip varying from 45° to nearly vertical. The series is disrupted by numerous faults resulting from strains introduced subsequently to the deposition of the rocks of the Younger Basic Group, which uncomformably overlie them. Sills of dolerite porphyry and dykes of gabbro intrude the rocks of this group."

" Veins of quartz and calcite occur between the successive igneous sheets; veinlets of the same minerals fill the fissures formed by some of the larger joints.

Pyrite is the common sulphide mineral associated with these veins, but chalcopyrite, galena, and sphalerite also occur."

"The rocks of the Older Basic Group can be assigned to no definite geological period, nor can any clue be obtained other than that they are the oldest observed on the Island."

Rocks of this division as mapped by Blake occupy a large area at the northern end of the Island, northward from Sandy Bay; also he shows isolated patches on the east coast near Lusitania Bay and on the west coast in the neighbourhood of Sandell Bay.

Among the specimens of this group of rocks available for examination there are several which are pyroclastics, and an odd one* or two which suggest that they were originally fine tuffaceous submarine sediments. Unfortunately none of the specimens bear any indication as to which series they belong; this can be inferred only by reference of the locality of collection to the field map (frontispiece).

An indirect piece of evidence bearing on this point is afforded by specimen [62], which shows an intrusive contact with one of the gabbroid rocks. Here the intruded rock, though now a hornfels, appears in all probability to have been a fine-grained sediment, possibly of pyroclastic origin.

What appears certain is that this series does not contain any continental type of sediment, for such could not have missed Blake's observation. It can therefore be accepted that the rocks contributing to it are at least predominantly dolerites and basalts, with which are associated some fine-grained, water-laid and, maybe, tuffaceous deposits, possibly submarine.

It is a feature of the rocks of this series as distinct from those of the Newer Basic Group that they usually exhibit some degree of mineral change; that is to say, they are as a whole palaeotypal in character, whereas the rocks of the later period are usually quite fresh or nearly so.

As further implying some antiquity is the considerable degree of folding to which these rocks have been subjected. The amount of contortion is indicated by a series of dotted lines in one area (the north-east coast) of Blake's geological map.

As regards the age of this Older Basic Group, no direct evidence is available, but suggestions as to their antiquity are forthcoming from the New Zealand Region with which the Macquarie Island ridge appears to be structurally linked.

In late Triassic or Jurassic time, in the region of Tasmania and Antarctica, dolerite intruded the upper crust on a grand scale. Igneous activity also flared up in several places in New Zealand. As an example may be mentioned Bartrum's discovery[35] of a splilitic series of rocks associated with greywacke and other sediments of mid-Mesozoic age at Great King Island. This series is older

* For example [209] which is a tuffaceous greywacke almost certainly associated with the Older Basic Group.

than the extensive basaltic flows and pillow-lavas which Bartrum and Turner[36] have described from near Cape Maria van Dieman at the north-west extremity of the mainland of New Zealand. These latter are now regarded by the authors[37] as Upper Cretaceous or later.

In the light of what has been said above and what will be added herein in discussing other formations the age of Blake's Older Basic Group may be tentatively taken to be Hokonuian or Cretaceous.

THE GABBROID GROUP.

Blake reported that: " The Older Basic Group is invaded by a series of intrusives in the form of dykes, sills and bosses which, taken together, are referred to as the Gabbroid Group. The larger intrusive masses, which are four in number, have a roughly ellipsoidal form, and consist of coarsely crystalline gabbroic rocks in which are numerous xenoliths of dolerite of the Older Basic Series. The xenoliths are especially numerous towards the margin of the intrusions. The longitudinal axis of each of these masses is roughly parallel to the folding axis of the older rocks, which is suggestive that a close relationship existed between the act of intrusion and the folding of the Older Basic Series."

" Dykes and sills radiate outwards from these large masses into the dolerite flows, and on the west coast near Half-Moon Bay they intersect and form a network so closely knit as to almost exclude the original rock."

" The rocks of this group all grade into one another and range from diorite* at the acid end of the series to an enstatite-peridotite (harzburgite) at the other extreme."

" A banded structure was observed in numbers of dykes near Half-Moon Bay, but in all cases was found to be an original character due to flowage before solidation of the semi-crystalline magma."

Examples of this division of the igneous rocks of Macquarie Island are well represented in the collection available for study. Also there is no possibility of confusion of members of this suite with rocks of either of the " Older Basic Group " or the " Younger Basic Group " for they are plutonites as distinct from micro-gabbros or basalts.

A microscopical and chemical investigation has proved them to be of quite special interest. They include gabbros exceptionally rich in lime and alumina (allivalite); and from such, a complete gradation is represented down to ultramafic types. This occurrence recalls that described by Harker[33] as existing on the Island of Rum and that described by Cooper[31] from the Blow-me-down Mountains — Lewis Hills region of Newfoundland.

Associated with these plutonites are some interesting pegmatites and lamprophyric veins.

* No true diorite is included in Blake's collection; all rocks of the Gabbro Group fall within the Gabbro Class.

Blake observed the banded arrangement of some of the gabbroid outcrops (Plate XXV, fig. 2), but interpreted such as examples of flow whilst still semi-crystallized. It seems equally probable, however, that this pseudo-stratification in the Macquarie Island gabbros is a case of gravitative crystal settling, and so a matter which can be finally disposed of only by further study on the spot. In any case, to produce the succession of types represented in the collection it appears certain that at some stage gravitative crystal settling had operated. It is suggested that at Macquarie Island erosion has exposed, for the most part, only the upper portion of the gabbroic intrusion, and as a consequence differentiates rich in feldspar are well represented.

Blake's Gabbroid Group includes not only all the gabbroic rocks detailed in this report, but also the allivalitic dolerite (or allivalite porphyry [7] and other closely related coarsely porphyritic types hereafter grouped for description with the normal dolerites. No. [7] occurs as a dyke on the Isthmus, but is obviously closely related magmatically to the gabbros, and is even prehnitized in the same manner as they are. A matter of considerable interest is the remarkable degree to which serpentinization of the ferromagnesian minerals of these rocks has been carried; in the case of enstatite-peridotite serpentinization is virtually complete. Colateral with this transformation has been the prehnitization of the lime-rich feldspars, more particularly where they occur in the serpentinized belts. The linkage between the processes, serpentinization of the mafic minerals and prehnitization of the feldspars had been recognised in the study of these rocks before it was discovered that Cooper[34] had already stressed the connection. Further, the fact that both processes are so well represented at Macquarie Island, where apparently we are dealing with the upper limits of a plutonite intrusion, suggests the view that such situations are most favourable to autometamorphic processes of the kind. In such situations the volatile constituents of the magma would be expected to accumulate and hence it is there that deuteric changes would be favoured in the late stages of crystallization.

Blake found these rocks intruding the Older Basic Group, but did not collect examples of the contact rock from *in situ* locations. There is, however, one specimen [62] picked up as a beach boulder, which shows very clearly the actual junction of the intrusive and intruded rocks (Plate XXXIII, fig. 1). Here a diallagic gabbro has intruded and recrystallized what appears to have been a fine-grained laminated sediment, probably a sub-marine tuffaceous mud. The intruded rock has had developed in it much granular amphibole which is notably pleochroic from almost colourless to light-brown. The amphibole is especially concentrated along certain laminae. At the contact, the laminae are frayed out, suggesting at least a minor degree of assimilation, which is further indicated by the occurrence of the same amphibole in the gabbro near the contact.

There are several other specimens in the collection, all erratics of the injected-hornfels type, which are also taken to represent the metamorphosed equivalents of sediments intruded by the igneous complex. In general appearance they are very fine-grained grey hornfels seamed with white veinlets.

All contain a notable proportion of amphibole which is optically negative, R.I. of 1·64–1·65, $Z \wedge c$ 17°, and is pleochroic from an almost colourless light straw yellow to a greenish shade of yellow-brown. The granular base also contains almost colourless grains of diopside, and colourless grains of plagioclase with R.I. 1·545–1·551. Specimen [1] has an average grain-size of 0·14 mm., and is specially characterised by a regular recurrence of dark, amphibole-rich laminae, usually 1 mm. thick, but periodically bulging to 4 mm. The suggestion is that these were original bedding-planes. No. [114] has a more definite alternation of white and coloured bands.

In [25] the coloured veinlets are not all accordant. The more prominent white veins are occupied by prehnite. A second type of vein-filling is greyish-yellow in thin section, but somewhat greenish when viewed in mass. It has a lower R.I. than the balsam and an exceedingly weak birefringence, exhibiting anomalous blue polarization colours. This is taken to be one of the chlorites.

In these rocks therefore there is further evidence indicating that the Older Basic Group which was invaded by the Gabbroid Group was not entirely constituted of igneous flows, but incorporates in its mass some sediments, possibly submarine and probably tuffaceous.

With regard to the period of injection of The Gabbroid Group, it is to be observed that large-scale intrusions of gabbros and ultramafics, in some respects very like those of Macquarie Island, are a feature of New Zealand. Everybody knows of the famous occurrence of dunite and prehnitized rodingite at Dun Mountain[37] in the north of South Island. There are other notable intrusions of ultramafic rocks further south along the structural axis of the Island, including the large area of harzburgite in the neighbourhood of Awarua.

Again at the northern extremity of the North Island, Bartrum and Turner[36] have described ultrabasic rocks intruding their Older Volcanic Series, which latter they now regard as Upper Cretaceous or later. In a recent personal communication Professor Bartrum, referring to these ultrabasics at North Cape, states: " I believe now that they are more likely to be contemporaneous with small peridotite intrusions general throughout North Auckland, which are injected into Middle-Eocene sediments and not into Middle Miocene ones. The date of intrusion of these peridotites has been pushed forward lately on account of Dr. Finlay's recent dating of the " hydraulic limestone " formation, into which they have been injected, as Middle Eocene. Previously it was thought to be Upper Cretaceous or else earliest Eocene."

THE YOUNGER BASIC GROUP.

Blake recorded that " The rocks included in this group consist of a series of interbedded basaltic and andesitic* agglomerates, breccias, tuffs, and lava. This division, whose thickness is at least 1,400 feet, rests unconformably on the dolerites of the Older Basic Group."

* No true andesites are to be found in Blake's collection. Blake's andesitic rocks are probably light-coloured basalts.

"The agglomerates and breccias consist of angular fragments of vesicular basalt set in a ground-mass of basic glass and other tuffaceous material. Tachylite occurs in one or two localities as large fragments in the agglomerates. Both the black and blue varieties of this glass occur on the eastern side of North Head, where the alteration product, palagonite, is also present."

"On the west coast 8 miles south of Handspike Point, slickensided purple shale, consisting of hardened volcanic tuffaceous mud, occurs, dipping south-west at an angle of 60°. A thorough search failed to reveal the presence of fossil life of any form in this shale bed. A similar rock occurs about 1 mile north of Lusitania Bay, but much disturbed, and a dip could not be obtained.

"The lavas, which are mainly andesitic,* vary in thickness in the different flows from a few feet to 100 feet or more. The peculiar 'pillow form' structure is well developed in most of these lavas, even occurring through the body of the largest flows. Joints caused by contraction during the cooling of the mass radiate from the centres of the individual 'pillows,' but fail to reach their edges. The interstices between the 'pillows' are often filled with a fine-grained compact limestone† of secondary origin, and veinlets of this mineral also occur throughout the volcanic breccias. The zeolites, chabazite and natrolite fill the amygdules and smaller fissures in these pyroclastic rocks. Zeolites also occur in the centre of small stony volcanic bombs, which are present in the glassy breccias near Brothers Point.

"Dykes of basalt and dolerite intrude the rocks of this series, and dykes of coarse olivine-dolerite occur in the breccias at Hut Point and Aerial Cove, all of which have a general southerly dip.

"This group of rocks is traversed by two sets of steeply dipping joint planes intersecting at an angle of about 100°, and in some of these fissures faulting was observed to have taken place. Quartz, associated with sphalerite, galena and pyrite, occurs in the form of true fissure veins. Near the Expedition Hut, such a vein was observed filling the fissure of a small fault."

Whereas it is doubtful into which of Blake's groups of igneous rocks many of the specimens of his collection belong, it is practically certain that the interesting soda-rich rocks, analcite-tephrite and analcite-basanite of Brothers Point are part of this division. This, however, is an exceptional occurrence, for the overwhelming majority of Macquarie Island igneous rocks are calc-alkali types.

Among the latest outbursts and certainly belonging to this division are the interesting glassy and semi-glassy tachylites of North Head and some other localities on the Island.

It would appear from Blake's references that the bulk of the basaltic lavas of his Newer Basic Group are pillow-lavas, and the association of Globigerina

* No true andesites are to be found in Blake's collection. Blake's andesitic rocks are probably light-coloured basalts.

† This is largely Globigerina ooze.

ooze with them and with the agglomerates leaves it quite clear that these outpourings were submarine.

Pyroclastic rocks of this division are abundant in the neighbourhood of Brothers Point and Wireless Hill, but examples were collected from several other localities. There is a dark-coloured mineral tuff [224] with a glass dust base which breaks with a shaley fracture, collected *in situ* at sea-level below Station 3Q. Unfortunately we cannot fix this position, but the symbol of this station suggests that it is in the southern half of the Island.

A basaltic breccia [199] at Hut Hill has the appearance of belonging to the Older Basic Group. It may be a fault breccia. The tachylitic breccias [231] from Finch Creek, [241] from Brothers Point, [59] from Aerial Cove, and [123] and [124] from Wireless Hill are all of this series.

Tachylite bombs as much as 1 foot in length and frequently hollow contribute to the agglomerates of the Younger Volcanic Series at a locality $\frac{1}{3}$ mile north of Brothers Point (Plate XXVII, fig. 2). The cavities in the bombs are occupied by zeolites.

At one locality on Wireless Hill glassy tachylite was observed veining a sub-marine tachylitic agglomerate. In this case, evidently the liquid magma had welled up into and solidified within a brecciated mass of an earlier consolidated section of the same magma. Such shattering of the hot consolidated glass can be explained by its contact with sea-water in the case of sub-marine outpourings.

Globigerina Ooze Associated with Pillow Lavas.

Rock [364] is tachylite agglomerate collected at a point about 100 yards west of the wireless station. There is some development of palagonite in this, but the main point of interest is the presence of buff-coloured consolidated Globigerina ooze, clearly proving its submarine origin.

Specimen [11] collected in the neighbourhood of North Head is a good example of the submarine tachylitic basalt breccias. In the hand specimen the basaltic fragments are quite obviously of two distinct types. The first of these is a dull, stony, dark-grey variety in angular fragments up to 2 inches in diameter; the second is a vitreous black, tachylite glass appearing as abundant small particles up to $\frac{1}{2}$ inch in diameter. The bright tachylite glass composes not more than 20 per cent. of the rock. Between the fragments of volcanic rock is a dirty-yellow cementing base of somewhat waxy appearance. The microscope slide shows the dull basalt fragments to be a semi-crystallized, hyalopilitic basalt which has been shattered after consolidation. All degrees of crystallinity are illustrated to examples containing as little as 20 per cent. of residual glass. The glass fragments as seen in the microscope preparation are of a light yellow colour, and embedded in it are tiny clear olivines and occasional laths of fresh basic plagioclase. The waxy material of the base cementing the foregoing rock fragments is observed to be mainly fine calcite, evidentally from the recrystallization of Globigerina ooze. Embedded in it are minute dust like particles of disrupted volcanic material. This specimen is not affected by palagonitization.

Specimen [219] from the foot of Wireless Hill on its south-east side is a variant of [11], but substantially the same in composition and genesis.

As already mentioned, Globigerina ooze is met with as a filling among the volcanic breccias of the Younger Basic Group at North Head, and occasionally in the pillow-lavas. There are also in the collection from this area specimens which are mainly hardened Globigerina ooze with only minor igneous contributions.

Specimen [190] is a good example of this material. In appearance it is a compact, very fine-grained, buff-coloured rock, breaking with a conchoidal fracture. It is so fine and even grained that it resembles the lithographic stone from Solenhofen.

In the microscope slide it is seen to be consolidated Globigerina ooze. It was therefore submitted to F. Chapman, of the National Museum, Melbourne, for report on the fossil contents. He reported as follows :—

" The contents of this rock, as seen in thin section, comprise the following foraminifera :—

Bulimina.

Largena sp.

Globigerina bulloides, d'Orb.

,, triloba, Rss.

,, cf. dutertrei, d'Orb.

,, aequilateralis, Brady.

There are also numerous Radiolarians present; the Spumellarians being especially in evidence, while the Nasselarians are rare.

" This rock is a consolidated Globigerina ooze with numerous Radiolaria. From its lithological and biological aspects it seems to have been accumulated at a depth between 1,000 and 2,000 fathoms."

It is obvious that in bursting through the sea-floor the basic magma of the breccias and pillow-lavas broke through a thick deposit of Globigerina ooze, some of which was baked hard and carried up as nodules; in other places the plastic ooze appears to have settled amongst the breccias and lava pillows.

Specimen [42] is similar to [190], but [42A] is a somewhat harder and slightly reddened Globigerina ooze in which are embedded lapillae and bombs of basic glass, now palagonitized. One such embedded bomb was 5 inches in length. In microscope slide these palagonitized bombs show an outer border, almost 0·5 cm. in width of a greenish-grey glass surrounding a stony central mass.

This occurrence of consolidated Globigerina ooze is of such interest that it was deemed advisable to have a complete analysis made of it. Accordingly the material of specimen [42] was analysed, with the result as stated below. With it is quoted a composite analysis of Globigerina ooze from the present sea floor. This latter is the mean of four analyses published in the reports[30] of the German South Polar Expedition of 1901–03. The analyses published by Philippi refer to samples of ooze from depths of 1,150 to 2,700 fathoms between the Equator and 33° south latitude.

	I.	II.
SiO_2 (Silica)	4·91	4·37
TiO_2 (Titania)	0·07	...
Al_2O_3 (Alumina)	0·98	1·27
Fe_2O_3 (Ferric Oxide)	0·85	0·45
Cr_2O_3 (Chromic Oxide)	Nil	...
FeO (Ferrous Oxide)	0·36	...
MnO (Manganous Oxide)	0·06	0·06
MgO (Magnesia)	2·38	0·45
CaO (Lime)	49·38	50·75
SrO (Strontia)	0·02	...
BaO (Baryta)	Nil	...
Na_2O (Soda)	0·22	0·63
K_2O (Potash)	0·18	...
H_2O+ (Combined Water)	0·21	...
H_2O- (Hygroscopic Water)	1·02	...
CO_2 (Carbon Dioxide)	39·28	38·50
P_2O_5 (Phosphorus Pentoxide)	0·10	Strong trace.
F (Fluorine)	0·08	...
Cl (Chlorine)	0·05	0·99
SO_3 (Sulphur Trioxide)	0·12	0·27
Moisture, organic matter and ammonia lost on ignition	...	2·54
	100·27	100·28
Less oxygen equiv. of F and Cl	0·04	...
Total	100·23	100·28

I : Specimen [42] from Macquarie Island; Globigerina ooze rock embedded in the Newer Volcanic Series at North Head. Analysis by W. B. Dallwitz, Dept. of Geology, University, Adelaide.

II : The chemical composition of Globigerina ooze collected from the sea floor by the Deutsche Südpolar-Expedition; mean of a number of analyses.

It is interesting to note that when, in 1929, we were engaged on the work of the B.A.N.Z.A.R. Expedition, similar nodules of consolidated Globigerina ooze were found among the volcanic breccias of Heard Island, which lies to the south of the Indian Ocean.

Specimen [207] is another example obtained from South-West Point, apparently *in situ*. It is a pink Globigerina ooze. In microscope slide it is seen to be a laminated bedded sediment. The finer laminations average 0·07 mm. in thickness. Super-imposed on this finer lamination is a coarser banding averaging 2·33 mm. in thickness. Thus, if the finer laminations represent annual depositions, then the major cycle is about a 33-year period. In one specimen there is a coarser-grained band in which distinct mineral particles are discernible, suggesting basic volcanic dust or ice-transported terrigenous matter.

No. [64] is a Globigerina ooze rock loaded with tiny fragments of palagonitized volcanic glass.

The association of Globigerina ooze with these pillow-lavas is a factor which gives some help in efforts to fix the age of these effusions, since cases of the kind, more or less comparable to this, are known to occur in the New Zealand region.

A thick formation of pelagic limestone apparently related to that met with at Macquarie Island is recorded by Marshall[40] to occur at Campbell Island overlying unconformably the eroded surface of gabbro.

Park and Uttley[41] have described in the neighbourhood of Oamaru a remarkable occurrence of tachylitic pillow-lava very similar to the occurrence at Macquarie Island. There it is interbedded with the Miocene, and marine calcareous sludge is found filling spaces between the tachylite pillows. In northernmost New Zealand also foraminiferal oozes of Miocene age are intruded by basic effusions. As a considerable period of erosion has supervened since the glassy tachylite pillow-lavas of Macquarie Island burst through the sea-floor it is quite likely that they correspond in age with the comparable Miocene outbursts at Oamaru.

TILL.

The whole surface of the island, except where it has suffered from marine erosion, and in a few localities where rock is exposed, is covered with a mantle of unsorted glacial drift (Till or Boulder Clay) having a maximum thickness of at least 60 feet (Plate XX, fig. 2). This Till varies greatly in colour and character, both of which factors being dependent upon the dominant type of original rock entering into its composition. That of the northern portion of the island is mainly composed of gabbroid rocks and dolerites, which impart a bluish colour to the Till. In the central and southern portions the Till is almost wholly composed of rocks of the Younger Basic Series, which impart to it a greyish tinge. Of the glaciated boulders in the Till, rocks of the Younger Series (dolerites and basalts) are not so well polished, nor are the striae so well defined as in the case of the gabbros of the Older Basic Series.

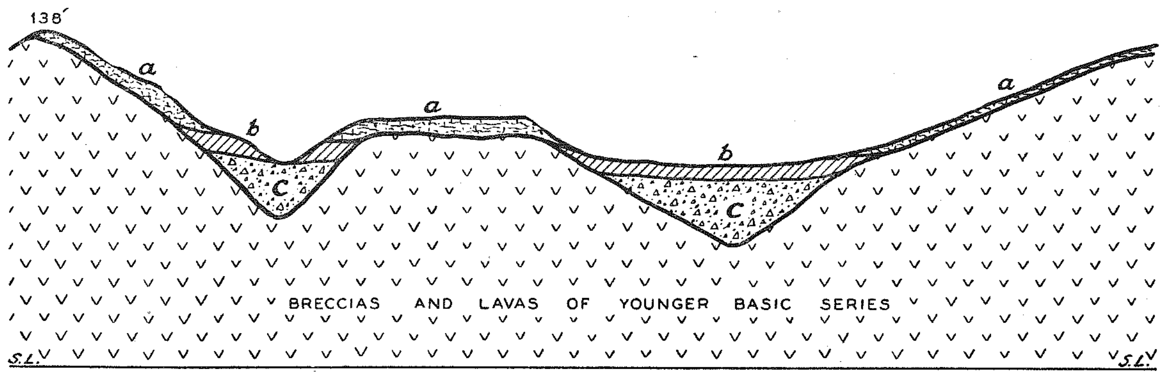


FIG. 35. Section 600 yards in length exposed in a coast cliff at ¼ mile north of Nuggets Point. Vertical scale is twice the horizontal scale. (*a*) Recent Peat below tussock-grass; (*b*) Fluvio-glacial deposits of clay, diatomaceous earth and peat; (*c*) Till filling small gully heads.

TILL EXPOSED IN THE COASTAL CLIFF NEAR NUGGETS POINT.

A section through the Till is exposed in a marine-cut cliff one-quarter of a mile north of Nuggets Point, and here it is seen to be filling up two small V-shaped channels cut out of the Younger Basic breccias; the base of the Till is only 40 feet above the sea-level (fig. 35). This Till [76], [115], and [118] consists of a stiff, light blue-grey "clay," the boulders in which are predominantly of enstatite-peridotite, obviously derived from the intrusion at Eagle Point. Blake's report states: "Occasional boulders of hypersthene-gabbro and dolerite are also present. Some of the boulders are 3 feet in diameter, and all are remarkably well polished and striated. The V-shaped channels in which these deposits occur appear to be the heads of old pre-glacial or inter-glacial gullies which have been subsequently polished and scratched by the ice-sheet. The Till, which is 35 feet in thickness, is overlain by fluvio-glacial deposits consisting of clay and silt. Numerous large boulders of enstatite-peridotite derived from the Till occur on the beach immediately below this section. Some of these boulders are polished and show faint striae, but the majority, being washed by the sea at high water, have had their surfaces abraded and so lost any polish that they may have had. The largest boulder has a diameter of 8 feet and weighs approximately 20 tons." This is illustrated in Plate CXIV, fig. 1, of Vol. I, Series A, of these Reports.

TILL-CHOKED VALLEY NEAR NUGGET POINT.

North-westerly from Nugget Point, Blake discovered an old U-shaped valley filled with Till which has been laid down in three distinct overlapping depositions, each of which is distinct in character, differing widely in composition from the others. A geological plan of the area is reproduced in figure 38. For photographic illustrations, see Plate XXI and Plate XXIII, fig. 1. The relation of these deposits to each other will be seen in figures 36 and 37. Blake's record states: "The lowest Till is composed almost entirely of material derived from the enstatite-peridotite of Eagle Point, and was laid down in the lower portion of the valley by an ice-sheet which approached and entered the valley at right-angles to its course. The second Till, consisting of gabbro and hypersthene-gabbro, was laid down by an ice sheet which appears to have entered the valley at a point higher up than the area at present occupied by it, then moved down the valley to the present position, and thus is found overlapping the first Till deposition. The uppermost Till consists almost solely of dolerite. Higher up the valley the occurrence of fluvio-glacial clays and silts a few feet thick were noticed."

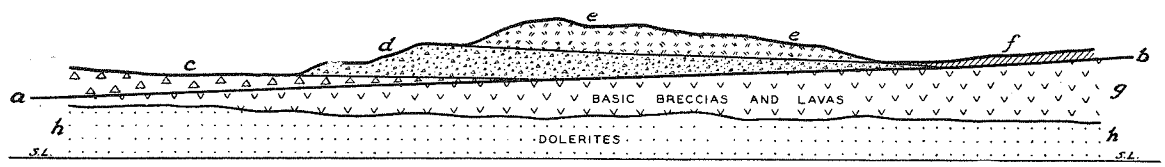


FIG. 36. Longitudinal section about 1,500 yards in length through an old valley north-west of Nuggets Point. (*a–b*) Old Valley grade; (*c*) Enstatite-Peridotite Till; (*d*) Hypersthene-Gabbro Till; (*e*) Dolerite Till; (*g*) Younger Basic Series; (*h*) Older Basic Series.

" The lowest of these three superimposed Tills is well exposed in a section in the banks of Nuggets Creek where this stream crosses the above old valley almost at right-angles. There the Till exposed is the lowest deposit (*c*) of fig. 36. It consists mainly of enstatite-peridotite, but boulders of the other gabbroid rocks are mixed with it. The " clay " is bluish in colour, being identical with that of the sea cliff section (fig. 35) above. It contains numerous beautifully polished and striated boulders. For a depth of 2 feet from the surface this Till is stained reddish-brown, due to the oxidation of the iron minerals. The maximum thickness of the Till exposed here is 60 feet, but the bed-rock was not seen near the centre of the section, so the thickness is probably greater.

" The second Till (*d*), shown in fig. 36, is about 70 feet in thickness, and consists mainly of gabbroic rocks. Weathering is far advanced in the surface zone of this Till, but as no natural section was seen it is impossible to state the depth to which weathering has proceeded. The erratics have been polished and striated, but not to the same degree as those of the earlier Till.

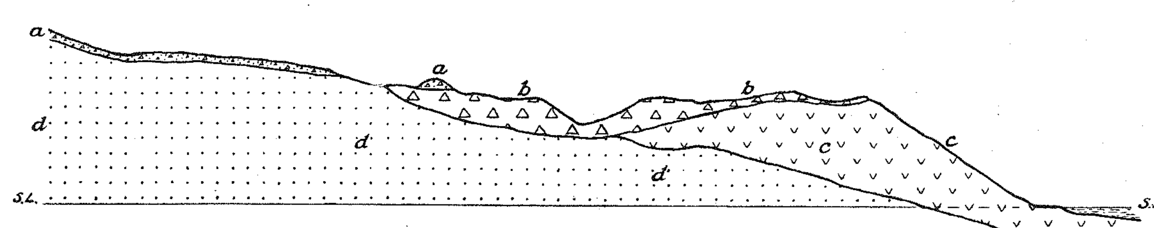


FIG. 37. Geological Section ⅓ mile in length through the Glacial Deposits at ¼ mile north of Nuggets Point. (*a*) Upper Deposit of Till; (*b*) Lower Till filling old valley; (*c*) Rocks of the Younger Basic Group; (*d*) Older Basic Group.

" The uppermost Till (*e*) of fig. 36 is about 60 feet in thickness, and the contained boulders consist almost wholly of dolerites. This has also weathered considerably on the surface, so that all trace of polish and striae has disappeared from the exposed boulders although still preserved on protected faces."

Train of Boulders from Eagle Point to the East Coast.

The boulders of enstatite-peridotite may be traced in a definite train from one side of the Island to the other. This rock, which occurs *in situ* on the west coast near Eagle Point may be found in the Till on top of the cliffs which overlook that locality, and traced thence up over the main divide at an elevation from 600 to 1,200 feet, and then down to almost sea-level on the east coast near Nuggets Point. This line of boulders in the Till shows that locally the ice sheet moved in a direction approximately due east.

Other Observations Relating to the Till.

Brothers Creek, a small stream debouching on the beach one quarter of a mile north of Brothers Point, is another U-shaped valley floored with typical unstratified Boulder-clay (fig. 41). A thickness of 10 feet of such Till is exposed, but as the bed rock is not seen, the glacial accumulation exceeds that thickness. Blake records : " This Till is light grey in colour and composed of Older Basic dolerites and Younger Basic lavas and breccias. The erratics are all ice-worn and show striae, but are not well polished.

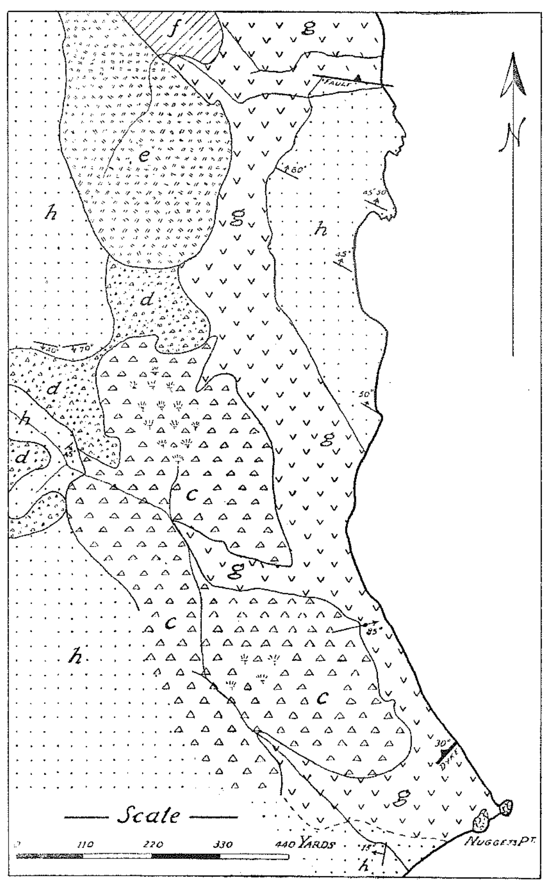


Fig. 38. Geological Map showing Till deposits choking an old pre-glacial valley north-west of Nuggets Point. (*c*) Till with erratics of enstatite-peridotite ; (*d*) Till with gabbro and norite erratics ; (*e*) Till with dolerite erratics ; (*f*) Fluvio-glacial lacustrine deposits ; (*g*) Rocks of the Younger Basic Group ; (*h*) Rocks of the Older Basic Group.

"Another section through the Till occurs on the edge of the west coast cliffs due west of North Mountain. This deposit is mainly composed of material derived from the enstatite-peridotite outcrop; boulders of dolerite and gabbro also occur in it. Here the Till, which is 10 feet thick, rests on an ice-worn and striated floor of dolerite and gabbro. Large boulders, some of which weigh many tons, are strewn over the weathered surface of the Till in this locality and in the area leading from thence towards Mt. Elder.

"In certain localities, where not protected by a covering of peat, the Till has been attacked by running water and frost to such an extent as to be almost unrecognizable unless seen exposed in a natural section.

"Polished and striated boulders are not plentiful over the central and southern portions of the Island, but several weathered examples were observed. Their general absence is probably due to the Till over these areas being composed of volcanic breccias and lavas, which are subject to rapid weathering after exposure at the surface.

"Two boulders of glacial conglomerate, both measuring roughly 3 feet by 2 feet, were found in the Till half a mile south of Mt. Elder. The rocks entering into the composition of these conglomerates are all of local origin, being enstatite-peridotite, gabbro, etc. The interstices between the boulders and particles of grit are filled with chabazite. No other specimens of this glacial conglomerate were observed, although a careful search was made in the locality." The inference is that these boulders of glacial Till cemented by a zeolite were derived from an older Till over-ridden by the ice-sheet responsible for the latter accumulation.

Terminal Moraines.

Rookery Creek, the main tributary of Nuggets Creek, has its source on the north-eastern slopes of Mt. Elder in a cirque-like amphitheatre. Describing this, Blake states: "From this amphitheatre a moraine extends from an elevation of 700 feet down to 100 feet above sea-level; it has a stepped or terraced profile common to recessional moraines. The debris, consisting of boulders of dolerite, gabbro and enstatite-peridotite, has been derived mainly from the Till deposited by the oldest ice sheet, but a large proportion of it consists of angular fragments of dolerite from the slopes of Mt. Elder and from the cliffs forming the amphitheatre at the head of the creek. At 500 feet above sea-level a small outwash plain occurs below the morainic debris, which has here a face 50 feet in height. In the banks of the creek below this plain fluvio-glacial deposits of blue and yellow clays and fine gravel were observed. At the base of the steep cliffs bounding the amphitheatre a moraine occurs 10 feet in height and 30 feet in width; it consists of large blocks of dolerite and enstatite-peridotite. This represents the final deposit left by the old valley-glacier, which at this stage appears to have been confined almost to the face of the cliffs."

The second specialised form of moraine noted by Blake, occurs in Brothers Creek (fig. 41). It stretches across the mouth of the creek at the edge of the beach, and rests on a rocky floor 12 feet above sea-level. It is of the terminal variety, and has a length of 200 feet, a height of 30 feet, and a width of 40 feet, and the material consists of rounded and subangular boulders set in a fine gritty base.

The character of this boulder bank suggests that it accumulated at the sea margin, where the glacier formerly occupying the valley contacted the ocean. Subsequent to its accumulation the Island rose slightly, so that the pebble bank is now met with on the margin of the elevated wave-cut terrace.

Erratics of Rocks Foreign to Macquarie Island.

So far as could be ascertained from inspection of the Till distributed over the highlands, all the boulders contained therein are of local origin. However, Blake did find on the beaches four erratics foreign to the Island, descriptions of which are as follows :—

Specimen [188] is portion of a sandstone erratic found on the beach 300 yards south of Station 3 (north end of west coast). The boulder was waterworn and measured 7 inches by 10 inches by 6 inches. It is a brown-toned, fine-grained sandstone composed in the main of angular fragments of quartz with some decomposed feldspar and occasional grains of zircon and brown tourmaline. The sand particles as viewed in the microscope slide average about 0·5 mm. diameter.

No. [16] is portion of a sandstone erratic about 1 foot in diameter, collected on the beach between Half-Way Hill and the Nuggets. Under the microscope the sand particles, which are angular, are observed to be quartz with a sprinkling of decomposed feldspar and scraps of muscovite; as accessories a little magnetite and some ilmenite appear as well as grains of grey zircon and a brown tourmaline.

No. [2] is from a beach boulder, 6 inches in diameter, found on the shore of Buckles Bay, 200 yards south of the Hut. This is a dynamically metamorphosed granite. The recognizable minerals are quartz, orthoclase, microcline, plagioclase, cordierite and mica, as well as sphene, zircon, magnetite and apatite. The larger minerals have suffered a considerable degree of granulation, the mica being presented as micaceous smears.

No. [143] is from a coarse-grained, pink, granite erratic, 18 inches in diameter, found as a beach boulder at Eagle Point. The principal constituents are quartz; both white and pink feldspar, now much decomposed, but originally evidently mainly microcline; biotite, now partly chloritized. As accessories there appear zircon, apatite, brown sphene, magnetite and partly leucoxenised ilmenite. The rock is not gneissic, but has suffered some strain for the quartz has been fractured and the particles displaced before recementation.

A creek draining a Till-choked valley debouches on to the beach a few yards from where these specimens were found, and as numerous glaciated boulders of local origin which have been transported by this stream also occur, it would seem from their association that, possibly, they also came from the same glacial drift.

* 43610—F

As regards the original *in situ* location of these foreign erratics, if weathered out of the Till now mantling the Island, they may have been transported by the former land-ice sheet from some locality not far distant, but now beneath the sea, or they may somehow have been transported across the sea by floating ice during the height of the ice age and deposited upon a sub-marine bank, subsequently to be elevated as Macquarie Island.

If not weathered out of the present mantle of Till they may have been recently transported to the coast by icebergs which had stranded in shallow water preceding the recent elevation of the shore terrace.

It is, of course, possible that these rocks were carried by some sealing craft as ballast or for some special purpose, and jettisoned on the beach or cast ashore from wrecks. Finally, it is not improbable that, if there be any sial layer in the underlying crust, odd fragments may have been brought to the surface among the igneous breccias of the Island's turbulent volcanic past.

FLUVIO-GLACIAL DEPOSITS.

Under this heading are included numerous deposits of stratified drift composed of sand, gravel, clay, and mud, which occur in several old valleys and on flat glacial terraces. Obviously this type of drift was laid down during the period of waning glaciation. The material composing these deposits is partly waterworn, but subangular boulders, scored with glacial striae, are also present, indicating derivation by water action on original morainic matter.

Deposits of somewhat water-worn glacial pebbles occur on almost all of the flat terraces which form such a notable topographic feature of the upland surface.

SECTION EXPOSED ON WIRELESS HILL.

Fluvio-glacial deposits occur on Wireless Hill, resting on an ice-worn surface of basic volcanic breccia between the 280 and 330 feet contours. A section of beds 15 feet in thickness exposed in the cliffs near the Wireless Station is illustrated in fig. 43. At the base there is a deposit 2 feet thick of stiff clay with boulders [133]. As a result of weathering this clay band is stained yellow by the presence of limonite, and limonite encrusts a number of the embedded boulders. The boulders, which are mainly of dolerite and dolerite-porphyry, are all slightly water-worn, but striae are visible on many of them.

Overlying the clay, sand, and gravel is a peaty post-glacial deposit, as follows: namely, directly upon the fluvio-glacial formation lies a 3-inch band of dark peaty mud, and above it 8 feet of peat. On examination, this peat [80] and [90] is found to be composed of vegetable fibres with some admixture of sand grains.

These deposits lie conformably on the ice-worn surface of Wireless Hill, which has a slope of 1 in 20 from the horizontal towards the south. The hill has precipitous sides, and is separated from the nearest land of the main portion of the Island by a gap half a mile in width.

On the west coast, 5 miles south-west of Nuggets Point, a natural section shows 4 feet of horizontally bedded subangular grit and sand similar to those occurring on Wireless Hill.

The Finch Creek Beds with Bird Bones.

These are regarded as late-glacial or early post-glacial in age. They are about 15 feet in thickness and are situated in the bed of an old U-shaped valley. Blake records that: "Two interesting sections were observed in the bank of the creek, where it has cut a narrow channel through these deposits (figs. 39 and 40).

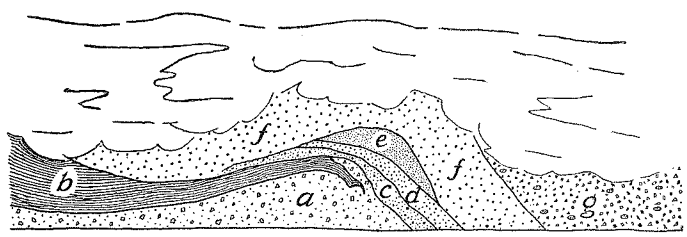


Fig. 39. Fluvio-glacial Deposits in Finch Creek. (*a*) Sand with angular pebbles; (*b*) Blue Silt or Mud; (*c*) Sand and Gravel; (*d*) Coarse Sand; (*e*) Fine Sand; (*f*) Coarse Sand; (*g*) Angular gravel with occasional striated pebbles, partly waterworn.

A section across this old valley (fig. 40) exposes, besides peaty mud, sand, and gravel beds of lesser interest, a conglomerate [233] composed of sub-angular pebbles with limonitic cement; in it, bird bones are sparsely distributed. This bed which, with underlying gravel and sand, is 8 feet in thickness, exhibits current bedding. Above this again are fine sub-angular sands and gravels in which are interbedded horizontally intercalations of consolidated mud containing vegetable remains. The presence of these bird bones,* which are in all probability those of a species of penguin, points to the existence of animal life on the Island at least as long ago as the closing stages of the ice age."

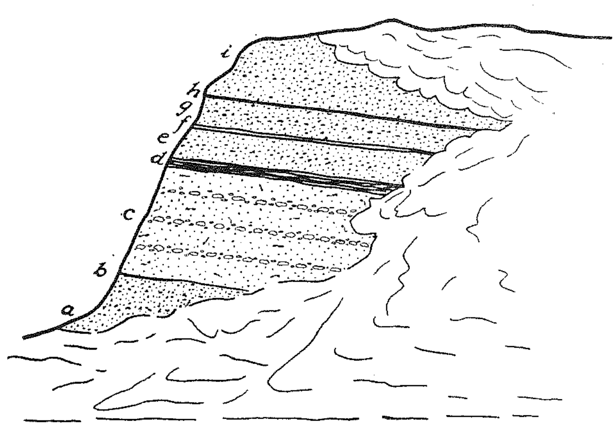


Fig. 40. Fluvio-glacial deposits in Finch Creek. (*a*) Gravel and Sand; (*b*) Peaty Mud 1-inch; (*c*) Coarse Sand Gravel with occasional bird bones—6ft. 6 inches; (*d*) Peaty Mud—9 inches; (*e*) Gravel and Sand—18 inches; (*f*) Peaty Mud—3 inches; (*g*) Gravel and Sand—18 inches; (*h*) Peaty Mud—1 inch; (*i*) Sand and Gravel—3 feet plus.

* These bones are too fragmentary and decomposed to allow of specific determination.

POST-GLACIAL FORMATIONS.

Diatomaceous Lacustrine Silts with Fossil Moss and Peat.

Overlying the Till exposed in the coastal cliffs a quarter of a mile north of Nuggets Point, deposits of fine blue and yellow clays interlaminated with thin felt-like peat bands were observed. The individual bands are between 1 and 2 inches in thickness, the whole deposit amounting to a total of 5 feet (fig. 35). This material has been laid down in former ponded depressions in the mantle of glacial Till immediately following upon the retreat of the former ice sheet and illustrates the existence of plant life on the Island at that time.

Specimens of this stratified pond deposit from a locality one-eighth of a mile north of Nuggets Point have been examined. Specimen [78] taken from the lower beds is a light-grey stratified sediment composed largely of diatomaceous earth with some admixture of "rock-flour" evidently transported by glacial streams. When dry it is of extremely light weight. The lighter-coloured bands are richer in diatom tests. Mr. F. Chapman, who examined a sample [78A] of this material reported that "the fine washings are richer in freshwater diatoms, including Cocconeis, Tabellaria and Grammatophora."

The remains of simple forms of vegetation, principally moss, are contained in this diatomaceous deposit (Plate XXXV, fig. 1). A feature of the material is its fine lamination, the laminae apparently representing annual depositions. The upper portion of the bed [79] is richer in plant remains, the latter forming felted sheets, in appearance resembling "paper coal." The laminae in coarser specimens from the deposit amount to about twenty-six to each inch of vertical thickness, while in the case of the more perfectly laminated portions as many as sixty-five laminae are represented in a single inch. In all probability each lamina represents one year's accumulation.

Water-borne Arenaceous Sediments.

Deposits of this kind, all of Recent age, occur in small quantity in various localities, particularly in the valleys of present streams, where depressions have been silted up since the recession of the ice. Ferrar[32] observed a formation of this kind on the raised-beach terrace at Lusitania Bay. The nature of two specimens of this group in the collection is referred to herewith.

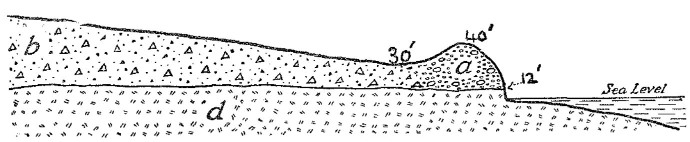


Fig. 41. Section through moraine at the mouth of Brothers Creek. (*a*) Rounded Boulders and Pebbles; (*b*) Morainic debris; (*d*) Dolerites, etc.

[34] is a somewhat crumbly, sandy sediment of a greenish-grey colour, occurring at First Gully, south of the Isthmus. Most of the particles range from

1 to 1·5 mm. diameter, with occasional fragments up to 3 mm. diameter. It is constituted of more or less rounded fragments of tachylite glass, hyalopilitic basalt, basic feldspar, olivine, a little pyroxene, and some indefinite serpentinized material.

It appears to be of Recent age, obviously post-dating the outburst of the Newer Volcanic Series. Apparently it is a fluvial accumulation of particles from the erosion of the Newer Volcanic Series and its tuffs.

[253] is a water-sorted, even-grained gravel rock with a large amount of interstitial limonite. This sediment, which occurs *in situ* on the saddle at the head of Finch Creek, is evidently of Recent age.

PEAT.

The almost continuous mists, broken only by intermittent bursts of sunshine, provide conditions favourable for the formation of peat. Under such waterlogged conditions in locations where plant-growth is abundant, the remains of the dead vegetation accumulates slowly. To this may be added a small addition of blown sand. The accumulation of peat is so extensive in some localities as to completely obscure the underlying rock formations.

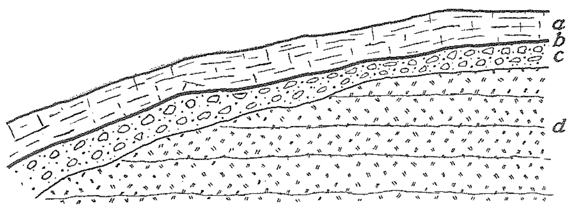


FIG. 42. Section illustrating the occurrence of lignite at a point about a half-mile south of the Expedition Hut. (*a*) Peat; (*b*) Lignite; (*c*) Fluvio-glacial gravel and clay; (*d*) Dolerites.

In many places the peat formed principally from the coarse tussock-grass reaches a thickness of 8 feet. It occurs over all the coastal slopes, lower foothills, and in wind-sheltered valleys on the uplands (Plate XX, fig. 1). In the swampy tracts along the elevated marine bench, flat valley bottoms, and on the sites of reclaimed lakelets, the peat is composed of sphagnum moss and other swamp-frequenting plants, but it seldom reaches a greater thickness than 1 foot, being generally only half that dimension.

The peat beds are thoroughly saturated with water and form an effective covering on the otherwise exposed rocks and Till, and so limit weathering and prevent denudation by mechanical transportation.

As the rock beneath the peat is usually quite fresh and unweathered, it is evident that the peat growth immediately succeeded the recession of the land ice-sheet.

Reference has already been made (page 84) to the occurrence of post-glacial peat [79] exposed in a section just north of Nuggets Point and to the peat [80] overlying the fluvio-glacial beds on Wireless Hill (page 82).

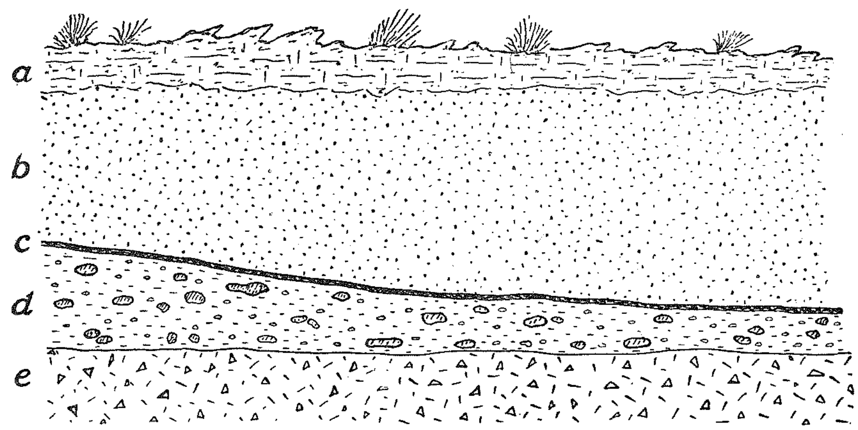


FIG. 43. Fluvio-glacial deposits on the eastern side of Wireless Hill. (*a*) Recent Peat—3 feet; (*b*) Fine sub-angular sand and grit—7 feet; (*c*) Dark peaty mud—3 inches; (*d*) Clay containing partly waterworn glacial boulders; (*e*) Volcanic Breccia.

At the head of a small gully half a mile south of the Expedition Hut a small seam of sapropelic lignite [116] & [117] was observed (fig. 42). It is of a brilliant appearance resembling jet in lustre and fracture. It occurs below the more recent peat, and rests on a thin layer of fluvio-glacial gravel and clay immediately above the dolerites of the Older Basic Series. The seam is one quarter of an inch in thickness, and its upper surface is conspicuously slickensided by former slipping movements of the overlying peat.

SOILS.

Samples of surface soil were collected by Blake from a number of localities. Their examination was kindly undertaken by F. B. Guthrie, Chief of the New South Wales Agricultural Department's laboratories. The mechanical and chemical analyses of these soil samples (which were made in the year 1916) are submitted herewith, accompanied by some remarks by Mr. Guthrie.

On visiting the Island in 1930, I secured further soil samples. These were submitted to the Waite Research Institute of Adelaide University, whose report concerning them has already been published.[29]

Soil Samples Submitted to F. B. Guthrie for Report.

No. [191]. A brown peaty soil full of root-fibres, and having a very high water capacity. Collected from above the glacio-fluvial deposits on Wireless Hill. The growing vegetation is *Poa foliosa*.

No. [192]. A brown peaty soil with a very high water capacity, collected on Wireless Hill from an area on which no vegetation was growing at the time. Probably *Poa foliosa* covered the area in former times, No. [193]. A dark-brown peaty soil, very sour and wet, and with a high water capacity. This was collected from the north-west slope of Wireless Hill overlying basic volcanic breccia. The local vegetation at this spot is *Poa foliosa* and *Stilbocarpa polaris*.

No. [197]. A dark-brown peaty soil overlying basaltic rock on Hut Hill. A large proportion of the sample was constituted of stones. The existing vegetation on Hut Hill is *Poa foliosa*.

No. [220]. A very moist light-grey sandy loam with a very unpleasant odour, collected from the slopes of Gadget Gully, whose underlying rock is dolerite.

No. [221]. A moist, chocolate-brown, peaty soil with an offensive odour, containing some stones. This was collected from above a fluvio-glacial deposit in a creek to the south-west of Station 3 (near north end of the west coast). The local vegetation is recorded as *Poa foliosa* and *Stilbocarpa polaris*.

No. [222]. A light-greyish brown, stony loam from the slopes of Half-Way Hill. The underlying rock is volcanic breccia and the existing vegetation is *Poa foliosa*.

No. [259]. A grey gravelly sand from the raised beach of the Isthmus at North End. The local vegetation is *Poa foliosa*.

No. [260]. A moist greyish-brown gravelly and sandy soil from the raised beach. There is a rich growth of *Stilbocarpa polaris* in the area. The sample had an extremely offensive odour.

No. [261]. A dark greyish-brown stony loam containing some clay from the talus slope above the locality where sample [260] was collected. The underlying rock is basaltic.

These soil samples were collected by Blake in 1913. They were sealed in containers in the wet state. It was not until the year 1916 that they were chemically examined. At that time some of them emitted an offensive odour which was certainly not anything like so apparent when they were freshly collected.

CHEMICAL ANALYSES OF MACQUARIE ISLAND SOILS.

Sample Number	191	192	193	197	220	221	222	259	260	261
Moisture	63·23	66·08	77·66	62·42	17·12	45·85	30·16	4·55	12·63	12·21
Organic Matter	17·04	15·05	11·11	13·55	5·12	9·44	8·20	2·96	2·35	4·80
Mineral Matter	19·73	18·87	11·23	24·03	77·76	44·71	61·64	92·49	85·02	82·99
Lime as Carbonate ($CaCO_3$)	1·18	1·75	3·28	1·25	3·28	2·78	3·64	12·36	7·95	4·91
Potash (K_2O)	0·41	0·67	0·54	0·11	0·09	0·14	0·43	0·09	0·07	0·06
Phosphoric Acid (P_2O_5)	0·70	0·38	0·78	1·11	0·15	0·38	0·43	0·26	1·08	0·28
Nitrogen as Nitrate (parts per million).	0·2	0·2	0·3	0·2	0·1	0·2	0·2	0·1	0·1	0·1

MECHANICAL ANALYSES OF MACQUARIE ISLAND SOILS.

Sample Number	191	192	193	197	220	221	222	259	260	261
Colour	Brown.	Brown.	Brown.	Brown.	Light-grey.	Brown.	Light grey-brown.	Grey.	Greyish-brown.	Greyish-brown.
Nature of Soil	Peat.	Peat.	Peat.	Peat and stones.	Sandy Loam.	Peaty Loam.	Stony Loam.	Sand.	Sand.	Stony Loam.
Reaction	Strongly Acid.	Strongly Acid.	Strongly Acid.	Strongly Acid.	Alkaline.	Acid.	Very faintly Acid.	Very faintly Alkaline.	Faintly Acid.	Alkaline.
Water Capacity (expressed in %).	142	76	136	57½	37	68	32½	22½	26	23
Capillary Power (inches in 3 hours).	6¾	6¾	...	5½	5¼	9	6¾	2¾	5½	5½
Root Fibres (%)	1·41	0·68	0·70	0·27	0·37	0·79	0·15	...	...	0·13
Stones (%) (over ¼″ diam.)	...	...	9·88	27·45	3·59	8·17	30·46	...	0·75	22·93
Coarse Gravel (%) (over 1/10″ diam.).	1·12	0·96	15·02	18·14	9·33	14·14	18·68	...	0·6	26·36
Fine Gravel (%) (over 1/50″ diam.).	3·88	10·03	2·64	11·78	28·51	13·51	16·48	74·50	75·12	25·98
Sand (%) 1/50″—1/2,500″ diam.).	18·76	20·90	5·35	7·46	32·03	39·46	32·06	25·50	23·53	10·20
Clay (%) (less than 1/2,500″ diam.).	...	...	...	...	26·17 }					
						23·93	2·16	...	Nil.	14·14
Humus (%)	74·83	67·43	66·41	34·90	Nil. }					

Some General Remarks on the Soils Examined.
By F. B. Guthrie.

Soils No. [191] to [193] are peaty soils, very wet when received and with strong acid reaction (sour). Owing to their high humus content, these soils have a very high water-absorbing and retaining power. The difference in the proportion of humus as disclosed by the mechanical analysis, and the amount of organic matter shown in the chemical analysis is to be explained by the fact that the humus in the mechanical analysis contains water, and is practically the fine material exclusive of sand, gravel, and clay; whereas the " organic matter " of the chemical analysis represents the volatile portion of the soil exclusive of water and carbonic acid. None of these soils contain clay.

Nos. [220], [221], [222] and [261] are the only soils containing clay in sufficient quantity to entitle them to be designated loamy, No. [221] being a peaty loam, and the others light sandy loams with very little humus.

Nos. [259] and [260] are practically pure sand or gravel. They are all fairly well supplied with lime. Nos. [222], [259] and [261] are alkaline in reaction. No. [259] is particularly rich in carbonate of lime.

The peaty soils are all fairly rich in potash and phosphoric acid, as is also No. [222]. In fact, if compared with ordinary arable soils of the Australian continent, all the soils are well supplied with mineral plant-food.

Nitrates are present in about the quantities one would expect from soils of this nature.

Beach Deposits.

The rough seas on the shores of Macquarie Island are great erosive agents and result in the rapid production of great quantities of sea-worn boulders, shingle and finer products. However, so turbulent is the sea that the finer products are carried well out from the land. Consequently sand is not much in evidence on the beaches (Plate VIII, fig. 1). Beds of shingle and boulders form the beaches in the more sheltered areas, elsewhere rocky cliffs and reefs form the coastline.

On the raised beach terrace, below recent peaty terrestrial accumulations, this shingle is met with overlying the solid rock. Out from the land, except in some of the major recessions of the coastline no large proportion of anything in the nature of sand appears on the sea-floor until well out from the shore. Our dredging operations proved that shingle beds extend out into quite deep water. It is often far from the land before a 100% sand or mud bottom makes its appearance. For instance, when dredging from the "Discovery" in 1930, located about 2½ statute miles on a bearing about north-west from North Head, the bottom sediment brought on deck from a depth of 60 fathoms was practically all fine grey sand (with molluscan shells). At a point about 2 miles from North Head on a bearing about north-north-west, in a depth of 40 fathoms, the bottom deposit was found to be dominantly coarse shingle. Off the east coast near Lusitania Bay, nearly a mile from the shore in 33 fathoms, the bottom deposit was again largely composed of shingle.

A sample of sand collected from the beach near the Nuggets has been examined in some detail. It represents material which, mainly by wind and wave action, has had the heavy minerals concentrated in it at the expense of lighter elements such as feldspar. The latter is found to be almost entirely absent. The chief constituents in order of abundance in the finer fraction are magnetite, ilmenite, picotite, and olivine. In the coarser fraction enstatite is notable. This sand was principally derived from the erosion of the Till which occupied part of the cliff face near by.

MINERAL VEINS.

Blake recorded that "Mineral veins occur in the pre-glacial rocks of all ages on Macquarie Island, but they are most abundant in the dolerites of the Older Basic Group near their contact with the gabbroid intrusives at the northern end of the Island." Consequently Blake regarded the veins in the Older Basic Group as genetically connected with the gabbroic intrusions. In this group of rocks, quartz is the principal vein filling, but calcite [131] is also a frequent constituent. In less amounts are pyrite, chalcopyrite and galena. In some of the quartz-calcite-pyrite veins, selenite occurs.

"The mineral veins, though numerous, are rarely more than 2 inches in thickness. They send out innumerable stringers, filling small fissures in the intruded dolerites, but show no predilection for either the upper or under side of the sills. In the joints and fissures in the dolerites of the cliffs near Nuggets Point, veins of an alabaster type of gypsum contain occasional small crystals of marcasite."

"The mineral veins of the Younger Basic Group belong to the true fissure type. Some of those observed were partly filled with brecciated wall rock in various stages of mineralization. They are always siliceous, quartz being the principal vein filling. In addition pyrite, sphalerite and galena are often present in greater or less amount."

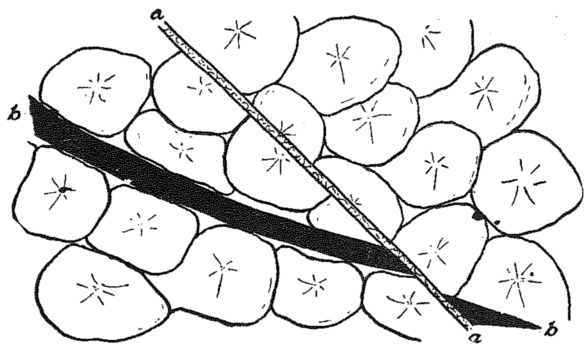


FIG. 44. Sketch Section through a dyke (*b*) intruding Pillow-Lava and subsequently displaced along the line of a quartz vein (*a*).

In the case of veins in the dolerites of the Older Basic Group, faulting subsequent to their deposition has been observed. In connection with the Younger Basic Group, Blake remarked that veins were observed filling fault fissures.

[65] is a banded quartz reef which intersects the dolerites on the west side of the Isthmus. It is composed almost entirely of quartz in fine-grained comb-structure. Distributed through it are pyrite and occasional particles of chalcopyrite as well as a little galena and brown zinc blende.

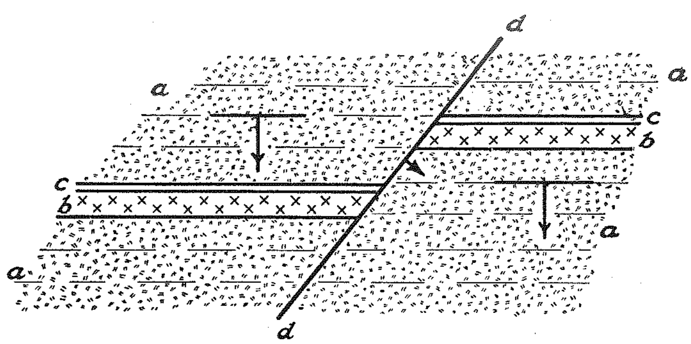


FIG. 45. (*b*) Is gabbroid intrusion into (*a*) dolerite of the Older Basic Group. (*c*) Is quartz vein with pyrite, etc.; (*d*) Is a line of subsequent fault.

[69] and [126] both illustrate vein quartz filling a shatter zone in dolerite, which latter has been profoundly altered and pyritized by the vein solutions.

Several pyritized vein-stuffs from Macquarie Island have been assayed, with the following results. A beach boulder containing pyrite, collected in the year 1909 by Capt. J. K. Davis, was assayed in London for precious metals and yielded 9 dwts. of silver to the ton, but no gold. Dolerite with pyrite from Caroline

Cove collected by me in 1911, assayed by J. H. Mingaye of the Mines Dept., Sydney, was found to contain neither gold nor silver.

More recently the examination of several specimens from Blake's collection of vein-stuffs was undertaken by T. W. Dalwood, Government Assay Department, Adelaide. Mr. Dalwood reports that gold was not found in any of them, but that the content of other useful metals is as follows :—

1. Specimen [237] from a reef in the creek north of Station 20 was found to contain 6·95% of copper and 13 oz. of silver to the ton.
2. A siliceous rock from a reef in Gadget Gully contains 4·15% of copper and 6 dwts. of silver.
3. Material from a siliceous reef on the shore of Hasselborough Bay contains 0·13% copper, 3·08% lead, 1·98% zinc, and 2 dwts. of silver.
4. Partly oxidized siliceous rock from the head of Rookery Creek contains 2·28% of copper, but no silver.

No quartz veins were observed in the body of the gabbro, but veins occupied by actinolite, tremolite and talc are not an uncommon feature. Also prehnite appears in the Gabbroid Group in small veins and stringers, more especially in connection with felspathic bands in the ultramafic rocks. A specially good example of prehnite rock is [252], which was collected as a vein formation at sea-level below Station 43. Examined microscopically, this proves to be a veined arrangement of prehnite crystals, exhibiting comb-structure, traversing a cryptocrystalline base which, if not entirely prehnite, is mainly so.

The zeolites, analcite and natrolite together with some calcite, are commonly present in hollow bombs and in cavities and fissures in volcanic breccias of the Younger Basic Group. Less frequently chabazite makes its appearance. The zeolites are often well crystallized. Several selected crystals of analcite from the volcanic breccias were examined by Mr. J. O. G. Glastonbury, then of the Dept. of Geology, Adelaide University. He found by goniometric measurements that the forms represented are the (411), (211), (112), (114), (121) and (141). A refractometer measurement of the refractive index gave 1·482.

Blake found a phosphatic encrustation on the walls of a cave on Wireless Hill. This appears to have originated from leachings from bird guano. The whitened feldspars of certain gabbro erratics in the Nuggets penguin rookery were found to be superficially phosphatized by reaction with the guano.

SUMMARY OF GEOLOGICAL HISTORY.

The earliest rock formation on the Island, Blake's Older Basic Group, is a thick series of basaltic flows and sills with associated tuffaceous greywacke. This formation may be Tertiary in age, but probably dates back to about middle-Mesozoic, and may be referable to the period of large-scale intrusions of dolerite into the Triassic sediments of Tasmania and Antarctica, and linked with the dissolution of Gondwana Land. Certain mineralogical changes which have been effected in some of the rocks of this Group, and the fact that they have been subjected to a high degree of folding since their formation supports the view that they may well be pre-Tertiary in age.

This oldest formation suffered crumpling, probably in Cretaceous or early-Tertiary time, and into the folded system welled up gabbroic magmas which by gravitative differentiation has yielded a well-graded series of gabbros and peridotites, probably homotaxial in point of age with the Dun Mountain ultra-mafic intrusion of New Zealand. There has been observed some local thermal metamorphism of the invaded rocks, as well as cases of propylitization with the introduction on a small scale of mineral veins carrying sulphides of iron and copper and less frequently lead and zinc which in some occurrences were found to be argentiferous.

Up to this time there is no clear indication as to whether the rock formation was sub-aerial or sub-marine.

Then followed a period of erosion, apparently sub-aerial, which laid bare the plutonite masses. This appears to have been in late Cretaceous and early Tertiary time.

The eroded land surface then, in part or whole, subsided to some considerable depth beneath the sea, receiving over it a deposit of Globigerina ooze. Then followed another period of diastrophism with large outpourings of glassy, basaltic pillow-lava which burst through the Globigerina ooze of the sea-floor. This effusion may correspond in time with that of the tachylitic pillow-lavas of the marine Miocene at Oamaru. The volcanic period appears to have ended with an area of land in the region of Macquarie Island probably considerably greater than exists at present.

After some degree of peneplanation of the land had been effected the Pleistocene Ice-Age intervened.

There is abundant evidence that any land that existed in the neighbourhood of Macquarie Island during the Pleistocene period suffered extreme glaciation. Certainly all that now remains was over-ridden by an ice sheet of considerable proportions which, from a gathering ground further to the west, moved towards the east-north-east across the present land area. The fact that the harzburgite found *in situ* only on the western margin of the Island was carried as erratics by the ice to the east coast, leaving a train of dumped blocks across the highlands at an elevation of about 1,200 feet above its present *in situ* location is proof that the glaciation was on a grand scale, and that the main ice-cap was situated to the west* of the present Island mass where there is now deep sea.

Though Blake located near Nuggets Point three different superimposed moraines, the varying rock assemblage in each indicating different sources of

*In his notes Blake made the suggestion that possibly, at the time of the Ice-Age, Macquarie Island was land coextensive with Antarctica, and that it was the Antarctic ice-sheet which over-rode it. This argument, however, cannot be sustained.

supply and varying directions of ice-movement, yet this information alone is not sufficient to demonstrate that at Macquarie Island the glacial period was divided into three divisions corresponding with those established by A. N. Lewis in Tasmania[45]. Such a record could well have resulted from changes in the land area owing to block faulting during the progress of glaciation. It appears incontrovertible that such block subsidences did take place in the Pleistocene, apparently corresponding to the Kaikouran deformation of New Zealand. The final result of such movements has been the submergence of portion of the ice-covered land and the survival of the present land mass as a horst.

During the height of the glacial period there can have been little if any of the land in that region not buried under ice. The only suggestion to the contrary comes indirectly from the existence on the Island to-day of certain invertebrates, apparently not capable of migrating across the sea, and whose presence appears to suggest that they are survivors from pre-glacial times.

Marine erosion which, in that latitude in the Southern Ocean, is a powerful agent, has in recent times carved a notable wave-cut platform around the Island. A very recent positive movement of the land, possibly related to isostatic adjustment after relief from the former ice load, has raised the wave-cut platform up to a height of 40 feet above sea-level. This raised-beach terrace is now, in its turn, being rapidly cut back. So rapidly is its destruction being accomplished that arms of it which protected what were known to the early sealers as Caroline Bay and South-East Bay are now represented only by broken chains of submerged reefs and rocks; thus have been rendered useless what at one time were serviceable anchorages.

PETROLOGY

THE GABBROID ROCKS AND ASSOCIATED DIFFERENTIATES

The plutonites of this division, though dominantly basic, include a considerable range of types, to representatives of which detailed references will be made hereafter.

THE GABBROS

Among these is a great development of anorthitic plagioclase (bytownite and even anorthite). In the case of these highly-calcic feldspars I have to thank my colleague, W. B. Dallwitz, for checking earlier determinations based on extinction angles and refractive indices by measurements which he made by the zonal method, using the Fedorow universal stage. Plagioclase as basic as Ab_5An_{95} was thus indicated. These anorthitic feldspars are strikingly twinned not only on the Carlsbad, albite and pericline laws, but rarer forms of twinning also appear to be represented.

The olivine is always partly or wholly serpentinized and never quite fresh. Consequently in the hand specimen the presence of olivine, and serpentine after olivine, is indicated by structureless black patches.

The common pyroxene is diallage, which is notably diopsidic. Seen in the hand specimen it is light-coloured and easily distinguished by flashes from its cleavage faces.

Enstatite, when present in the serpentinized ultramafics, is converted to bastite, which, as flashing bronzy plates, stands out clearly against the featureless serpentine derived from olivine.

A brown hornblende and a red-brown biotite (phlogopite) have been observed, but are of quite rare occurrence except in pegmatite veins or other abnormal situations.

Magnetite where it occurs is usually of secondary origin consequent on serpentinization of the olivine. As a primary constituent it is inconspicuous.

The spinelid, picotite, is present in small quantities, especially in the richly olivinic rocks. It is probably chromiferous. Occasional grains of what appears to be chromite has been observed in association with the picotite.

Secondary changes which have affected these rocks include not only wholesale serpentinization but also prehnitization, which is widely evidenced, more particularly in rocks rich in anorthitic plagioclase. Nothing unusual has been observed concerning the process of serpentinization. An illustration of the partial serpentinization of olivine in these rocks is supplied in Plate XXXVII, fig. 2.

The development of prehnite calls for special mention. It is the calcic feldspars that are prone to this change. In the microscope preparations every stage in the development of prehnite is represented from a first beginning as a clouding of the feldspar to the ultimate recrystallization as coarse aggregates (Plate XXXII, fig. 3). The latter are usually granular, and it is not uncommon for single individuals of these aggregates to reach a diameter of 1 mm. The bow-tie structure commonly exhibited by prehnite is but very poorly represented.

Prehnite is also met with, filling narrow secondary veins which traverse the rock at random. Such veins are usually very narrow and only faintly marked in the hand specimen, but show up strongly in the microscope slide (Plate XXXII, fig. 4).

Normally the pyroxenes of these rocks have not been affected by uralitic changes. Where this has occurred it is usually restricted to local stressed areas, but exceptions do occur.

It will be noted that on account of the advanced state of serpentinization in some of the richly olivinic rocks, the specific gravity of such is greatly lowered.

GABBRO.

Rock [66] was collected by Blake *in situ* from the highland near the north-west corner of the Island. The nature of the outcrop is not stated, but it is one of the coarse gabbroic rocks intruding the Older Volcanic Series. It is very coarse-grained and somewhat schlieric, suggesting in the hand specimen that it represents a somewhat pegmatitic phase of gabbroic magma. The pyroxene reaches a maximum length of 4 cms. The specific gravity determined on the powdered rock as analysed is 2·893; determinations on random pieces of the rock ranged from 2·83 to 2·96.

Microscopically examined, it is observed to be a holocrystalline, allotriomorphic, coarse-grained, granular rock composed essentially of plagioclase and pyroxene.

The plagioclase is observed to be unusually fresh and to exhibit albite, Carlsbad, and pericline twinning in broad lamellae. It is optically positive, and has a high optic-axial angle. Measurements of extinction angles on twin lamellae give a composition $Ab_{42}An_{58}$, which corresponds to the theoretical composition as deduced from the norm. The mean refractive index determined on chips is about 1·56. It appears, therefore, to be a medium type of labradorite, and is thus less basic than the feldspars of the other gabbroic rocks herein described from Macquarie Island.

The pyroxene is in large individuals. In some cases abundant, minute, parallel inclusions of iron ore result in a schiller effect. Diallagic parting is well marked in some individuals, and there is evidence that diallage has developed from augite in local stressed areas. A faint pleochroism is just discernable: X = warm pinkish tone, Y = colourless, Z = faintly greenish. Most sections exhibit oblique extinction, giving angles of about 44 degrees. The majority of the pyroxene crystals are biaxial positive, length slow, have a mean refractive index of 1·70, and a large optic-axial angle. These characters indicate it to be a diallage rather rich in calcium and magnesium. In addition, there are occasional more highly pleochroic pyroxenes which are optically negative and therefore hypersthene.

Magnetite is irregularly distributed, some of it as inclusions in the pyroxene, and almost all the remainder as irregular forms adhering to the periphery of the pyroxene. Pyrrhotite, which appears in less amount than the magnetite and pyrite, is present only as occasional grains.

There is little in the nature of secondary alteration products, but some faintly-greenish chlorite appears occasionally along lines of fissuring.

The chemical character of this rock is illustrated by the analysis given in the table on page 108. From this the norm has been calculated as follows:—

Orthoclase	0·50	Apatite	0·10
Albite	24·94	Calcite	0·34
Anorthite	34·53	Pyrite	0·16
Diopside	19·17		
Hypersthene	12·03		99·32
Olivine	3·07	Water (combined)	0·48
Magnetite	2·69	Water (hygroscopic)	0·19
Ilmenite	1·79		
		Total	99·99

The C.I.P.W. classification based on this norm is III (II). 5. 4. 4–5 (Hessose Auvergnose).

[92] is a highly-feldspathic, diopsidic diallage-gabbro, free from olivine. It occurs *in situ* near Station 2. The feldspars which are labradorite are quite fresh, which feature is in contrast to the case of all the other gabbros excepting [66]. In this rock the feldspars are for the most part hypidomorphic and elongated, so that the texture is not the usual allotriomorphic granular type characteristic of the plutonites. It is probable that the occurrence is of the nature of a minor intrusion.

NORITE.

[246] is a light-grey, fine-grained gabbro from the creek, 200 yards north of Sandy Bay Camp. Presumably this rock was found *in situ*. It is composed of basic labradorite and ash-grey enstatite in the proportion of about 75% to 25% respectively.

OLIVINE GABBRO.

Rock [91] is a gabbro from near Blake's "Station 2," which is a hill-top 718 feet in height shown on his map just south of latitude 54° 30′ S. The specimens examined are of a coarse, dark-coloured rock, with a specific gravity of 3·01. The average diameter of the mineral grains as viewed in the hand specimens collected is about 0·5 cm. However, there appears one large individual of diallage measuring 3 cm. in length; this, it is assumed, is an exceptional and adventitious occurrence.

Microscopically examined, it is seen to have a gabbroic allotriomorphic granular texture. The plagioclase is approximately of the order of $Ab_{32}An_{68}$, a basic labradorite. A nearly colourless variety of diallage is abundant; it frequently shows peripheral change to a slightly greenish, uralitic amphibole and some chlorite.

The original rock contained large olivines, but almost all of these have been converted to aggregates of secondary minerals, amongst which are discernible much serpentine, some fine granular talc and a little magnetite.

The slide examined indicates the approximate volume (micrometrically determined) composition of the original rock to have been plagioclase 36%, pyroxene 35%, and olivine 27%, and iron ores, etc., 2%.

The chemical composition is given on page 108. The norm has been computed as follows :—

Orthoclase	0·95	Magnetite	2·67
Albite	10·53	Apatite	0·77
Anorthite	28·80		
Diopside	25·99		97·46
Hypersthene	4·72	Water (combined) ...	2·10
Olivine	23·03	Water (hygroscopic) ...	0·46
		Total ...	100·04

In the C.I.P.W. classification this is III. 5. 4. 4–5 (Auvergnose).

[369] is an olivine-gabbro collected as an erratic at Aerial Cove. It is rich in anorthitic labradorite and contains plentiful diallage and partly serpentinized olivine. Idiomorphic bytownite is met with embedded in large crystals of diallage.

[370] is an olivine-gabbro erratic from Aerial Cove. It is rich in diallage and low in olivine. Plagioclase crystals are embedded in both the olivine and the diallage. Some of the olivines have reaction rims of enstatite.

[358] both olivine and diallage are abundant with decrease in the plagioclase. [351] is another of this group.

TROCTOLITE.

[369A] is a coarse-grained olivine-gabbro with only very little diallage. The plagioclase is notably calcic.

[386] and [353A] are also of this group, with only a very minor percentage of diallage. The feldspars are very basic and serpentinization of the olivines far advanced. The specific gravity of 353A was ascertained to be 2·743.

EUCRITE.

These are bytownite-diallage-gabbros, free or nearly free from olivine.

[355] is a light-coloured, coarse-grained gabbroic rock free from olivine, collected as a boulder on the beach north of Nuggets Point. Its specific gravity is 3·019. The feldspar is a highly calcic plagioclase, but it has been prehnitized to such a degree that the determination of the original composition is not possible. Where best developed the prehnite is in coarse granular aggregates Plate (XXXII, fig. 3) and the original feldspar reduced to a dull porcelain-white paramorph. Diallagic pyroxene in crystals about 1·5 cms. in length is abundant ; from it, but only to a minor degree, there has been developed uralitic tremolite. There are present occasional scattered grains of sphene.

[370A] is essentially a bytownite-diallage-gabbro, with the addition of a very little olivine. The specific gravity is 2·852. This was collected as a loose pebble at Aerial Cove. It has undergone a certain degree of secondary change, resulting in the serpentinization of the olivine and partial breakdown of the plagioclase. The more notable of the secondary minerals is prehnite, which has been developed on a considerable scale in local concentrations and veins. The silvery-grey diallage is diopside. Feldspar is present to the extent of about 65%.

[266] is a gabbro collected as a beach boulder at Hasselborough Bay. Its specific gravity is 2·834. This gabbro is composed of basic labradorite, a high percentage of diallage, and some enstatite. Olivine is absent. As the result of secondary changes, there have been introduced a little epidote and talc, some serpentine and prehnite, which latter is restricted to patches and veins. (369) is closely related to this.

OLIVINE-EUCRITE.

Rock [3] is a eucrite which occurs *in situ* at Handspike Point. It is a coarse-grained grey rock of mottled appearance. The latter effect is due to its being constituted of a mixture of somewhat whitened feldspars and dark-grey ferro-magnesian constituents. The specific gravity is 2·984.

Examined microscopically, it is observed to be a holocrystalline, hypidiomorphic equigranular rock with a mean grain-size of about 4 mm. The essential primary constituents are plagioclase, pyroxene and some olivine. Secondary changes have profoundly affected the olivine, and to a less extent, also, the plagioclase and pyroxene.

Plagioclase is the dominant mineral. Albite twin lamellae are on a coarse scale; Carlsbad and pericline twinning are well represented. The measurement of extinction angles indicates the composition to be not less anorthitic than $Ab_{20}An_{80}$. It is biaxial negative. The mean refractive index was found to be about 1·573. Thus the feldspar is bytownite. To a limited extent secondary changes have operated, resulting in a turbidity of the feldspar in some areas. The change products appear to be principally kaolinite or gibbsite and occasional minute grains of calcite.

Pyroxene of a colourless to grey colour as seen in the microscope section is a prominent constituent developed in subhedral crystals up to as much as 8 mm. in diameter. The cleavage traces stand out strongly, and in basal sections three sets are well defined. It is biaxial positive and has positive elongation. The extinction angle $Z \wedge c = 49°$. It is thus diallagic augite. In general this diallage has not suffered change to secondary products, but in several cases there exists a narrow marginal zone of uralite.

Olivine is present in subordinate amount, though usually appearing as large individuals reaching as much as 9 mm. in length. In a few cases there is a narrow marginal reaction rim of diallage. The olivine is considerably altered to antigorite with a sprinkling of magnetite grains. A little talc also appears to be present in the paramorphic assemblage of alteration products.

The chemical analysis of the rock is stated in the table on page 108.

The Norm has the following composition :—

Orthoclase	0·56	Ilmenite	0·21
Albite	11·89	Apatite	0·10
Anorthite	52·93		
Nepheline	0·91		99·01
Diopside	17·41	Water (combined) ...	1·21
Olivine	13·98	Water (hygroscopic) ...	0·14
Magnetite	1·00		
		Total ...	100·36

From the above the C.I.P.W. classification is II. 5. 5. 4–5.

A Rosiwal micrometric analysis in terms of the outstanding constituents gives the modal composition of this rock as follows :—

Bytownite		52
Pyroxene	32·5	37
Secondary products from the alteration of pyroxene	4·5	
Olivine	5	11
Serpentine from the alteration of olivine	6	
Total ...		100

Some hand-specimens of this rock contain a slightly higher content of the ferro-magnesian minerals. Microscopic preparations from one which had this appearance gave, on measurement, a feldspar content of only 47·5%. Thus it is indicated that the average type of this gabbro must have a feldspar content of about 50%.

ALLIVALITE.

Rock [9] is a moderately coarse-grained, light-coloured allivalite which occurs as a dyke-like intrusion in the Older Volcanic Series at Half-Moon Bay and Langdon Bay. In the hand specimen it is presented as black spots, averaging 5 mm. diameter, studded through a white feldspathic base. The whitened feldspar greatly predominates in amount, there being on the average an area of feldspar 1 cm. in width between each of the spots of serpentinized olivine. The specific gravity of this rock is 2·791.

Microscopically examined, it is observed to be a holocrystalline, hypidiomorphic, granular rock of about 1·5 mm. average grain-size as viewed in microscope slide. The more obvious constituents are plagioclase and serpentinized olivine.

Plagioclase is very abundant, and much of it is quite fresh, though some areas are affected by saussuritization. Twinning on the albite and Carlsbad law is general and pericline twins are not uncommon. The composition as determined by extinction angles on twin lamellae is not less than $Ab_{15}An_{85}$, and this is supported by a determination of the mean refractive index which is 1·575 or somewhat higher. The feldspar is thus anorthitic bytownite. The theoretical composition as indicated by the norm is $Ab_{11}An_{89}$. In some areas, the feldspars are considerably affected by secondary processes with the production of clinozoizite and tiny particles of a mineral, which so far as can be ascertained has the characters of gibbsite.

Olivine appears in the slide in individuals up to 1·5 c.m. diameter. It is rather abundant, but much has been converted to secondary products among which appear antigorite, with a little greenish chlorite and serpentine studded with magnetite dust. A matter of special interest is the appearance of a narrow zone of fresh, optically continuous pyroxene fringing portions of the periphery of some of the olivines.

Diopsidic pyroxene in very small grains is embedded in the feldspar of one portion of the slide. It is inconspicuous and in very small amount.

Scattered through the slide are patches up to 2 mm. diameter, with strong relief and distinct cleavage which exhibits anomalous blue-grey interference colours. It is biaxial positive, and in other respects also has the optical characters of clinozoizite. Its appearance in this rock is, in fact, a notable occurrence of a type of clinozoizite exceptionally low in the pistacite molecule.

The chemical character of this rock is stated in the table on page 108. The norm deduced from the chemical analysis is as follows :—

Orthoclase	0·56	Magnetite	2·95
Albite	14·62	Apatite	trace
Anorthite	60·41		
Nepheline	0·14		97·48
Diopside	4·87	Water (combined) ...	2·24
Olivine	13·93	Water (hygroscopic) ...	0·16
		Total ...	99·88

The C.I.P.W. classification is II. 5. 5. 4–5.

The Mode as relating to the original constituents of the rock, has been determined by micrometric analysis as follows :—

Feldspar	87·0	Pyroxene	1·0
Olivine (fresh)	4·5	Clinozoizite	0·8
Olivine (alteration products)	6·7		
		Total ...	100

Rock [4] is an allivalite occurring as a dyke at Half-Moon Bay. It is closely related to [3], differing from it by containing much more olivine at the expense of the pyroxene. Macroscopically examined, the feldspars appear milky white and the ferromagnesian minerals are dark blotches. The change of colour in these minerals is due to saussitization and prehnitization in the one case and serpentinization in the other. The appearance of the rock is, thus, coarsely and characteristically spotted (troctolite type). The specific gravity of this rock is 2·840.

The microscopic examination reveals it to be a coarse-grained holocrystalline, allotriomorphic, granular rock, originally consisting of plagioclase, olivine, and diallage, but these minerals have been greatly affected by secondary changes. The average grain-size of the mineral particles is about 8 mm.

The plagioclase comes within the range of anorthite. Much of it is now presented as paramorphs in secondary minerals.

The olivine, which is abundant and in large individuals, is greatly affected by serpentinization, but the diallage is comparatively fresh. Some of the diallage is developed as a narrow rim around olivine crystals. Some primary iron-ore is recognizable, but most is secondary, derived from the olivine. A special feature is the appearance, on a limited scale, of some brown hornblende in small crystals along definite tracts intergrown with the diallage; it has every appearance of being a primary mineral.

A micrometric analysis gave the following proportions of the mineral constituents :—

Bytownite-Anorthite		59·1
Olivine, fresh	9·0	26·8
Olivine, serpentinized	17·8	
Diallage		13·3
Hornblende		0·7
Primary iron ores		0·1
Total ...		100·0

HARRISITE.

(Serpentinized.)

Grouped here are serpentinized rocks which must have originally corresponded closely to Harker's harrisite. They are characterized by a very low percentage of highly-anorthitic plagioclase and great abundance of olivine. All specimens of this group were collected as erratics directly out of the Till or shed from the Till. Nos. [353], [357] (Plate XXXIII, fig. 3) and [387] are examples that have been completely serpentinized. In the case of [43] some olivine kernels have escaped alteration. Diallage is present. Bytownite amounts to about 15% of the rock.

ULTRAMAFIC ROCKS

HARZBURGITE.

(Serpentinized.)

Rock [5] is stated to occur as a dyke at Half-Moon Bay. It is an enstatite peridotite, which has undergone almost complete serpentinization. It is a dark-grey rock in which bright reflecting crystals of a bronzy appearance (bastite) are embedded in dull, featureless serpentine. Its specific gravity is 2·637.

The microscope section reveals that the bulk of the rock is serpentine representing former olivine. The only other original mineral appears to have been enstatite, but even this is almost entirely converted to bastite. There remain only occasional kernels of enstatite. As observed in the microscope slide, the average diameter of the enstatites and their bastite pseudomorphs is about 4 mm., though some reach a diameter of 7 mm. Tiny flakes of talc are located in the peripheral area surrounding the bastite. Feldspar is absent. Glaciated erratics of this rock occur abundantly in the Till at the north end of the

Island. In microscope slides of some of these latter, grains of chromite have been observed.

By micrometric measurement it was ascertained that the mineral composition of this rock is 75% antigorite after olivine and 25% enstatite and bastite (after enstatite).

In appearance this rock closely resembles specimens of the well-known serpentinized-enstatite peridotite from Kuttenberg, Bohemia.

This Macquarie Island example is traversed by several types of veins resulting from shearing movements which latter have favoured mineral changes. One of these bleached veins, measuring up to 1 cm. in width, exemplified by specimen [28] was found to be a zone of special alteration products, including talc and chlorite. Others, exemplified by [156], up to 3 cms. in width, were occupied by talc with marginal tremolite. A third type [157] was observed to be mainly a zone of serpentine and talc.

[31], [96], [102], [168], [195], [227], and [363] are erratics composed of completely serpentinized enstatite-peridotite, collected from the Till in the northern areas of the Island. Such erratics are so closely similar petrologically to [5] that there is no reason to doubt Blake's conclusion that they were derived from the intrusion at Half-Moon Bay.

DUNITE.

(Serpentinized.)

Somewhere in the former extension of Macquarie Island there must be an area of dunite for erratics of serpentine with all the characters of that derived by the serpentinization of dunite are met with in the Till. Examples of such are [88], [89], [165] and [167]. The latter two are studded through with brilliant specks of what appears to be chromite, though these particles were not translucent in the micro-section.

PEGMATITES

GABBRO PEGMATITE.

Remarkably coarse-grained examples were collected from two localities, namely [104], which occurs in dyke-like form at Eagle Point, and [254] which was got on the creek 200 yards north of Sandy Bay Camp. These are both essentially similar in mineral and structural character. They bear a relationship to the gabbro [66], but are a very much coarser crystallization.

These examples represent a very striking type of pegmatite, composed almost entirely of dark-coloured pyroxene and greyish-white plagioclase. The only other primary minerals are magnetite, occasionally in notable concentrations, sporadic grains of pyrrhotite, and rather rare rods of apatite embedded in or associated with the magnetite. All these minerals show little evidence of secondary change, though rare cases are recorded in the slides of serpentinous and uralitic developments on the margins of the pyroxene. A little leucoxene has been observed on the margin of one iron-ore cluster and some turbidity and dusty degeneration is to be noted in the feldspar.

On account of their colour and excellent cleavage the pyroxenes stand out conspicuously, and individuals are observed to range up to 15 cms. in length. This pyroxene has a mean refractive index of 1·70 and it is optically positive; there is an absence of pleochroism. Determinations of the extinction angle ($Z \wedge c$) on suitable sections ranged between 36° and 40°.

An analysis covering the more important constituents of the pyroxene made by Mr. E. R. Segnit is as follows: SiO_2 = 50·31, Al_2O_3 = 3·92, Fe_2O_3 = 3·26, FeO = 5·87, CaO = 18·90, MgO = 15·74, TiO_2 = 1·54; total = 99·54, which does not take account of trace elements and H_2O. It is a pyroxene very rich in the diopside molecule, less rich in the hedenbergite molecule, and still less rich in the sesquioxide (iron and aluminium) silicate group which latter is a feature of common augite. This pyroxene, therefore, is linked with augite on account of the latter, though it is unusually rich in the diopside molecule.

In some microscope sections the cleavage faces are studded with tiny flecks of a deeper colour than the pyroxene itself, though in optical continuity with it. In most specimens diallagic cleavage is developed, consequently this pyroxene can best be referred to as diallagic augite.

The feldspar has a mean refractive index of 1·55 and in its other properties also corresponds with andesine.

Specimens [163], [77] and [103] are related forms of a somewhat different type of gabbro pegmatite. The first of these is composed of light-grey, pearly amphiboles up to 8 cms. in length and a milky-white, structureless, paramorph after feldspar in which there is some prehnite. The amphibole is tremolite now altering to talc. In [77] radial aggregates of prehnite appear.

VEINS, SCHLIERS, AND SHEAR-ZONES ASSOCIATED WITH THE HARZBURGITE.

Specimen [139] is a cross-section of a pegmatite vein 20 cms. in width which well illustrates a type in which coarse red-brown mica is a feature. The main mass of the vein-stuff, including all the central area, has been plagioclase, probably originally having a composition about oligoclase-andesine, but now represented by a white paramorphic aggregate, largely cryptocrystalline in character, in which some prehnite is distinguishable. The plates of mica reach 5 cms. in diameter; they are embedded in the feldspathic material of the marginal area on either side of the vein-filling, and are set perpendicular to the wall of the pegmatite formation. The mica is pleochroic from light-yellow to maroon-red. The mean R.I. is about 1·60, and 2V is very small. Consequently it is taken to be phlogopite.

There are also, in the collection, a number of closely-related gabbroic pegmatitic rocks which are notable for their content of lustrous black amphibole and for mortar and other cataclastic structures. They appear to have originated as pegmatitic veins, but have been subjected to shearing stresses probably operating partly during the period of their formation. However, it is impossible to deal authoritatively with these in the absence of any field study. Of these [146], [149] and [151] have conspicuous augen of amphibole which, in the microscope slide, is strongly pleochroic from light-yellow to a deep red-brown and has an extinction angle of about 14°. This is taken to be barkevikite. Other original minerals are diopsidic pyroxene and plagioclase. The former of these is in a fine granular form, and in some specimens evidences change to brown amphibole. The plagioclase is always greatly changed to aggregates of secondary minerals, so that it had almost entirely lost its original identity. In this reconstructed feldspathic material, the only clearly determinable mineral is prehnite, which is developed in recognizable crystalline form as veins and patches distributed through a cryptocrystalline base.

Recently a detailed investigation of prehnitized plagioclase occurring in somewhat comparable circumstances with that at Macquarie Island has been published[42] emphasizing, as with ours, the hard and tough nature of the resulting paramorphic aggregate.

Other examples in a more advanced state of cataclasis are [153] and [147]. In the latter, prehnite appears in a conspicuous radial arrangement. In these rocks patches of serpentine may be met with, and occasional grains of apatite are discernible. In the reconstructed feldspathic areas there are occasional patches of a chloritic mineral conspicuous for its ultra-blue polarization colours.

There are a number of other specimens [113], [140] and [141] related to the above which all contain one or other or both the red-brown biotite and red-brown amphibole and which illustrates further the effects of shearing and recrystallization.

Still others [145], [155], [158] and [159] represent schliers in which prehnite and phlogopite figure, and talc may or may not be present.

LAMPROPHYRIC AND OTHER APHANITIC VEINS IN THE GABBROS

In Blake's collection are many specimens of gabbro intersected by dark-grey to black aphanitic veins. These are, in part, lamprophyric exudations which have collected in fissure in the already solidified parent magma. In other cases they are merely intrusive stringers of normal basalt of a later period of injection.

The specimens are all in the nature of beach boulders, most of which have certainly been derived as erratics from the Pleistocene tillite. These dark veins contrast strongly with the light-coloured gabbro and make the pebbles conspicuous amongst others on the beaches, hence it is that such specimens are so numerous in the collection. In no case are they recorded as having been collected *in situ*, consequently no chemical analysis has been undertaken, and only brief reference will be made to them.

Specimen [48] is an example of black lamprophyric vein matter intersecting a member of the gabbro series. Here, however, the composition of the diallagic gabbro is locally changed by depletion of ferromagnesian constituents on either side of the 1·5 cm. wide vein which intersects it. This indicates that the fracture of the gabbro along the line now occupied by the vein occurred at a late stage in the crystallization of the gabbro magma, but when there was still a mobile but more highly pyroxenic liquid residuum remaining which, to form the vein, seeped through the spongy mass into the fissure.

No. [63] is a boulder of gabbro crossed by a dense, fine-grained black vein up to 3 cms. thick. The host rock is a diallage-bytownite gabbro, which has undergone some secondary changes. The pyroxene shows stages in alteration to pale-green uralitic hornblende. Some pale-brown hornblende is present also. Associated with the uralite is some secondary sphene. The bytownite has a composition about $Ab_{25}An_{75}$.

The material composing the intersecting vein is a granular mass of brownish, pleochroic hornblende, with some colourless granular pyroxene, some greenish chloritic material and extremely fine feldspar laths. This feldspar is more acid than that of the enclosing rock, namely about $Ab_{40}An_{60}$. The amphibole appears to have been derived by uralitization from the pyroxene, which latter was originally titaniferous, as is shown by the abundance of sphene included in the amphibole. There is discernible in the slide a palimpsest micro-doleritic texture. Evidently the vein material is comagmatic with the gabbro, a lamprophyric variant thereof.

No. [67] is a beach boulder from Buckles Bay, also exhibiting the contact of a black, fine-grained vein rock with the gabbro. In this case the pyroxene of the gabbro has been almost entirely converted to brown pleochroic hornblende. Other change products in the gabbro are zoizite and some chlorite. The lamprophyric vein material has been amphibolitized, but retains a palimpsest dolerite structure.

Specimen [36] is unique in that the gabbro is here crossed by two black aphanitic veins, respectively 1 cm. and 0·5 cm. in width, which intersect at right angles. Some displacement of the narrower vein at its intersection is evidence that, of the two, the broader vein was the later formed. (See Plate XXXII, fig. 2.)

No. [37] is a case where a black aphanitic vein 2·5 cms. wide intersects gabbro which carries a little olivine in addition to abundant diallage. There is clear evidence here of the invasion of the vein matter, for at its absolute contact there is a 2 mm. wide border of what has been glass with specks of ilmenite; this is now semi-opaque and the ilmenites have been reduced to leucoxene. From this selvage there is an increasing degree of crystallization to the main hyalopilitic filling, which is now a semi-opaque serpentinized mass through which are distributed fine plagioclase needles with random orientation.

No. [24] is a coarse, speckled gabbro consisting of basic labradorite, diallage and a very little olivine. It is intersected by two fine, even-grained, dark-coloured injections of micro-gabbro, of an average grain-size in the micro-slide of about 0·3 mm. Occasional large-sized corroded olivines are embedded in it.

CHEMICAL ANALYSES OF THE GABBROS.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
SiO_2	44·92	44·12	46·84	47·51	45·30	46·48	50·51	49·82
Al_2O_3	25·16	25·13	22·17	23·03	20·54	12·79	17·62	17·61
Fe_2O_3	2·03	0·87	0·69	1·08	0·88	1·81	1·86	0·96
FeO	2·42	3·85	3·23	4·00	2·90	5·21	5·91	4·66
MgO	7·68	9·51	9·09	6·69	8·10	16·50	7·12	9·78
CaO	13·41	14·19	15·14	15·08	15·43	12·84	11·97	14·67
Na_2O	1·76	1·16	1·61	1·41	1·98	1·25	2·95	1·23
K_2O	0·10	0·17	0·10	0·22	0·64	0·16	0·08	0·10
H_2O+	2·24	0·25	1·21	0·98	} 4·01	2·12	0·48	0·56
H_2O-	0·16	0·11	0·14	0·00	}	0·46	0·19	0·19
CO_2	...	...	Trace	...	Nil.	Nil.	0·15	0·04
TiO_2	Trace	0·21	0·12	0·38	0·20	Trace	0·95	0·25
P_2O_5...	0·32	0·10	0·05	...	...	0·32	0·14	0·03
NiO	...	...	...	...	...	...	...	0·15
MnO	...	...	Trace	...	0·25	0·14	0·08	0·15
Cr_2O_3	...	...	Nil	...	0·04	...	Nil	0·03
SrO	...	...	...	...	...	...	0·05	Nil
BaO	...	...	Nil	...	...	...	Nil	Trace
ZrO_2	...	...	Nil	...	...	...	...	Nil
S	...	...	Nil	...	...	...	0·08	0·03
Total	99·88	99·67	100·39	100·38	100·27	100·11	100·01*	100·15
Density ...	2·791	...	2·984	...	...	3·010	2·893	...

*Allowance made for oxygen equivalent = 0·03.

I. Allivalite [9] from Half-Moon Bay, Macquarie Island. Analysed by E. R. Segnit, Dept. of Geology, University, Adelaide.

II. Allivalite from Mount Fonjay, Madagascar. Recorded by A. Lacroix. C.R. Vol. 157 (1913), p. 14.

III. Eucrite [3] from Handspike Point, Macquarie Island. Analysed by E. R. Segnit, Dept. of Geology, University, Adelaide.

IV. Gabbro from Leonie Island, Weddell Quadrant, Antarctica, recorded by E. Gourdon. Published by H. S. Washington, U.S.G.S., Professional Paper 99.

V. Mean of two analyses of "Prehnite-Rodingite" recorded by W. M. Bell. N.Z. Geological Survey Bull. 12 (1911), p. 35.

VI. Olivine-Gabbro [91] from near Blake's Station 2, Macquarie Island. Analysed in 1926 by A. R. Alderman, Dept. of Geology, University, Adelaide.

VII. Gabbro [66] from the highland near the north-west corner of Macquarie Island. Analysed by W. B. Dallwitz, Dept. of Geology, University, Adelaide.

VIII. Noritic Gabbro from North Cape, New Zealand. Recorded by J. A. Bartrum. Trans. N.Z. Inst., vol. 59 (1928), p. 131.

THE MICROGABBROS

It is unfortunate that Blake's collection is unaccompanied by any field notes detailing the nature and relation of the occurrences, beyond merely stating the general locality where found, and whether *in situ* or not, and, in the case of igneous rocks, whether massive or in dyke form. As a result, little useful discussion as to the mutual relations of the microgabbros and basalts can be attempted. However, as many rocks of this division are characterized by phenocrysts of anorthitic feldspars, it would appear that all such have kinship with the Gabbroid Group. In the case of [7] it is quite clear that we are dealing with a minor intrusion of the allivalitic gabbros. The rock is extremely rich in feldspar, almost anorthositic, whereas [14] is remarkable for the abundance of its phenocrystic chrysolite and thus is a representative of the other extreme in crystal differentiation.

There are some dolerites with a higher alkali content and in which one or other or both titanaugite and barkevikite occur. In such rocks there can usually be detected tiny irregular residual areas of analcite. These are exceptional types, notably fresher than the bulk of the calc-alkali types, and apparently members of Blake's Newer Basic Group.

By far the major number of the microgabbros have been affected in some degree by propylitization, uralitization, or partial spilitization. Thus, as a whole, they tend to be more grey than black, and often there is clearly a very faint greenish tinge in the grey.

CALC-ALKALI DOLERITES

MEGAPHYRIC FELDSPATHIC DOLERITES.

ANORTHITE DOLERITE.

[185] is a coarsely-porphyritic anorthite-dolerite. Large anorthite phenocrysts up to 3 cms. in length show up clearly on the ice-polished face of the rock, where they are rendered more obvious owing to the fact that they are depressed by chemical corrosion well below the general level of the rock surface. Fragments of this feldspar were found to have a maximum refractive index of 1·580; this fact, in conjunction with other optical characters, define it as anorthite. The dolerite base of this rock has been greatly altered by uralitization and chloritization; the plagioclase is considerably broken down, but appears to be andesine.

BYTOWNITE-DOLERITE.

Rock [7] is a coarsely-porphyritic bytownite-dolerite which occurs as a dyke at Buckles Bay. It is holocrystalline, porphyritic, and of a somewhat dark shade of ash-grey colour. Large white plagioclase up to 2 cms. in length stand out conspicuously in a finer grained base. The specific gravity of this rock was found to be 2·772.

FIG. 46. Microscopic appearance of Megaphyric Bytownite-Dolerite.

The microscope section reveals abundant phenocrystic plagioclases of an earlier generation, sub-euhedral in form, embedded in a fine-grained, doleritic base (Text, fig. 46). The groundmass, which is 44% of the rock, consists mainly of a plagioclase grid with intergranular pyroxene of a light-grey colour. Ophitic texture is developed only to a very minor degree.

The phenocrystic plagioclase, which amounts to 56% by volume of the rock (micrometric measurement), exhibits broad twin lamellae of the albite, Carlsbad and pericline types. It is zoned and notably anorthitic. The optical character conforms to the composition of sodic bytownite in the peripheral region of the crystals to anorthite (Ab_7An_{93}) in the core. These large feldspars are riddled with a minute veining, along the margin of which veins, can usually be noted local albitization of the basic feldspars. These veins, where they have definite width, are filled with a featureless, often very faintly greenish substance which is almost isotropic and has a higher R.I. than balsam. This filling, which also appears in some tiny patches in the groundmass of the rock, is taken to be a chloritic mineral substance.

As no nepheline could be detected in the slides but appears in the norm, it may be that the carnegieite molecule is present in these feldspars.

The feldspar of the groundmass is somewhat less basic, namely about $Ab_{45}An_{55}$. Zoning is evident in some of the larger individuals. In places, feldspar laths penetrate into the outer portion of the pyroxenes, thus constituting a poorly developed ophitic arrangement. Secondary changes, particularly albitization, have affected, to some extent, this second generation of feldspar making it blurry and blotchy.

The pyroxene is almost entirely that of the doleritic base. Only one porphyritic pyroxene (diallagic) of the earlier generation was met with in all the three slides examined. As viewed under the microscope, the pyroxenes of the groundmass average about 0·5 mm. in diameter, but some of them reach a length of 1 mm. They are of a pale-grey colour and are quite fresh. The larger individuals have an outer zone of a faint mauve tone and slightly higher extinction angle. It is biaxial positive and $Z \wedge c$ is about 40°. As the optic axial angle is small it comes within the category of pigeonite.

Grains of ilmenite, partly leucoxenized, are scattered through the slide. Some very tiny particles of what appears to be sphene are embedded in certain of the large feldspars.

Prehnite occurs in this rock as a secondary mineral mainly concentrated in occasional microscopic, random veinlets; also it is to be found in apophyses (Plate XXXII, fig. 3), extending from these veinlets to fade out into the unaltered substance of the rock. These veinlets in the slides examined have a maximum width of about 0·5 mm. The prehnite fills these veins (Plate XXXII, fig. 4) as granular aggregates of strong relief and high birefringence. The largest individual noted has a length of 0·75 mm. It is biaxial positive, with straight extinction and a cleavage parallel to the faster ray. The optic axial angle is only moderate, not large enough for lawsonite.

Quartz occurs filling several hair-like veins, but in much smaller particles and in very much less amount than the prehnite. One of these quartz-bearing veinlets crosses and thus post-dates a prehnite formation.

An analysis of this rock is recorded in the table on page 120. From this the norm has been deduced as follows :—

Orthoclase	1·11	Apatite	0·20
Albite	13·62		———
Anorthite	53·38		97·67
Nepheline	5·68	Water (combined) ...	2·20
Diopside	13·41	Water (hygroscopic) ...	0·67
Olivine	8·05		———
Ilmenite	1·52	Total ...	100·54
Magnetite	0·70		———

The C.I.P.W. classification is II. 5. 5. 4–5 (Hessose).

A Rosiwal micrometric analysis gave the following volume composition :—

	per cent.
Feldspar	70·5
Prehnite (secondary)	5·0
Quartz (secondary)	0·5
Chlorite (very low D.R. areas)	2·0
Pigeonite	20·0
Magnetite	2·0
Total ...	100·0

[354] is a coarsely-porphyritic bytownite-dolerite. In the hand specimen the feldspars, which are roughly rectangular, and as much as 2·5 cms. in length, are embedded in a base of fine-grained grey dolerite. The feldspar has a composition about $Ab_{25}An_{75}$. The base is doleritic in texture and mainly composed of labradorite and grey ophitic augite. As secondary minerals, calcite and chlorite are present; also the ilmenite is partly leucoxenized. This rock differs from [7] mainly in that it carries a smaller proportion of the fine-grained base.

[169] is another coarsely-porphyritic bytownite-dolerite. Here the phenocrysts of feldspar, of a diameter up to 2·5 cms., have the composition $Ab_{25}An_{75}$ and R.I. 1·575. The base has suffered severely from the secondary processes, chloritization and uralitization. Thus uralite, chlorite and epidote all appear. There is also, in cracks traversing the feldspar phenocrysts, a notable amount of a faintly green, chloritic substance with a low D.R. and R.I. greater than balsam.

[137] is a coarsely-porphyritic anorthite-dolerite occurring as a dyke. It is of a light-ash grey colour, in which large phenocrysts of anorthite up to 2 cms. in diameter are distributed abundantly through a coarse holocrystalline base which is more doleritic than basaltic in character. The phenocrysts may not all come within the range of anorthite, but a large individual subjected to a careful optical examination was found to answer to Ab_7An_{93}; its R.I. is somewhat over 1·570. Secondary processes have resulted in the introduction of chlorite, a little calcite and some yellow epidote. Albitization is evidenced along the path of cracks traversing the feldspar phenocrysts.

[213] is a coarsely-porphyritic bytownite-dolerite. It has a quite different appearance to the preceding, owing to the very dark colour of the base. The porphyritic plagioclase is in euhedral crystals up to 2 cms. in diameter (Plate XXXIII, fig. 2). Optical measurements show it to contain from 85% to 90% of the anorthite molecule. Its mean R.I. is about 1·570. The base of this rock is a true dolerite of medium grain size and exhibits ophitic structure. The augite has a faint mauve tint. The plagioclase of the base is distinctly more sodic than

the phenocrysts. The magnetite is fresh, but some chlorite and a little serpentine have been developed in small evenly-distributed centres; much of the latter probably derived from former tiny olivines. Embedded in the feldspar phenocrysts are some pockets and patches of tiny particles of clear albite.

LABRADORITE-DOLERITE.

[74] is a medium-grained, porphyritic dolerite in which there are labradorites of an earlier generation up to 0·6 cm. in length. In the base large augites of a faint brown tone ophitically enclose plagioclase laths. The rock is fresh in appearance, except for traces of chloritization of the pyroxene and leucoxenization of the ilmenite. Olivine is absent. Some specks of pyrite are observable.

MEGAPHYRIC CHRYSOLITIC DOLERITES.

OLIVINE-DOLERITES.

Rock [14] is a porphyritic olivine-dolerite from a dyke at Hut Point. It is dark-grey, but studded through the groundmass are phenocrysts of clear olive-green olivine. This rock is remarkably fresh, having suffered little in the nature of secondary mineral changes. The specific gravity was found to be 3·066.

Examined microscopically, two periods of crystallization are clearly indicated. There are very abundant large subhedral olivines, and much less frequent augite phenocrysts and occasional feldspar phenocrysts representing an earlier generation. These are embedded in a later crystallization of a typically doleritic nature, namely coarse plagioclase mesh structure with ophitic pyroxene.

The porphyritic plagioclases, which are few in number, are euhedral, and exhibit both albite and Carlsbad twin lamellae; the optical characters are those of $Ab_{30}An_{70}$. The bulk of the plagioclase is in the groundmass, and this has a composition about $Ab_{45}An_{55}$. The feldspars are all very fresh.

The porphyritic olivines which are very abundant and constitute a large proportion of the rock, range up to 5 mm. in diameter. As seen in microscope slide, they are colourless and perfectly fresh, except for traces of pale-green serpentinous product along cracks.

The pyroxene, which occurs ophitically and interstitially in the doleritic base, is colourless to faintly mauve coloured. The more highly-coloured individuals are distinctly pleochroic. In some cases the ophitic crystals cover large areas. The optical character is biaxial positive and elongation positive. As it has a large extinction angle it is obviously augite.

A black spinelid appearing as particles up to 0·5 mm. in diameter and dark brown by transmitted light may be either chromite or picotite. As, however, the percentage of chromic oxide in the rock is so low, it may be assumed that the mineral is chromiferous picotite. The bulk of the black, opaque to semi-opaque mineral particles appear to be of this nature and only very few grains are magnetite or ilmenite. Some apatite rods can be distinguished.

The chemical analysis is stated on page 120. From this has been calculated the following composition of the norm :—

Orthoclase	2·22	Ilmenite	1·37
Albite	7·34	Apatite	0·74
Anorthite	19·74		
Nepheline	8·24		99·64
Diopside	9·13	Water (combined) ...	1·02
Olivine	46·17	Water (hygroscopic) ...	0·41
Chromite	0·05		
Magnetite	4·64	Total ...	101·07

The place of this rock on the C.I.P.W. classification is III. 6. 3. 5. (Bekinkinose), but approaches IV. 1. 4. 1–1 (Cortlandose).

[245] is a coarsely-porphyritic olivine-dolerite. It is unusually fresh and nearly black in colour. The appearance of the rock as presented in micro-slide is dominated by the presence of unusually large phenocrysts of olivine, as much as 7 mm. in length, constituting 30% by volume of the rock. Other phenocrystic minerals are augite, peripherally tinted a pale mauve colour and measuring up to 2 mm. in length; also occasional labradorites rarely reaching 3 mm. in length. The augite phenocrysts are much less frequent than the olivines, and the plagioclase is distinctly less abundant than the augite. All these phenocrysts are embedded in a somewhat ophitic, doleritic base primarily composed of plagioclase, augite, olivine and magnetite. The feldspars of the base have been greatly affected by late magmatic reactions which have resulted in a considerable degree of albitization.

[214], which is extensively serpentinized, was originally a porphyritic dolerite, remarkable for abundance and size of its olivine phenocrysts. These, which are now partly converted to serpentine, are embedded in a medium to fine-grained doleritic base originally consisting essentially of warm-toned augite and plagioclase. Now, however, the feldspar has almost entirely broken down to aggregates of low birefringence, though the augite has largely resisted serpentinization.

MICROPHYRIC DOLERITES.

COARSELY-OPHITIC DOLERITE.

[374A] is a coarsely-ophitic dolerite. It carries some phenocrysts of basic plagioclase which, though of considerable size, are not outstanding when considered in relation to the very coarse crystallinity of the rock. It is comparatively fresh, but there is some chlorite distributed in small patches, and the ilmenite has been partly leucoxenized.

[177], which occurs *in situ* at Hut Point, is an unusually fresh, coarsely-ophitic dolerite, the augites of which are as much as 0·7 cm. in length. Labradorite is abundant. Olivine is present only in very minor amount, and has suffered peripheral change to serpentine.

SUB-OPHITIC DOLERITE.

[132] occurs as a sill on the western side of the Isthmus. It is a light grey slightly chloritized dolerite with sub-ophitic structure. It carries a sprinkling of small plagioclase phenocrysts of a diameter not exceeding 3 mm.

APHYRIC DOLERITES.

All of these examples are palaeotypal forms or have been affected to a greater or less degree by autometamorphic processes.

[172] is a coarse, medium-to-dark grey dolerite. Its specific gravity is 2·885. Microscopically examined, this rock is found to have a typical dolerite structure, but has suffered advanced uralitization. The plagioclase is labradorite and andesine. Unaltered pyroxene is still observable as scattered relics of a light colour and with a large extinction angle. Most of the pyroxene has been converted to a faintly-coloured amphibole, but some chloritization is also evidenced. Black grains of iron ore are apparently magnetite, but leucoxenized ilmenite is also present.

The chemical composition is stated on page 120. The norm is as follows :—

Orthoclase	2·72	Apatite	0·67
Albite	22·64		———
Anorthite...	29·19		97·84
Diopside	16·10	Water (combined)	1·58
Hypersthene	20·97	Water (hygroscopic) ...	0·31
Ilmenite	2·93		———
Magnetite	2·62	Total ...	99·73

The C.I.P.W. classification is III. 5. 4. 4–5 (Auvergnose).

[201] is an even-grained, medium-grey dolerite from Lusitania Bay. The specific gravity is 2·940.

As viewed under the microscope, it is observed to have completely crystallized as an intergranular mass. Early stages in the development of ophitic intergrowths are occasionally in evidence.

The plagioclase laths are rather more sodic than usual for a basalt, namely, andesine bordering on labradorite. The theoretical composition deduced from the norm is Ab_{48} An_{52}. The pyroxene is present as small hypidiomorphic grains of a very pale colour, almost colourless. Ilmenite, more or less leucoxenized, is comparatively abundant. There is also a little granular sphene. Specks of pyrite are rare.

The feldspars and pyroxenes have suffered little alteration, but some chlorite is distributed through the section, probably derived from a pyroxene now completely transformed. Interstitial chlorite, green and slightly pleochroic, is rather abundant.

The chemical analysis appears on page 120. From this, the norm has been calculated as follows :—

Orthoclase	2·89	Apatite	0·67
Albite	21·10		———
Anorthite	26·13		97·79
Diopside	21·01	Water (combined) ...	2·05
Hypersthene	9·58	Water (hygroscopic) ...	0·29
Olivine	8·53		———
Ilmenite	2·63	Total ...	100·13
Magnetite	2·25		———

In the C.I.P.W. classification the rock is III. 5. 4. 4–5 (Auvergnose).

Rock [10] is from an outcrop on the Isthmus at the north end of the Island. It is a fine even-grained basalt of grey colour in which some specks of pyrite are visible on examination with a pocket lense. Its specific gravity was ascertained to be 2·893.

Examination of the microscope slide demonstrates that it is holocrystalline, composed of a mesh of plagioclase laths with interstitial pyroxene, and secondary minerals. A form of ophitic structure is evidenced which indicates the character of the rock to be intermediate between that of basalt and dolerite.

The feldspar laths have an irregular and vague outline and are somewhat more sodic (andesine) than normal for Macquarie Island basalts. The pyroxene is colourless to grey, with a maximum extinction angle of 39°. Fibrous aggregates of uralitic amphibole are present as alteration products of the pyroxene. Of iron ores there is a notable amount of ilmenite partly transformed to leucoxene; also a little pyrite.

Secondary minerals, apart from uralitic amphibole, are chlorite in considerable amount, a little serpentine, some dusty magnetite resulting from the alteration of pyroxene, a little clinozoizite, and quite rarely a few specks of calcite.

The chemical composition is stated in the table on page 120. From this the norm has been calculated as follows :—

Orthoclase	1·72	Apatite	0·91
Albite	24·84	Pyrite	0·13
Anorthite	36·08		
Diopside	7·80		97·82
Hypersthene	18·03	Water (combined)	1·68
Olivine	0·79	Water (hygroscopic)	0·78
Ilmenite	2·86		
Magnetite	4·66	Total	100·28

The C.I.P.W. classification is therefore II (III). 5. 4. 4–5 (Hessose).

[179] is a coarse gabbroic dolerite occurring as a dyke 200 yards south of Blake's Station 1, which is a hill somewhat more than 650 feet in height, located at the head of Gadget Gully on the north side. The feldspars have been sufficiently whitened, as the result of secondary changes, to contrast strongly with the dark ferromagnesian constituents, giving the rock a speckled appearance. The specific gravity is 2·873.

Microscopically examined, it is seen to have a coarse dolerite structure. The large anhedral plagioclases have the composition of labradorite; many of them are strongly zoned. A micrometric analysis shows the feldspar to constitute 60% by volume of the rock.

The pyroxene, which is present as faintly mauve coloured euhedral grains, is biaxial positive, and has a medium to large optic axial angle. It is slightly pleochroic, has extinction angles ranging from zero up to 22 degrees, and is optically positive, suggesting that it is probably clinoenstatite. Some chloritic and uralitic changes are manifest on the margins of the pyroxene.

There is a notable development of yellow epidote in patches sporadically distributed through the section. Ilmenite occurs in comparatively large individuals presenting a barred appearance resulting from partial conversion to leucoxene. Some rods of apatite are clearly visible in the slide.

The chemical composition is given on page 120. The norm has been calculated as follows :—

Orthoclase	1·55	Apatite	0·50
Albite	25·15		
Anorthite	35·58		98·15
Diopside	25·28	Water (combined)	1·60
Hypersthene	0·53	Water (hygroscopic)	0·64
Olivine	4·82		
Ilmenite	2·65	Total	100·39
Magnetite	2·09		

In the C.I.P.W. classification the rock is II. 5. 4. 4–5 (Hessose).

[205] is an almost completely uralitized dolerite from the rookery area at Lusitania Bay. It appears to be closely related to [172].

[376], which is *in situ* 1 mile north of Lusitania Bay, is a light-grey dolerite which is uralitized to the extent of about 50% of the pyroxene. Chlorite is not uncommon, and some spots of copper pyrites are visible in the hand specimen.

[200] is a coarse dolerite from 1·6 miles north of Lusitania Bay. In it the original faintly mauve augite has been almost completely uralitized. The plagioclase is labradorite in elongated forms about 2 mm. in length; it is clouded with incipient change-products. Skeletal ilmenite is in notable quantity. Veins of prehnite traverse the rock.

[238] exemplifies the rock composing a dyke located north of Station 20. Alongside of it in the field is a pyritic quartz reef. It is a very coarse-grained dolerite which has undergone propylitization with introduction of some pyrite. Fine-grained granular sphene is present. Ilmenite is leucoxenized and calcite and chlorite are widely distributed.

[223] is a fine-grained, dark-grey, olivine-dolerite from Halfway Hill. Its specific gravity is 2·812. The microscopic examination reveals that it is composed of a mesh of plagioclase laths, with interstitial and ophitically intergrown pyroxene. The plagioclase, which is a basic labradorite, is quite fresh. So also is the pyroxene, which is an augite with high extinction angle and a light-brown to purple colour. There appears originally to have been a little olivine scattered throughout the rock; this is now presented as fine-grained aggregates of talc, chlorite and brown iron-stained serpentine. Magnetite is present in very small amount only. Occasional rods of apatite are visible.

The chemical composition is stated on page 120, and from it the norm has been calculated as follows :—

Orthoclase	1·67	Apatite	1·01
Albite	18·86		———
Anorthite	32·80		96·10
Diopside	14·66	Water (combined) ...	2·59
Hypersthene	16·72	Water (hygroscopic) ...	1·40
Olivine	1·77		———
Ilmenite	3·04	Total ...	100·09
Magnetite	5·57		———

In the C.I.P.W. classification this is III. 5. 4. 4–5 (Auvergnose).

Rock [13] is a dolerite occurring as a dyke on the shore of Hasselborough Bay. In the hand specimen it is of a medium grey colour and has a fine speckled appearance. The latter is due to whitening of the plagioclase laths which makes evident a doleritic texture plainly seen with the aid of a pocket lens. The specific gravity is 2·841.

In the microscopic section the plagioclases are observed to be partly epidotized. Some of the plagioclase is as calcic as $Ab_{35}An_{65}$, but a feature is the appearance of a soda-rich rim which comes into the range of andesine.

The pyroxene, which is fresh, is faintly pleochroic. Ophitic structure is well represented. It is biaxial positive and $Z \wedge c$ is 44°. Thus it is augite and is apparently titaniferous.

Patches of nearly uniform, faintly yellowish-green chlorite in which are occasional grains of calcite and some serpentine may represent paramorphs after olivine. Secondary changes affecting this rock have been specially active in developing both chlorite and calcite.

Accessories are ilmenite altering to leucoxene, apatite in tiny rods, and very rarely specks of pyrite.

An analysis of this rock is recorded in the table in page 120. From this the following norm has been calculated :—

Orthoclase	3·89	Apatite	0·44
Albite	22·01		———
Anorthite	30·86		97·54
Nepheline	3·98	Water (combined) ...	1·82
Diopside	17·60	Water (hygroscopic) ...	0·92
Olivine	14·16		———
Ilmenite	2·74	Total ...	100·28
Magnetite	1·86		———

The C.I.P.W. classification is III (II). 5. 4. 4–5 (Auvergnose).

ALKALI-DOLERITES

OLIVINE-MICROTESCHENITE.

[218] is a very coarse-grained speckled dolerite collected as a beach boulder from near Hut Hill. The plagioclase is mainly oligoclase. The pyroxene is titanaugite. The brown amphibole barkevikite is present. Small areas of serpentine appear to represent original olivine. Scraps of brown biotite are distributed throughout the section in small amount, more particularly in close association with some coarse granular magnetite. There are occasional dusty patches of analcite, in which are embedded long rods of apatite.

[251], collected at Brother's Point, is a soda-rich dolerite carrying only a small proportion of olivine partly converted to iddingsite and serpentinized. The pyroxene is violet titanaugite. The plagioclase, arranged in a coarse mesh structure, exhibits shadowy extinction, and is oligoclase together with some albite. There is observable a small quantity of analcite residue with tiny apatites.

SODA-RICH DOLERITE.

[68] is a very light-grey rock studded with elongated black amphiboles from 0·5 to 2 cms. in length. In the microscope slide these amphiboles were found to be barkevikite. There are also some remnants of a strongly pleochroic red-brown biotite in progress of corrosion and resorption. Apatite prisms are abundant. There is much secondary sphene and other breakdown products of ilmenite and biotite. Elsewhere the section is composed of dusty, uncoloured areas of low double refraction which, for the most part at least, represent change products of feldspar. Some trace of former twinning indicates that originally the feldspar was plagioclase; such as now remains determinable appears to be oligoclase. No undoubted analcite was observed. The original structure of this rock has been partly destroyed by secondary processes; it is included with the microgabbros for convenience.

It is not clear whether these alkali-dolerites and alkali-basalts of Macquarie Island belong to Blake's older or newer effusive series, but it is interesting to note that a dolerite, mineralogically similar, and with partial replacement of the plagioclase by analcite is recorded from Auckland Province.[38] It is there associated with other dolerites and picotite-bearing peridotite intruding late Cretaceous to early-Tertiary strata.

Chemical Analyses of the Microgabbros.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
SiO_2	45·88	43·04	49·38	49·02	47·81	46·75	50·12	49·31	53·26
AlO_3	24·55	12·01	18·23	18·39	17·65	15·95	15·62	14·81	15·64
Fe_2O_3	0·38	3·19	1·44	3·22	1·25	3·84	1·81	1·55	0·24
FeO	3·64	3·74	4·94	3·72	5·93	4·49	7·27	8·17	7·44
MgO	5·04	26·75	5·45	8·47	8·24	9·33	7·77	7·92	8·64
CaO	14·22	6·72	13·75	9·78	10·85	10·91	10·27	10·80	12·08
Na_2O	2·85	2·64	2·97	2·94	3·51	2·25	2·68	2·86	1·25
K_2O	0·18	0·35	0·26	0·29	0·65	0·33	0·46	0·49	0·58
H_2O+	2·20	1·02	1·60	1·68	1·82	2·59	1·58	2·05	0·41
H_2O-	0·67	0·41	0·64	0·78	0·92	1·40	0·31	0·29	0·35
CO_2	...	...	...	Nil	...	Nil	Nil	Nil	...
TiO_2	0·79	0·69	1·39	1·51	1·40	1·55	1·54	1·39	0·70
P_2O_5	0·09	0·31	0·21	0·39	0·18	0·43	0·29	0·29	0·04
MnO	...	...	0·12	0·04	...	0·15	0·15	0·18	0·11
Cr_2O_3	...	...	...	Nil	...	...	...	...	...
BaO	...	...	...	Nil	...	...	...	...	...
ZrO_2	...	...	...	Nil	...	...	...	...	...
S	...	...	...	0·07*	...	...	...	...	...
Total	99·49	100·87	100·38	100·30	100·21	99·97	99·86	100·03	100·74
Density ...	2·772	3·066	2·873	2·893	2·841	2·812	2·885	2·940	...

*Material of analysis selected as free as possible from pyrite.

I. Megaphyric, Bytownite-Dolerite [7] from a dyke at Buckles Bay, Macquarie Island. Analysed (1926) by A. R. Alderman, Dept. of Geology, University, Adelaide.

II. Megaphyric Picritic Dolerite [14] from a dyke at Hut Point, Macquarie Island. Analysed (1926) by A. R. Alderman.

III. Aphyric Dolerite [179] occurring as a dyke near North Mountain, Macquarie Island. Analysed (1926) by A. R. Alderman.

IV. Aphyric Dolerite [10] occurring as a dyke on the Isthmus, Macquarie Island. Analysed (1925) by R. G. Thomas, Dept. of Geology, University, Adelaide.

V. A Coarse-Grained, Aphyric Dolerite [13] occurring as a dyke at Hasselborough Bay, Macquarie Island. Analysed (1926) by A. R. Alderman.

VI. Aphyric Dolerite [223] from Half-Way Hill, Macquarie Island. Analysed (1926) by A. R. Alderman.

VII. A Fine-Grained Aphyric Dolerite [172] occurring 50 yards south of Station 20, Macquarie Island. Analysed (1926) by A. R. Alderman.

VIII. Aphyric Dolerite [201] from Lusitania Bay, Macquarie Island. Analysed (1926) by A. R. Alderman.

IX. Dolerite of sill at Knob Head Mountain, South Victoria Land: Nat. Ant. Exped., 1901–04; Scientific Reports, Geology, p. 137.

THE BASALTS

The rocks falling into this division can be grouped into several sections, of which three are obviously natural groups. Firstly, there are the megaphyric bytownite-basalts which, mainly on account of their anorthitic feldspars, may be linked with the Gabbroid Group. Then there are the glassy basalts which are all very fresh, and are quite similar magmatically. Their freshness and their geographical distribution indicate that they are to be reckoned with the latest outpourings on the Island.

Finally, there are some basalts comparatively rich in alkali which are to be linked with the corresponding section of the micro-gabbros. Mineralogically they are quite similar to the latter and evidently belong to the same suite and period of eruption. Their comparative freshness suggests that they may belong to the Newer Volcanic Group. No chemical analysis of a representative of these alkali-rocks has been undertaken because only two were collected *in situ,* and in neither case was there available sufficient material for a full microscopic and chemical examination.

In micro-slides of some of these basalts and microgabbros there are found occasionally octahedral crystals of picotite quite similar to those occurring in the ultramafic rocks. This affords further evidence of a magmatic relationship throughout the whole of the igneous rocks of Macquarie Island.

A common feature of all divisions of the Island's igneous rocks is their comparative richness in lime and alumina with corresponding poverty in iron oxides, magnesia, and titania. This characteristic is well illustrated by comparison with the more normal basalts of other areas. As an example of the latter, an average composition computed for plateau basalts is quoted in the table on page 131. In the same place is given the composition of a basalt from New Zealand which is rather similar chemically to the aphyric and glassy calc-alkali basalts of Macquarie Island.

CALC-ALKALI BASALTS

MEGAPHYRIC BYTOWNITE-BASALTS,

[203] is a coarsely-porphyritic bytownite-basalt. It is composed of abundant, large, euhedral plagioclase crystals in what was originally a hyalopilitic groundmass. Secondary changes, chiefly chloritization, have affected the minerals and broken down the glass base.

The feldspar phenocrysts have a composition about $Ab_{15}An_{85}$ as determined by extinction angles on the symmetrical zone. It is biaxial negative. The mean refractive index of chips by the immersion method is 1·57. Its composition is therefore that of a rather basic bytownite.

The microlitic feldspars appear to be andesine, with a composition about $Ab_{55}An_{45}$. Distributed through the dusty glass base are occasional isotropic octahedrons of picotite up to 0·25 mm. in length.

The chemical character of this rock is illustrated by the analysis on page 131. From this the norm has been computed as follows :—

Orthoclase	2·78	Apatite	1·25
Albite	19·96		
Anorthite	49·57		96·24
Nephelite	1·11		
Diopside	7·96	Water (combined) ...	2·85
Olivine	12·80	Water (hygroscopic) ...	0·15
Ilmenite	1·14		
Magnetite	0·20	Total ...	99·77

The C.I.P.W. classification is II. 5. 4. 4–5.

[215] is a coarsely-porphyritic, bytownite-basalt occurring on Hut Hill. Abundant plagioclase phenocrysts up to 1 cm. in diameter of a composition $Ab_{25}An_{75}$ are studded through a fine crystalline basalt base. The latter is constituted of acid labradorite laths, augite, and some tiny olivines now entirely replaced by

iddingsite and serpentine. The accessories are picotite and ilmenite, partly converted to leucoxene. Secondary changes are far advanced with the development of chlorite, serpentine, a little pistacite and zoizite. In this rock there are lots of tiny interstitial spaces occupied by an almost isotropic substance which appears to be residual glass converted to antigorite. Specimen [15] is generally similar to this one, but is composed of a considerable proportion of dusty glass more or less serpentinized and chloritized.

[374] is a coarsely-porphyritic bytownite-basalt composed of equidimensional feldspar phenocrysts up to 1·5 cm. in length embedded in a dark, formerly hyalopilitic basaltic base. In this base unusually long plagioclase needles and a spinelid, apparently picotite, are discernible. The whole rock has been considerably serpentinized and chloritized.

[373] is a coarsely-porphyritic bytownite-basalt in which large phenocrysts as much as 3 cms. in diameter with the composition of bytownite (near labradorite) are studded through a grey devitrified, hyalopilitic basaltic base. The plagioclase needles and laths of the base show evidence of flow around the phenocrysts. There is no indication of the presence of olivine. Secondary changes have been active to a limited degree, more particularly expressed in the development of chlorite. This rock is closely related to [203] and near to [215].

[371] is a coarsely-porphyritic bytownite-basalt. The phenocrysts, some of which exceed 1 cm. in length, are rather basic bytownites. The base of this rock was originally hyalopilitic, but has suffered chloritization and calcitization. Occasional grains of picotite are distributed through it. This rock bears a general resemblance to [373].

[268] is a propylitized, megaphyric, olivine-plagioclase-basalt. It illustrates an advanced stage in propylitization of a coarsely porphyritic basalt, the original minerals and structures now being but vaguely evidenced. The phenocrysts appear to have been anorthitic plagioclase and olivine. Scattered crystals of picotite remain unaffected by the agents which have chloritized, carbonated and pyritized this rock.

[242] is a megaphyric, hyalopilitic, bytownite-basalt. The porphyritic bytownites are very abundant and greyish-white in colour. The hyalopilitic base is dark grey in the hand specimen. In the micro-slide tiny needles and crystallites of plagioclase are seen to be thickly studded through the dark, dusty glass base. Steam-holes often lined with chlorite are usually filled with analcite, but sometimes contain calcite. The feldspar phenocrysts have a mean refractive index of about 1·577 and appear to conform to $Ab_{10}An_{90}$. These are riddled (Plate XXXV, figs. 3 and 4) with ramifying veinlets usually occupied with analcite, but there is no evidence of albitization having proceeded from these veins into the substance of the felspar. In other places the veinlets are filled with calcite.

[234] is a coarsely-porphyritic bytownite-basalt. The bytownites are as much as 1·5 cms. in diameter. They are notable for unusual freedom from albite twinning, only very broad lamellae or entire absence of lamellae being the

usual feature. The mean R.I. is about 1·577, and it is optically negative, consequently appears to be a bytownite bordering on anorthite. The phenocrysts are numerous. The base is very fine-grained and completely crystalline; actually it is more crystalline granular than the normal inter-granular structure of crystalline basalts. There are tiny olivines studded through the base. A few cavities and cracks in the rock contain natrolite.

MICROPHYRIC AND APHYRIC BASALTS.

Rock [198] is a fine-grained, medium to dark-grey basalt occurring at the site of the Expedition Hut at the north end of the isthmus. The specific gravity was ascertained to be 2·851.

Microscopically examined, it is observed to be a mesh of tiny plagioclase microlites with interstitial pyroxene. The plagioclase appears to be an acid labradorite. The pyroxene is a grey to nearly colourless diopsidic augite. Particles of ilmenite throughout the rock have been almost entirely leucoxenized. Pyrite occurs sparingly and sporadically.

There is a great deal of chlorite throughout the rock, much of it apparently replacing original residual glass, or occupying what appear to have been steam-holes. Secondary calcite is present also, distributed as minute specks and some small patches amongst the chlorite.

The chemical composition is stated on page 131. The norm is as follows :—

Quartz	0·56	Apatite	0·47
Orthoclase	1·61	Calcite	3·70
Albite	21·38		
Anorthite	30·11		96·57
Diopside	10·09	Water (combined) ...	2·87
Hypersthene	23·23	Water (hygroscopic) ...	0·68
Ilmenite	2·68		
Magnetite	2·74	Total ...	100·12

The C.I.P.W. classification is III. 5. 4. 4–5 (Auvergnose).

[202] is a porphyritic basalt from Lusitania Bay. It is a medium grey, fine-grained rock with occasional porphyritic feldspars of a faintly greenish colour up to 1·5 cms. diameter. The specific gravity is 2·885.

Examined microscopically, the base is seen to be composed of interlaced plagioclase laths with some light-coloured interstitial pyroxene. Embedded in this base are scattered porphyritic plagioclases, all more or less affected by secondary changes in which chlorite fills veins traversing them; more rarely grains of pistacite appear.

The feldspars of the base are tiny laths which appear to have the composition of acid labradorite. The pyroxene is an almost colourless pigeonitic augite. A little chlorite is present in the general base of the rock, which may represent chloritized residual glass. Iron ore which has been present only in very tiny particles and small amount, is now leucoxenized.

The chemical composition is stated on page 131. The norm is as follows :—

Orthoclase	1·39	Magnetite	0·34
Albite	25·15		
Anorthite	34·47		96·82
Diopside	16·81	Water (combined)	2·59
Hypersthene	2·16	Water (hygroscopic)	0·41
Olivine	12·45		
Apatite	1·62	Total	99·82
Ilmenite	2·43		

The C.I.P.W. classification is III. 5. 4. 4–5 (Auvergnose).

[164] is a medium-grey, fine-grained, microphyric holocrystalline basalt. There are occasional porphyritic plagioclases of a first generation up to 5 mm. diameter. The base is rich in augite. The iron-ore is leucoxenized.

[243] is a fine-grained, holocrystalline, olivine-basalt occurring *in situ* at Brothers Point. Some phenocrysts of basic labradorite up to 4 mm. diameter are present. Small olivines, partly iddingsitized and serpentinized, are enmeshed among the plagioclase laths with the pyroxenes. Small steam-holes are observed to be occupied by analcite, natrolite and calcite.

[125] is a holocrystalline olivine-basalt closely similar to [367], occurring as a dyke at Aerial Cove. Abundant light-brown augite and little centres of yellow-green serpentine after olivine fill the plagioclase mesh. There are also occasional porphyritic fragments of a basic plagioclase of an earlier generation.

[239] is a brownish, holocrystalline, fine, even-grained olivine-basalt from Brothers Point. It is studded with circular amygdales of about 1·5 mm. diameter, each filled with calcite and natrolite. It contains some porphyritic basic labradorites, up to 3 mm. in length, and intersertial augites and iddingsitized olivines.

[264] is a propylitized, holocrystalline, somewhat greenish-grey, fine-grained olivine-basalt occurring as a dyke on the western side of the Isthmus. Studded through the fine-grained base of plagioclase and augite are occasional small phenocrysts of labradorite. The augite is notably light coloured. The original minerals have been attacked with the production of secondary chlorite, calcite, and some serpentine. Rock [263] is very similar to this.

[70] is propylitized basalt with evidence of former shattering along certain planes. Propylitization is far advanced with the development of much calcite,

chlorite and leucoxenization of the iron-ore. The original basaltic structure has not been entirely obliterated.

[8] is a greenish-grey, fine and even-grained, propylitized basalt traversed by roughly parallel, dark chloritic veinlets, each about 0·5 mm. in width. The plagioclase laths are andesine in part, but others appear to be more albitic. The augite has been converted to light-grey, cloudy aggregates of mixed carbonates. Much chlorite and calcite are developed throughout the slide.

[138] is rather a light-grey, holocrystalline basalt partially uralitized and chloritized. The pyroxene exhibits an early development in ophitic structure.

[17] is a holocrystalline basalt which has been subjected to a certain degree of secondary change; the ilmenite has been leucoxenized and there are in it, faintly-greenish, chloritic patches of low birefringence and R.I. above that of Canada balsam.

[367] is a coarsely and completely crystalline basalt collected *in situ* at Aerial Cove. In the hand specimen some white spots which are visible are vesicles filled with natrolite. This rock is composed of plentiful plagioclase (anorthitic andesine) as a meshwork of thin laths up to 2mms. in length, abundant pale mauve augite notably prismatic in habit, scattered serpentine areas representing former small olivines and leucoxenized ilmenite. Secondary changes have introduced much fine calcite or related carbonate minerals which are distributed in small patches throughout the slide.

[255] is a chloritized hypocrystalline basalt. It formerly contained a very little olivine, but the pyroxene is now the only original mineral which remains unaltered.

[134] is a medium-grey rock constituted of a few small phenocrysts of plagioclase needles and olivine embedded in a fine-grained base. The latter is a meshwork of plagioclase and interstitial augite and glass with a little olivine. The plagioclase needles appear to be andesine. The augite is faintly mauve coloured. The residual glass is cloudy and serpentinized. Small brown translucent picotites are present.

[135] is closely related to [134], differing from it mainly in that some of the glass is serpentinized and in the presence of steam holes filled with calcite. There are some small phenocrysts of basic labradorite.

[173] is a basalt from the first gully on the north side of Finch Creek. It is composed of oligoclase rods and grey granular augite. Both this and the succeeding rock [44] are not characteristic mugearites, but appear to have acquired their unusual character as deuteric modifications in the direction of spilitization.

[44] is a holocrystalline spilitic basalt. The plagioclase laths, where entirely reduced to aggregates, extinguish parallel to the vibration directions of the nicols, and the R.I. corresponds to that of Canada balsam, thus indicating oligoclase.

Propylitization responsible for the albitization of the feldspar has advanced far with the production of much calcite and chlorite.

[130] is a medium-grey, fine-grained basalt which is rich in amphibole. The latter is of an elongated prismatic form and a yellow-brown colour. Colourless to grey pyroxene is also present. These minerals, together with the plagioclase laths, which are more sodic than usual constitute the main bulk of the rock. Olivines are also present, often relatively large, but all have been serpentinized, setting free much black iron oxide. The whole rock is greatly affected by secondary processes which have developed chlorite and fine calcite throughout its fabric.

GLASSY BASALTS.

TACHYLITIC BASALTS.

[41] from North Head is a ropy basalt with a variolitic glass base in which are embedded some small porphyritic basic plagioclases. The glass base has been partly palagonitized. Steam holes filled with radial-fibrous natrolite are abundant.

[247] is a vitrophyric basalt occurring as a dyke at a point in the creek 200 yards north of Sandy Bay Camp. The specimen has a clouded, glassy base carrying tiny feldspar needles. It has a pitch-like, quickly-chilled marginal contact zone 1·5 cms. thick.

[106] is a tachylitic basalt of stony appearance. In microscope slide clear fresh idiomorphic olivines stand out in an almost opaque base of glass clouded with microlites. Occasional steam-holes are filled with clear analcite.

[250] is a dull tachylitic basalt. There are some very small olivines already serpentinized. The base is partly devitrified dusty glass loaded with bundles of crystal needles and rods so that it presents a subdued variolitic structure.

TACHYLITE (HYALINE).

Tachylite glass of the Younger Volcanic Series is met with in several localities. When fresh, it is black, brilliantly vitreous, and breaks with a conchoidal fracture. It has the appearance of fresh obsidian, but is less translucent on thin edges. One of the best localities for the highly glassy variety of tachylite is North Head.

Rock [71] of the collection is from North Head. This is massive glass traversed by cracks along which secondary changes have proceeded with the formation of early stages in the development of palagonite, characterized by a dull to pearly appearance and a waxy lustre. Under the microscope in thin slice, the tachylite glass is of a light yellow colour, and is notably uniform in appearance. Small, perfectly fresh porphyritic olivines and rarer plagioclase laths are embedded in the glass, also small, hollow vesicles are not uncommon. Embedded in the olivines are tiny opaque cubes and octahedrons; in the case of very thin slides some of these octahedrons are seen to be translucent in dark brown, suggesting picotite, or possible chromite.

In a specimen [256] from another outcrop at North Head the glassy tachylite is presented in black kernels up to several inches in diameter, each surrounded by dull, bluish-grey semi-palagonite. This rock appears to have been accumulated as a glass breccia. Tiny steam vesicles are visible to the naked eye on the fresh fracture faces, and on this account care had to be taken to eliminate such vesicles where determining the specific gravity of the glass. To this end the glass was reduced to a fine state and weighed in a pycnometer; the specific gravity thus determined is 2·86. The refractive index of the clear glass of this specimen was found to be 1·605. The microscope slide reveals that studded through the glass, in some places fairly numerous, are small clear crystals of olivine ranging from 0·25 to 0·5 mm. in length. Fluction lines in the glass are clearly distinguishable in case of thick slices. Fine veins traversing the slide are occupied by the clear, colourless zeolites, natrolite and analcite which have been introduced as secondary depositions, cementing the fragmented tachylite glass.

Specimen [212] is a fresh, black, glassy tachylite, collected about 1½ miles north of Lusitania Bay. Specimen [377], which was collected as a large transported block at a point about 1 mile north of Lusitania Bay, is another fresh tachylite, which, on cooling, developed a system of cracks after the manner of perlitic structure, but without affecting the lustre of the glass.

[232] Brecciated porphyritic olivine-tachylite from Brothers Point.

[366] is a striking fresh tachylite glass in which are embedded fresh olivine and plagioclase phenocrysts. The feldspar individuals, though usually much smaller, reach a length of 1 cm.

The chemical character of the tachylite is recorded on page 129, where analyses of three different samples from North Head are given, together with the arithmetic mean of all three, which latter may be regarded as well representing the composition of the unaltered black tachylite glass of Macquarie Island.

The norm calculated on the mean of the analyses has the following composition :—

Orthoclase	3·34	Apatite	0·32
Albite	22·53	Pyrite	1·11
Anorthite	31·14		
Diopside	12·17		97·48
Hypersthene	15·36	Water (combined) ...	1·60
Olivine	10·01	Water (hygroscopic) ...	1·08
Magnetite	1·86		
Ilmenite	5·62	Total ...	100·16

This rock ranks in the C.I.P.W. classification as III. 5. 4. 4–5 (Auvergnose).

PALAGONITIZATION OF THE TACHYLITE.

In most of the localities where observed the tachylite has been partly converted to at least early stages in the development of palagonite. Specimens [72,] [256], [258], [212] and [124] all illustrate such change. Stages in this conversion are well illustrated at North Head. There the product is usually an ash-grey, stony, opaque substance.

In specimen [72] the commencement of palagonitization is marked by the appearance of a bluish-grey film on the black tachylite glass.

In the case of [256] change to a grey-green palagonitic substance is well illustrated. In the microscope slide of this rock there is illustrated an intermediate zone in which the original fresh yellow-brown glass has become discoloured and is loaded with rod-like and hair-like bodies only distinguishable under moderately high magnification. In the more highly altered zone beyond, abundant minute greenish crystallites are distinguishable under high magnification. Where the change has advanced further the whole of the glass has changed to a minutely cryptocrystalline mass of a greenish colour.

A chemical analysis of semi-palagonitized tachylite from [256] is given in the table herewith. Comparison of its composition with that of the unaltered tachylite glass shows that the process is essentially one of hydration with losses mainly in silica and soda, but to a less extent in other bases except alumina.

CHEMICAL ANALYSES OF TACHYLITES.

	I.	II.	III.	IV.	V.
SiO_2	48·15	48·42	48·41	48·36	44·28
TiO_2	3·15	2·93	2·81	2·96	1·98
Al_2O_3	16·55	16·21	16·52	16·42	18·06
Fe_2O_3	1·20	1·23	1·21	1·21	2·51
FeO	6·75	6·88	6·77	6·80	5·78
MnO	......	......	......	......	0·12
MgO	8·75	8·68	8·71	8·71	7·97
CaO	9·85	9·37	9·49	9·57	9·98
Na_2O	2·70	2·53	2·74	2·65	1·49
K_2O	0·70	0·61	0·69	0·66	0·75
H_2O + 110° C. ...	1·60	1·68	1·51	1·60	3·05
H_2O — 110° C.	1·00	1·14	1·10	1·08	3·59
P_2O_5	......	0·11	0·11	0·11	0·65
CO_2	......	......	......	......	Nil
ZrO_2	......	......	......	......	Nil
S	0·20	......	......	0·20	......
SO_3	......	......	......	......	0·08
Cr_2O_3	......	......	......	......	Trace
BaO	Nil	......	......	Nil	Nil
Total	100·60	99·79	99·67	100·33	100·29

I. Tachylite glass [71] from North Head, Macquarie Island. Analysed in 1925 by C. S. Piper, Dept. of Geology, University, Adelaide.

II. Tachylite glass [256A] from North Head, Macquarie Island. Analysed in 1924 by R. G. Thomas, Dept. of Geology, University, Adelaide.

III. Tachylite glass [256B] from North Head, Macquarie Island. Analysed in 1924 by A. R. Alderman, Dept. of Geology, University, Adelaide.

IV. Mean of Analyses I, II and III.

V. Semi-palagonitized tachylite [256C] from North Head, Macquarie Island. Analysed in 1925 by R. G. Thomas.

ALKALI-BASALTS

FELDSPATHOID-BASALTS.

ANALCITE-BASANITES.

[224] is a coarse and completely crystalline analcite-basanite from Half-Way Hill. The olivines have been peripherally iddingsitized, and later serpentinized. The pyroxenes are weakly mauve coloured. The plagioclases have suffered some degree of albitization, exhibiting shadowy extinction under crossed nicols. Residual patches of analcite are well shown in the microscope slide.

[228] is a boulder of analcite-(leucite ?)-basanite, which is rather a rough-surfaced rock of a medium-grey colour studded, as seen in the hand specimen, with tiny white spots which are vesicles filled with zeolites. In microscope slide the more obvious constituents are observed to be a lattice-work of long slender plagioclase needles individually up to 3 mms. long, together with abundant mauve-coloured augite, also in elongated forms. Then there are yellow to orange-red spots which are taken to be serpentinized tiny olivines. There are also some indefinite dusty serpentinous and chloritic areas through which well-developed idiomorphic apatites are scattered. Finally, small clear patches mainly occupied by analcite, though some are taken to be leucite; these are studded throughout the section (Plate XXXVI, fig. 4) recalling the ocellar structure of leucite-bearing rocks. These clear spaces, however, are rarely polygonal in form, being usually irregular in outline with marked tendency to a circular form; they do not exhibit any of the specially characteristic features of leucite to distinguish them from analcite, but an alkali determination on this rock yielded Na_2O 2·07% and K_2O 1·44%. This high potash value, higher than in any of the other Macquarie Island rocks chemically examined, suggests the presence of leucite.

ANALCITE-TEPHRITES.

[204] is an analcite-tephrite. The most conspicuous minerals present are violet titanaugite, in coarse grains and short prisms and the brown amphibole barkevikite in elongated prisms. In many instances the barkevikite is grown around the violet pyroxene and is in crystallographic continuity therewith,

consequently it is obvious that a close relationship exists between this titanaugite and barkevikite. Another feature heightening the strong colour effects in the microscope slide is the development of a green margin around the barkevikite. This appears to be the result of reaction with richly sodic residual liquors at the closing stages of the period of crystallization.

A considerable portion of the slide is occupied firstly by secondary aggregates resulting from the alteration of earlier minerals, portion of which appears to have been feldspar, secondly by turbid and dusty glass residue in which clearer patches answer to analcite. Apatite as comparatively large crystals occurs in abundance, mainly embedded in the glass base and analcite, and, to a less extent, in the barkevikite. A little ilmenite is present. An approximate estimate of the alkali content gave soda 3·73% and potash 0·92%. Taken as a whole, this rock is notable for the abundance of its large phenocrysts of mafic minerals.

[111] is a grey, even-grained basalt free from olivine. Some natrolite occupies steam holes. Violet-tinted pyroxene and brown amphibole are the most prominent minerals appearing in the microscope slide. A secondary chloritic substance of extremely low birefringence is distributed throughout. The feldspars appear to have suffered considerable late magmatic change. The clearer feldspar remaining has R.I. lower than the balsam and is taken to be albite. There is an extremely small amount of isotropic interstitial residue which appears to be analcite, thus it just qualifies as a tephrite.

CHEMICAL ANALYSES OF THE BASALTS.

	I.	II.	III	IV.	V.	VI.
SiO_2	48·05	47·56	46·57	48·36	49·76	49·35
Al_2O_3	17·75	15·50	22·93	16·42	15·72	14·05
Fe_2O_3	1·13	1·88	0·87	1·21	2·31	3·40
FeO	6·19	6·82	4·43	6·80	6·52	9·94
MgO	7·69	7·77	6·02	8·71	7·15	6·36
CaO	11·32	10·92	12·09	9·56	9·85	9·73
Na_2O	2·99	2·53	2·60	2·65	3·68	2·90
K_2O	0·25	0·27	0·50	0·66	0·34	1·00
H_2O + ...	2·59	2·87	2·85	1·60	2·55	......
H_2O −	0·41	0·68	0·15	1·08	0·56	......
CO_2	......	1·63	......	......	Trace	......
TiO_2	1·30	1·41	0·60	2·96	1·04	2·59
P_2O_5	0·21	0·20	0·08	0·11	0·10	0·47
MnO	......	0·13	0·04	......	0·22	0·21
NiO	......	......	......	......	0·03	......
Cr_2O_3	......	......	......	......	0·03	......
SrO	......	......	......	......	Trace	......
BaO	......	......	......	Nil	Trace	......
S	......	......	......	0·20	0·12	......
Total	99·88	100·17	99·73	100·33	99·98	100·00
Density	2·885	2·851	2·847	2·86	......	......

I. Porphyritic basalt [202] from Lusitania Bay, Macquarie Island. Analysed (1926) by A. R. Alderman.

II. A Fine-Grained, Aphyric Basalt [198] from outcrop at the Expedition Hut at the north end of Macquarie Island. Analysed (1926) by A. R. Alderman.

III. Megaphyric Bytownite-Basalt [203] from near Lusitania Bay, Macquarie Island. Analysed by E. R. Segnit, Dept. of Geology, University, Adelaide.

IV. Average composition of glassy tachylite from North Head, Macquarie Island. (See table on page 129.)

V. Basalt of Older Volcanic Series, Taputaputa, east of Cape Reinga. Recorded by J. A. Bartrum : Trans. N.Z. Inst., Vol. 59 (1928), p. 131.

VI. The average analyses of Plateau Basalts : H. S. Washington, Bull. Geol. Soc. America, Vol. 33 (1922), p. 797.

DESCRIPTION OF PHOTOGRAPHIC PLATES

Plate I.

(Folded plate in pocket.)

A panoramic winter prospect from the summit of Wireless Hill, looking south over the Isthmus to an end-on view of the main mass of the Island. The Expedition Hut can be seen on the Isthmus about half-way from the centre to the left of the picture. To the right is Hasselborough Bay; to the left is Buckles Bay. Nuggets Point is on the extreme left, and Handspike Point (West Point) on the extreme right. Photo. by A. C. Sandell : Negs. C304, 305, 306.

Plate II.

(Folded plate in pocket.)

Panorama of the highlands of Macquarie Island, looking north in the region west of Victoria Point. Pyramid Peak is the pyramidal hill immediately west of the lake appearing in the distance near the right-hand side of the view. Photo. by L. R. Blake : Negs. H264 and 265.

Plate III.

(Folded plate in pocket.)

Fig. 1. Panorama of the highland plateau of Macquarie Island taken at a point a little to the west-north-west of North Mountain. The top of Mt. Elder appears on the extreme left, and the tip of Eagle Point is seen on the extreme right. Note the abundance of glacial tarns. Extending from the west coast across this country there is a train of erratics of a characteristic enstatite-peridotite plucked by the former ice-sheet from the vicinity of Eagle Point. Photo. by L. R. Blake : Negs. H459, 460 and 461.

Fig. 2. Waterfall Lake, a glacially eroded basin of 62 acres in extent, located at 750 feet above sea-level. The topography shows steep rocky banks and a large glaciated dome near the outlet of the lake on the right. Photo. by L. R. Blake : Negs. H456, 457 and 458.

Plate IV.

Fig. 1. Wireless Hill on the left and Hut Hill on the right, as seen from the Isthmus. One of the wireless masts is visible on the sky-line. In between the two hills a corner of the Expedition Hut shows behind a large sheltering rock mass. Photo. by L. R. Blake : Negs. H462 and 463.

Fig. 2. View from near the head of Half-Moon Bay, looking south down the raised wave-cut terrace of the west coast. Note former sea-stacks now standing out of reach of the sea. Photo. by D. Mawson : Banzare Negs. 880, 883 and 884.

Plate V.

Portion of the Royal penguin rookery at Hurd Point. Photo. by J. F. Hurley : Negs. C302 and 303.

Plate VI.

The elevated wave-cut platform on the west side of Macquarie Island. The distant wall ranging from 500 to 700 feet in height is a former line of sea cliffs. The shingle beach in front of the tussock-grass flat is occupied by a rookery of sea-elephants. Photo. by H. Hamilton : Neg. P. 260.

Plate VII.

The tussock-clad hills overlooking the Nuggets Beach. Mt. Elder is on the sky-line in the centre. Royal penguins are observed on the beach and streaming inland along the creek to their rookeries on the distant elevated hill slopes. Barrels of penguin oil rolled out of the Digestor Works are ready for shipment. Photo. by H. Hamilton : Negs. H.266 and 267.

Plate VIII.

Fig. 1. The pebbly beach of Buckles Bay with remains of the wrecked "Clyde." Photo. by X. Mertz : Neg. C.132.

Fig. 2. The west coast, viewed from near its northern end, illustrating its rocky nature and the extent of the elevated wave-cut bench. Mt. Waite appears in the extreme distance. Photo. by L. R. Blake : Neg. H.570.

Plate IX.

Fig. 1. Looking south over Sandy Bay to Brothers Hill, 583 feet high. Photo. by L. R. Blake : Neg. H339.

Fig. 2. Looking north along the east coast, with Victoria Point in the far distance. Mt. Aurora is the first hill immediately north of the observer. The shoulder of Mt. Aurora cuts off the view of Lusitania Bay. Photo by L. R. Blake : Neg. H.311.

Fig. 3. The east coast, viewed from 2 miles north of the Lusitania Bay Hut. Mt. Aurora with its round top is the middle one of the three hills showing. Photo. by L. R. Blake : Neg. H.316.

Fig. 4. View up the east coast, commencing at the northern limit of Lusitania Bay. Victoria Point in the distance. Photo. by L. R. Blake : Neg. H.317.

Plate X.

Fig. 1. View from the main mass of the Island, looking north over The Isthmus and North End Promontory. Buckles Bay lies on the right and Hasselborough Bay on the left. Anchor Rock is the large sea-stack near the left side of the picture standing well out in Hasselborough Bay. The Elliott Reef is the line of rocks beyond North Head. The Expedition Hut is seen as a white speck at the foot of Hut Hill. Photo. by L. R. Blake : Neg. H.418.

Fig. 2. View from North End, looking south over the Isthmus. In the foreground is the Expedition Hut. The white object in the middle view is the meteorological screen. The white shed on the Isthmus near the tent hill at its southern extremity is the sealers' boiling-down shed. Photo. by C. A. Sandell : Neg. Q. 82.

Plate XI.

Fig. 1. The spit at Hurd Point, viewed from the brow of the cliff 400 feet above. The greater part of the area is observed to be occupied by a dense mass of Royal penguins. Photo. by J. F. Hurley : Neg. C.106.

Fig. 2. Rockhopper penguins in occupation of the wave-worn cavernous rocks forming the sea front at North Head. Photo. by H. Hamilton : Neg. H.574.

Plate XII.

Fig. 1. The main portion of the King penguin rookery on the coast platform at Lusitania Bay; the s.y. "Discovery" at anchor. Photographed in November, 1930, to illustrate the lamentably shrunken population of the rookery. Photo. by J. F. Hurley: Banzare Neg. R.164.

Fig. 2. The Nuggets: a striking example of a sea-stack now joined to the land by a shingle beach. This locality is one of the most populous centres of the Royal penguin community. Photo. by J. F. Hurley: Neg. H.565.

Plate XIII.

The glaciated surface of the highlands. The glacial rock basin in the centre of the picture is located three-quarters of a mile to the west of Lusitania Bay, and is about 1,000 feet above sea-level. View looking in a southerly direction, with Mt. Aurora, 1,258 feet, on the sky-line to the left. Photo. by L. R. Blake: Neg. H.350.

Plate XIV.

Fig. 1. The raised-beach terrace on the south side of Hasselborough Bay, looking towards the east. Wireless Hill is on the extreme left, and the small peaked mass off its toe is Hut Hill. The distant flat-topped ridge located at the south end of the Isthmus shelters the sealers' huts. Photo. by L. R. Blake: Neg. H.360.

Fig. 2. Portion of the raised-beach platform at West Point (Handspike Point). The higher part is about 50 feet above sea-level, but it gradually slopes down to the sea. Numbers of former sea-stacks rise from the wave-cut bench. *Pleurophyllum Hookeri* is seen in abundance arranged in wind-rows on the peaty flat. Photo: D. Mawson: Banzare Neg. 873.

Plate XV.

Fig. 1. View looking north along the coast from the head of Caroline Cove. Note the sea-stacks in the middle distance. Photo. D. Mawson: Neg. C.136.

Fig. 2. View over the raised wave-cut terrace as seen from near its inner margin looking west towards the northern shore of Half-Moon Bay. The raised sea-stacks are composed of gabbro. Photo. by D. Mawson: Banzare Neg. 881.

PLATE XVI.

Fig. 1. Looking northwards: a glacial lake about 2 miles west of Victoria Point. The longitudinal axis trends north and south and is transverse to the direction of the ice movement. Photo. by L. R. Blake: Neg. H.358.

Fig. 2. Prion Lake: another glacial lake viewed from the northern end. Photo. by L. R. Blake: Neg. H.348.

Fig. 3. A long narrow lake, 750 feet above sea-level, elongated in a north and south direction, located 1 mile to the south-south-west from Mt. Elder. This basin is excavated in boulder-clay. Photo. by L. R. Blake: Neg. H.335.

Fig. 4. View of Major Lake, 644 feet above sea-level, looking towards the south-south-west, with Mt. Hamilton in the far distance. The coastal cliffs on the right are about 650 feet high. Photo. by L. R. Blake: Neg. H.724.

PLATE XVII.

Figs. 1 and 2. Waterfalls on the west coast. Torrents of water are seen descending from the highlands to the sea by courses carved in the precipitous wave-cut cliffs. In fig. 1, as an indication of the scale, there is to be seen in the middle view the figure of J. Ferguson, a member of the meteorological party in 1915. Photos. by F. J. Henderson.

PLATE XVIII.

Fig. 1. L. R. Blake engaged upon his survey. Photo. by H. Hamilton: Neg. H.147.

Fig. 2. The Bench-Mark established by Blake at Garden Bay. It represents 8·96 feet above mean sea-level. Photo. by L. R. Blake: Neg. H.168.

Fig. 3. A cushion of *Azorella Selago*, one of the umbelliferae, with a remarkable tolerance for wind. It is the dominant vegetation of the wind-swept highlands. Photo. by H. Hamilton: Neg. H.17.

Fig. 4. *Pleurophyllum Hookeri* in flower on the left, and *Stilbocarpa polaris* with its rhubarb-like leaves, also in flower, on the right. Photo. by H. Hamilton: Neg. H.304.

Plate XIX.

Fig. 1. View looking north-north-west over a rock-basin lake located three-quarters of a mile west of Lusitania Bay Hut. Mt. Hamilton, 1,421 feet in height, which is the peak on the sky-line near the centre of the view, is the highest point of the Island. Note that the glacial topography illustrates movement of the former ice sheet from west to east. Photo. by L. R. Blake : Neg. H.356.

Fig. 2. View from the highland to the south-west of Mt. Aurora looking north-west with Mt. Hamilton in the far distance. Note the obvious "stoss-seite" and "lee-seite" in the glacial topography. Solifluction is evidenced, resulting in a terracing with Azorella banks as risers and with gravel covered treads. Photo. by L. R. Blake : Neg. H.302.

Plate XX.

Fig. 1. Grass turf on the summit of Wireless Hill, growing on a bed of peat, overlying water-sorted glacial gravel, which in turn rests upon tachylitic agglomerate of the Younger Basic Series. Photo. by H. Hamilton : Neg. H.405.

Fig. 2. A glacial moraine field on the highlands of Macquarie Island south of North Mountain. In the centre of the picture is a large erratic block of harzburgite which has been transported from the neighbourhood of Eagle Point. The larger boulders support growths of moss ; the lesser rocks are bound together and partly covered with a carpet of *Azorella Selago* and *Colobanthus muscoides*. Photo. by L. R. Blake : Neg. H.16.

Plate XXI.

Fig. 1. Here is a former valley choked with glacial Till located one-third of a mile north of the Nuggets. Erosion is now actively tearing out the soft Till and re-excavating the valley. The top of the Till formation seen in the middle view is about 200 feet above sea-level. Photo. by L. R. Blake : Neg. H.372.

Fig. 2. A weathered face of boulder-clay at 1,000 feet above sea-level. This occurs at the head of Rookery Creek overlooking Nuggets Beach. Photo. by L. R. Blake : Neg. H.370.

Plate XXII.

Fig. 1. The upper channel of the northern branch of Lusitania Creek, looking to the north-north-west. The summit on the left reaches 1,000 feet above sea-level, that on the right 999 feet. In the centre distance is a hill 1,223 feet. Photo. by L. R. Blake : Neg. H.345.

Fig. 2. A view of the seaward slope of Half-Way Hill, illustrating the unconformable junction between dolerites of the Older Basic Series, and volcanic breccias of the Younger Basic Series. Photo. by L. R. Blake : Neg. H.361.

Plate XXIII.

Fig. 1. A natural section through the glacial Till in Nuggets Creek. Photo. by L. R. Blake : Neg. H.396.

Fig. 2. Volcanic agglomerate of the Younger Basic Series exposed on the south-east slope of Wireless Hill. Photo. by L. R. Blake : Neg. H.336.

Plate XXIV.

Fig. 1. The distant hill is an outcrop of gabbro on the northern highlands. Photo. by L. R. Blake : Neg. H.341.

Fig. 2. An outcrop of gabbro on the beach near West Point (Handspike Pt.). Photo. by L. R. Blake : Neg. H. 334.

Plate XXV.

Fig. 1. Dolerites and tuffaceous beds of the Older Basic Series at a point on the coast one mile south-west of the Expedition Hut. Low tide here exposes an extensive growth of a gigantic form of seaweed (*Durvillaea antarctica*). Note the angle of inclination of the igneous series. Photo. by L. R. Blake : Neg. H.273.

Fig. 2. A gabbro outcrop at Half-Moon Bay. Note the banded structure (pseudo-stratification) which was referred to by Blake as "gneiss" or "flow" structure, but which appears to be an illustration of gravitative crystal settlement. Photo. by L. R. Blake : Neg. H.362.

Plate XXVI.

Fig. 1. The "Aurora" at anchor, Hasselborough Bay. Note the parallel outcrops of basic sheets brought into relief by the erosion of softer intervening beds of tuff and agglomerate. Photo. by L. R. Blake : Neg. H.383.

Fig. 2. The bar across the lee end of Island Lake. This has been formed partly by the agency of wind and partly by the action of lake ice. Photo. by L. R. Blake : Neg. H.332.

Fig. 3. Gabbro outcrop two miles west of Nuggets Point. Note the ice eroded roche moutonnées surface. Photo. by L. R. Blake.

Plate XXVII.

Fig. 1. Pillow-lava of the Younger Basic Series, 750 feet above sea-level to the west of Victoria Point. Photo. by L. R. Blake : Neg. H.367.

Fig. 2. Glassy, tachylite bombs, containing zeolites; embedded in volcanic agglomerate located one-third of a mile north of Brothers Point. Photo. by L. R. Blake : Neg. H.366.

Plate XXVIII.

Fig. 1. The face of a large block of serpentinized harzburgite in the course of Nuggets Creek near the rookery. The rock is polished and deeply scored by the long-continued passage of the clawed feet of millions of Royal penguins. Photo. by H. Hamilton : Neg. P.120.

Fig. 2. A monolith of the Younger Basic Group located half mile north of Brothers Point. Volcanic breccia below and pillow-lava above. Photo. by L. R. Blake : Neg. H.368.

Plate XXIX.

Fig. 1. Volcanic agglomerate of the Younger Basic Series on the beach at the foot of Half-Way Hill. Photo. by L. R. Blake : Neg. H.338.

Fig. 2. To the right of the camera case in a basic dyke intruding volcanic agglomerate of the Younger Basic Series. The location is one-eighth mile south of Nuggets Point. Photo. by L. R. Blake : Neg. H.309.

Fig. 3. A sheet-dyke of the Younger Basic Group intruding volcanic breccia at Aerial Cove. The camera case marks the intrusive sheet. Photo. by L. R. Blake : Neg. H.354.

Fig. 4. A large wind-weathered erratic standing in the snow at half-a-mile south-east of North Mountain. This is of Eagle Point harzburgite weathered out of the underlying Till. Photo. by L. R. Blake : Neg. H.397.

Plate XXX.

Fig. 1. An ice-worn hill of pillow-lava located one mile west-north-west of Victoria Point. Photo. by L. R. Blake : Neg. H.331.

Fig. 2. A close view of the outcrop of pillow-lava west-north-west of Victoria Point. Photo. by L. R. Blake : Neg. H.329.

Fig. 3. The face exposed in a cross-section of pillow-lava at Nuggets Point. Photo. by L. R. Blake : Neg. H.323.

Plate XXXI.

Fig. 1. A highly-polished and striated erratic [97] of serpentinized harzburgite from the Till near Nuggets Point. Mag. $\times \frac{3}{4}$.

Fig. 2. Glacially facetted and striated erratic [196] of grey dolerite of the Older Basic Group. The scale is in inches.

Fig. 3. A fresh face of boulder-clay [118] from the Till. Nat. scale.

Fig. 4. Palagonitized tachylite glass of the Younger Basic Group embedded in the faintly straw-coloured Globigerina ooze rock. Specimen [42A] from North Head. Nat. scale.

Plate XXXII.

Fig. 1. Penguin-scored face of serpentinized harzburgite [109]. Mag. $\times$ 1.

Fig. 2. Veins of aphyric basaltic rock intersecting gabbro [36]. Mag. $\times \frac{7}{8}$.

Fig. 3. Coarse prehnite in rock [355], under crossed nicols. Mag. $\times$ 64.

Fig. 4. A vein in bytownite dolerite [7] occupied by prehnite. Mag. × 64.

Fig. 5. A polished face of a specimen [256] of tachylite with kernels of bright black glass embedded in dull, shattered and slightly palagonitized base material. Mag × $\frac{1}{2}$.

Fig. 6. Enlarged view of micro-slide of Globigerina ooze rock [42]. Mag. × 23.

Plate XXXIII.

Fig. 1. Contact between intrusive gabbro and intruded injected-hornfels [62] Mag. × $\frac{3}{4}$.

Fig. 2. Polished face of megaphyric bytownite-basalt [213]. Nat. size

Fig. 3. Polished face of partly serpentinized harrisite [357]. The dark areas are olivine and the white are anorthitic plagioclase. Nat. size.

Fig. 4. A large phenocryst of bytownite embedded in the basaltic base of [242]. Photo. of micro-slide under crossed nicols. The dark tract wandering through the bytownite is isotropic analcite. It will be noted that the tract of analcite crosses the dark base of the rock into a second feldspar phenocryst. Mag. × 42.

Plate XXXIV.

Fig. 1. A beach boulder of troctolite [353A]. The dark areas are olivine, darkened by serpentinization. Nat. size.

Fig. 2. A fracture face of allivalite [9]. The light areas are feldspar and the dark partly serpentinized olivine. Nat. size.

Fig. 3. Brecciated tachylite glass [71]. Nat. size.

Fig. 4. Photograph of a face of megaphyric bytownite-basalt [373]. Mag. × $\frac{3}{4}$.

Plate XXXV.

Fig. 1. Diatomaceous shale with dark traces of fossil moss [78]. Nat. size.

Fig. 2. Micro-photo of analcite-basanite [228] in ordinary light. The large clear area in the right-centre crossed by a few faint cracks is analcite. There is another patch in the left-hand bottom corner. Other minerals present are lath-shaped plagioclase, dark-coloured pyroxene and very dark-coloured serpentinized olivine. Mag. × 64.

Fig. 3. Micro-photo of megaphyric bytownite-basalt [242] in ordinary light, illustrating a system of ramifying cracks occupied by analcite traversing a large bytownite crystal. Mag. × 65.

Fig. 4. Same as Fig. 3, but under partly-crossed nicols. The nicols were not entirely crossed, in order not to entirely black-out the analcite, for it would then be indistinguishable from the base material. Mag. × 65.

Plate XXXVI.

Fig. 1. Micro-photo of megaphyric bytownite-basalt [215] in ordinary light to show the character of the groundmass in which the large bytownites are embedded. Mag. × 25.

Fig. 2. Micro-photo of megaphyric bytownite-basalt [203] in ordinary light to show the character of the basaltic base in which the phenocrysts of bytownite are embedded. Mag. × 25.

Fig. 3. Micro-photo in ordinary light of a slide of the megaphyric bytownite-basalt [373] to show the nature of the groundmass which is shown at contact with a large phenocryst. Mag. × 64.

Fig. 4. Micro-photo in ordinary light of the analcite-basanite [228] which exhibits ocellar structure and long needles of plagioclase. The clear "cells" are mainly if not entirely analcite, though some may be leucite. Mag. × 25.

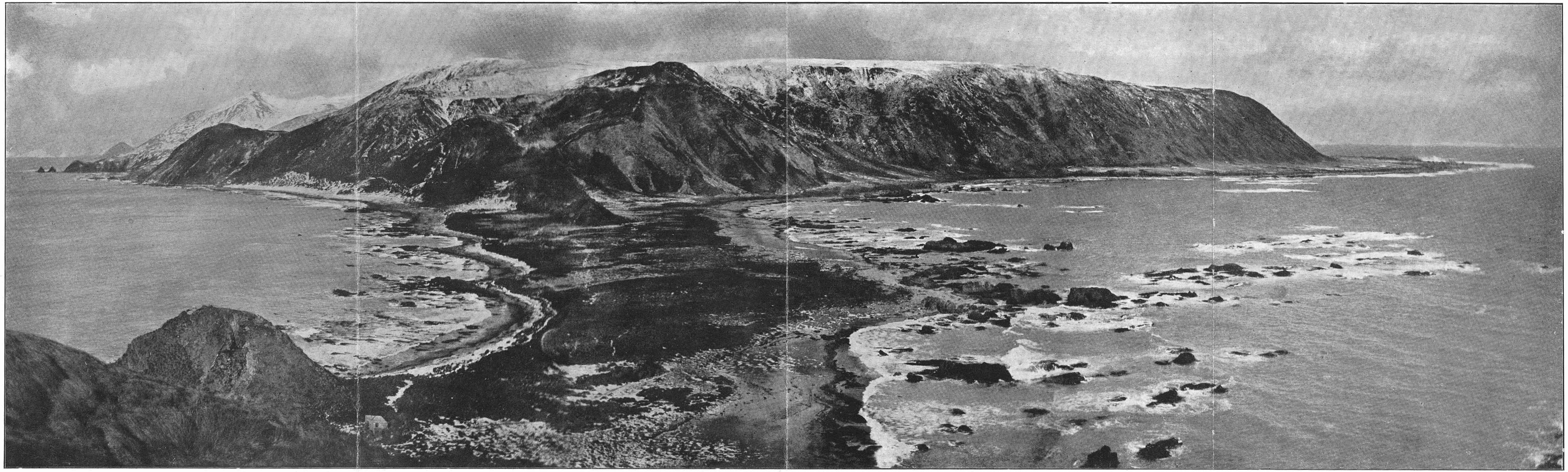
Plate XXXVII.

Fig. 1. Micro-photo in ordinary light of a coarse ophitic dolerite [177]. The large shaded area extending from the top left, through the centre to the right lower corner is optically-continuous augite enclosing feldspar. Mag. × 25.

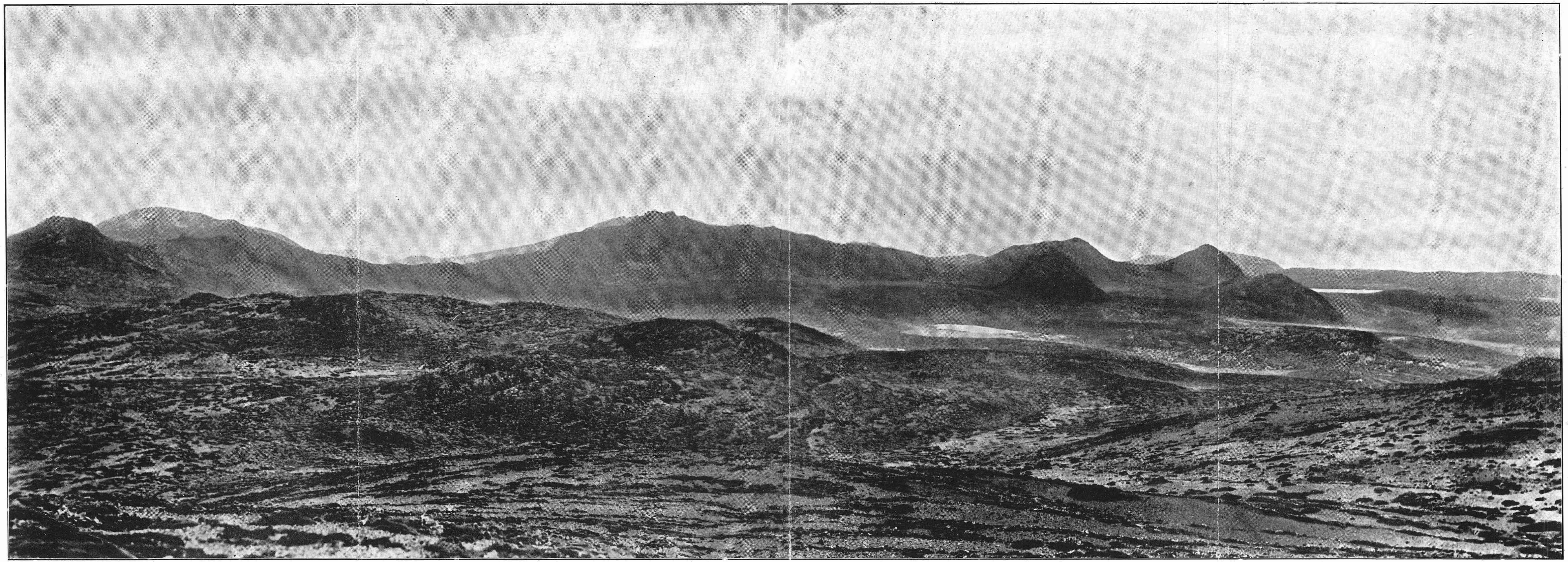
Fig. 2. Micro-photo in ordinary light of a megaphyric chrysolite-dolerite [214]. The whole view is occupied by portion of a large olivine, which is seamed with tracts occupied by serpentine which appears in half-tone in the reproduction. Mag. × 25.

Fig. 3. Micro-photo of tachylitic basalt [219] showing plagioclase needles and laths in a glass base. Mag. × 64.

Fig. 4. Photograph of a micro-slide of variolitic basalt glass embedded in Globigerina ooze [42A]. Note the sheaf-like bundles of plagioclase fibres. Mag. × 64.



A Panoramic Winter Prospect from the Summit of Wireless Hill.



Panorama of the Highlands of Macquarie Island.

In pocket.

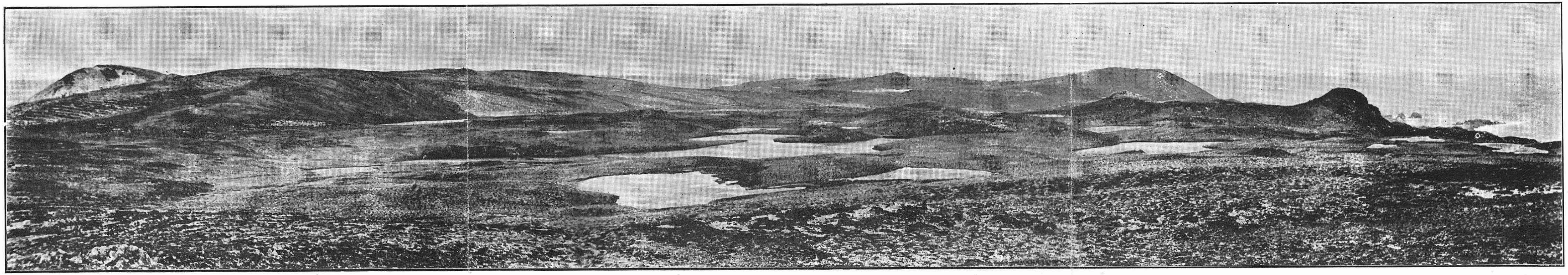


Fig. 1. Panorama of the Plateau from Mt. Elder to Eagle Point.

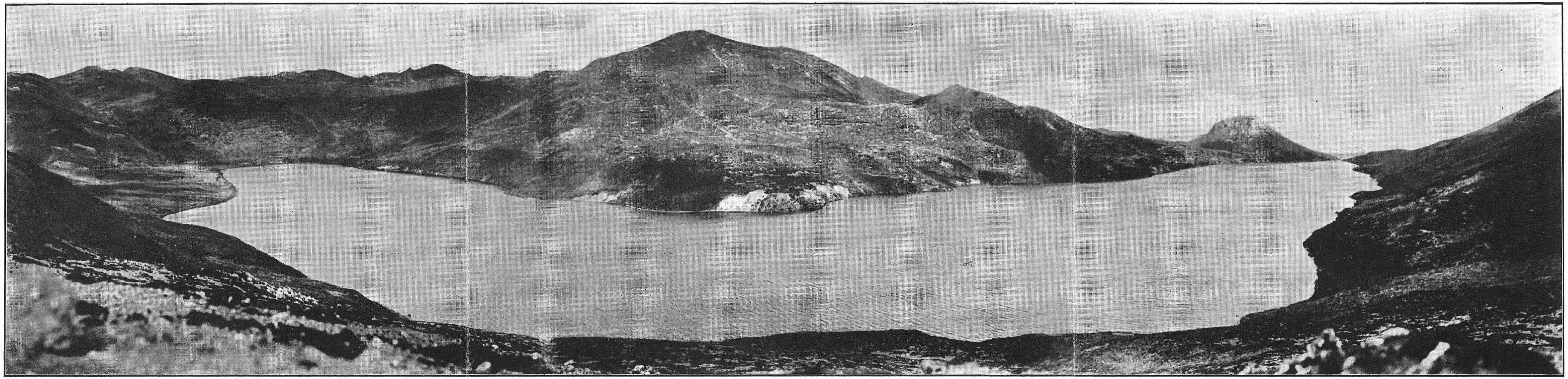


Fig. 2. Waterfall Lake.

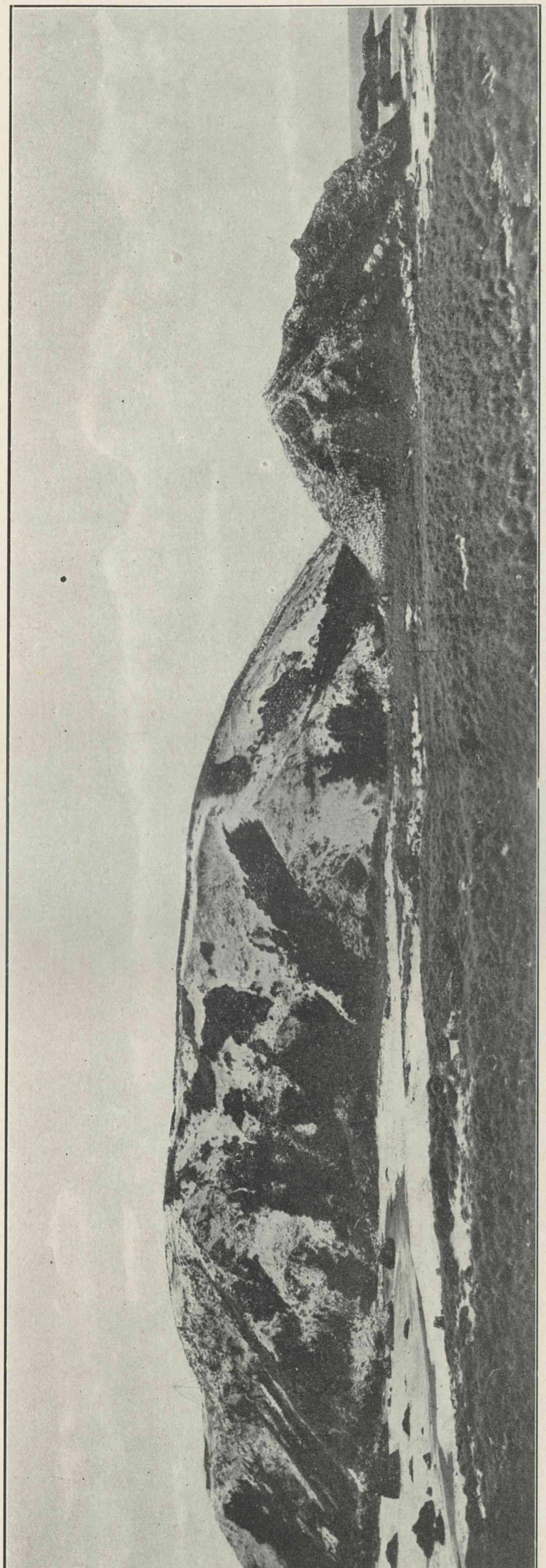


Fig. 1. Wireless Hill and Hut Hill from the Isthmus.

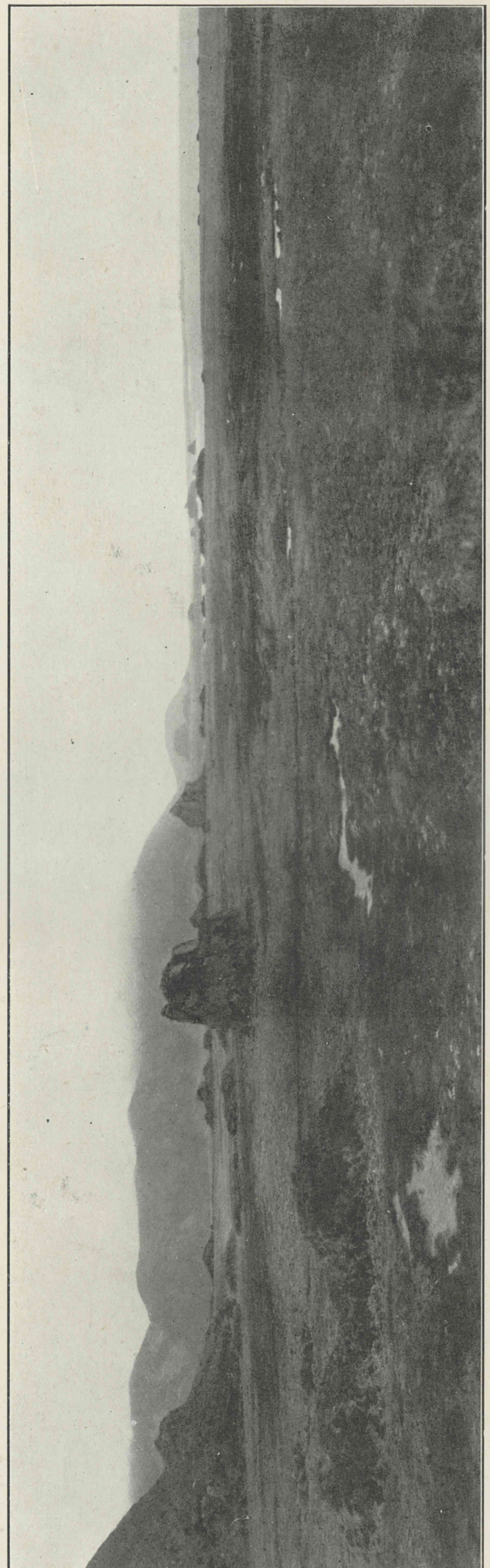
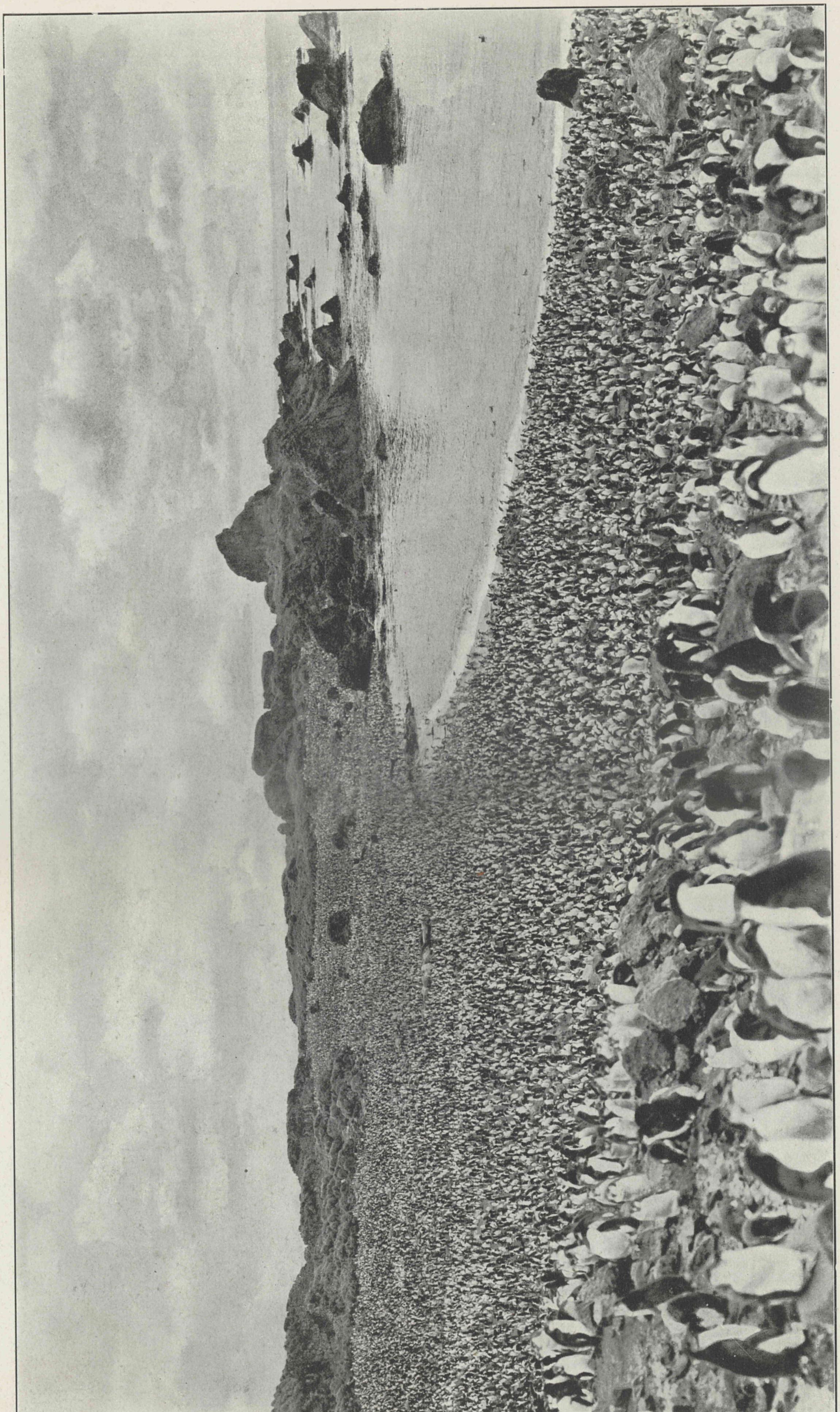
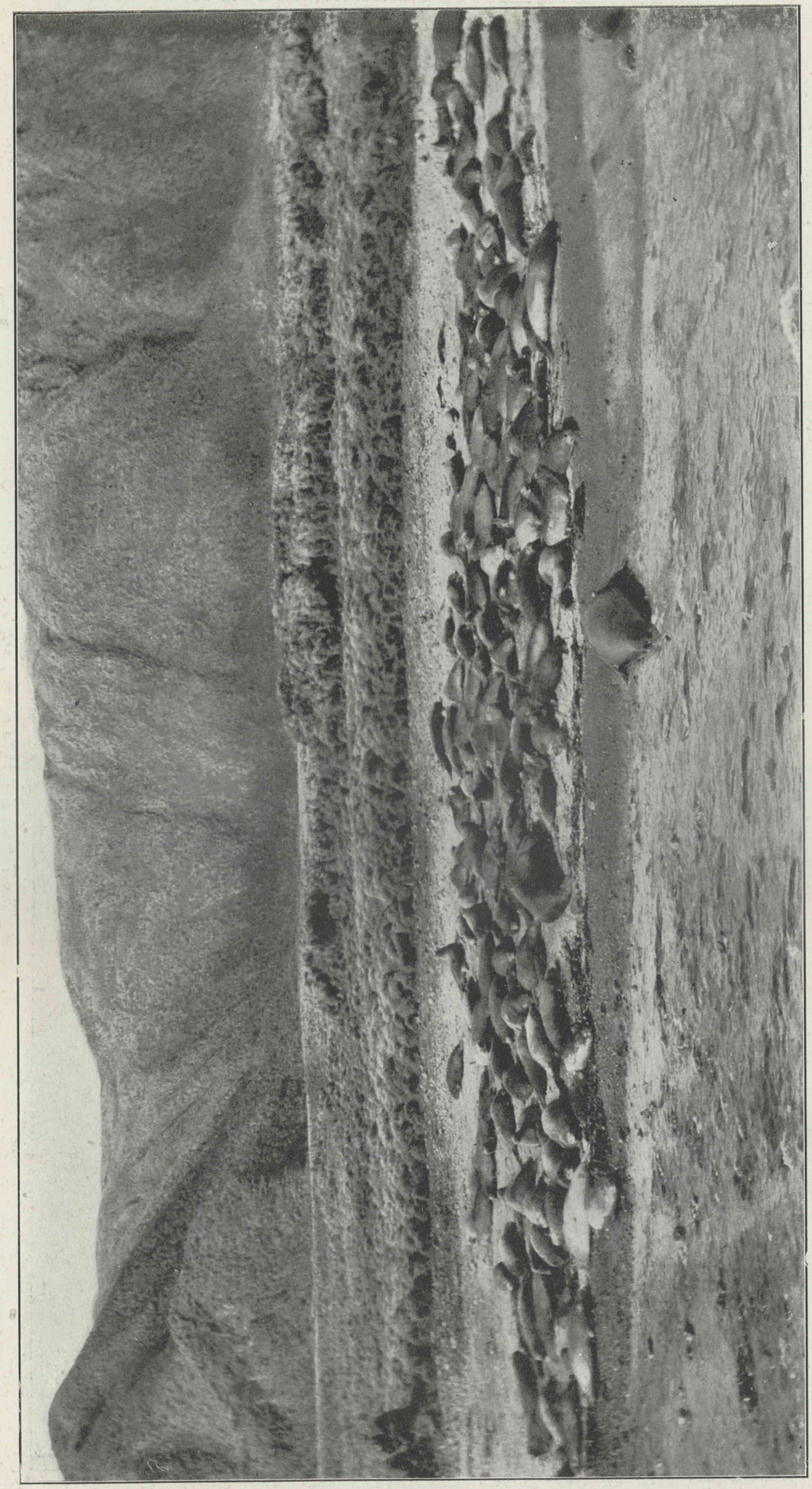


Fig. 2. The West Coast Raised-Beach Terrace.



Royal Penguin Rookery at Hurd Point.



A Sea-elephant Rookery on the West Coast Raised-Beach.

The Tussock-clad Hills above Nuggets Beach.

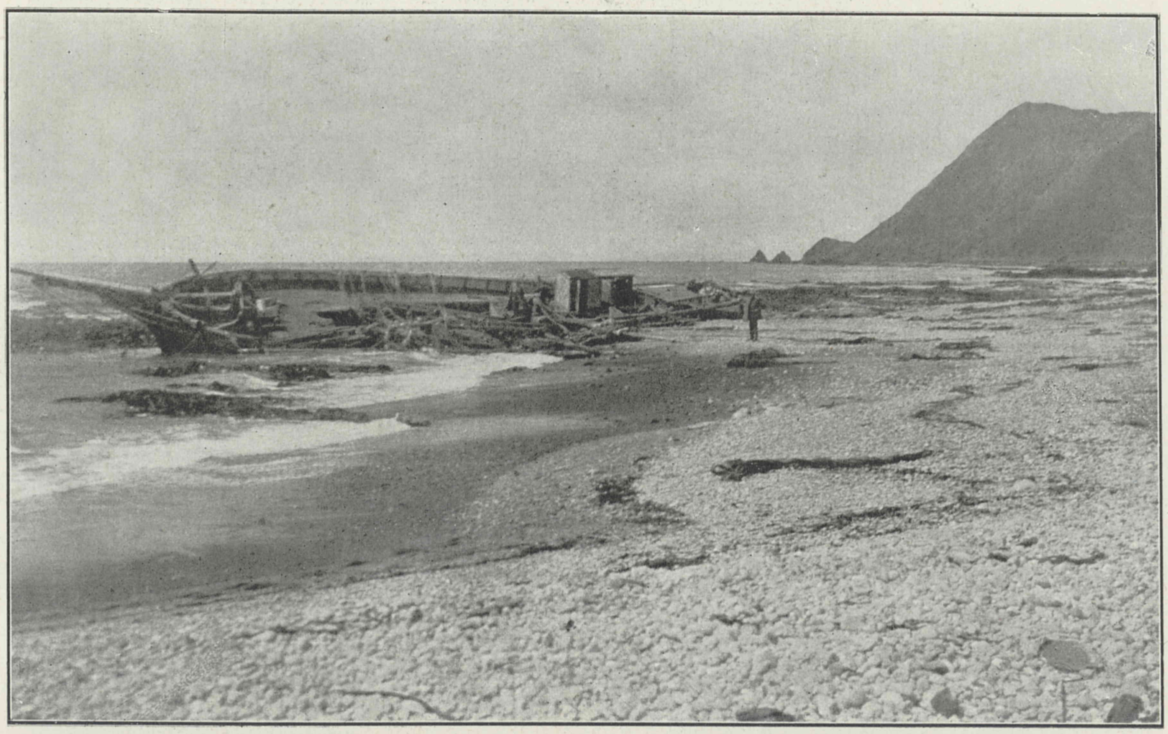


Fig. 1. The Pebbly Beach of Buckles Bay.

Fig. 2. View down the West Coast.

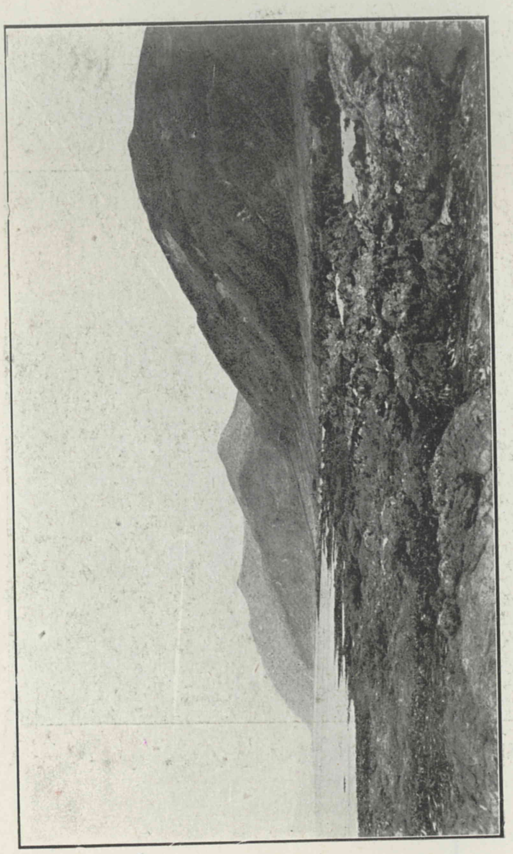


Fig. 1. View across Sandy Bay to Brothers Point.

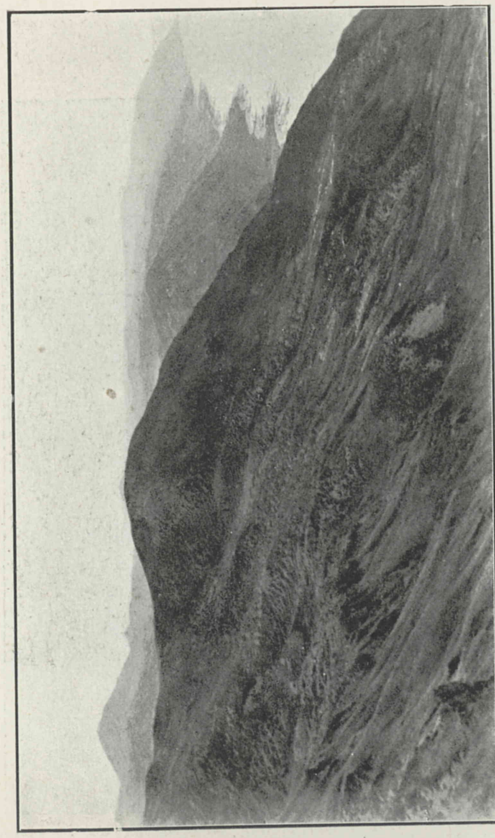


Fig. 2. The East Coast near Victoria Point.

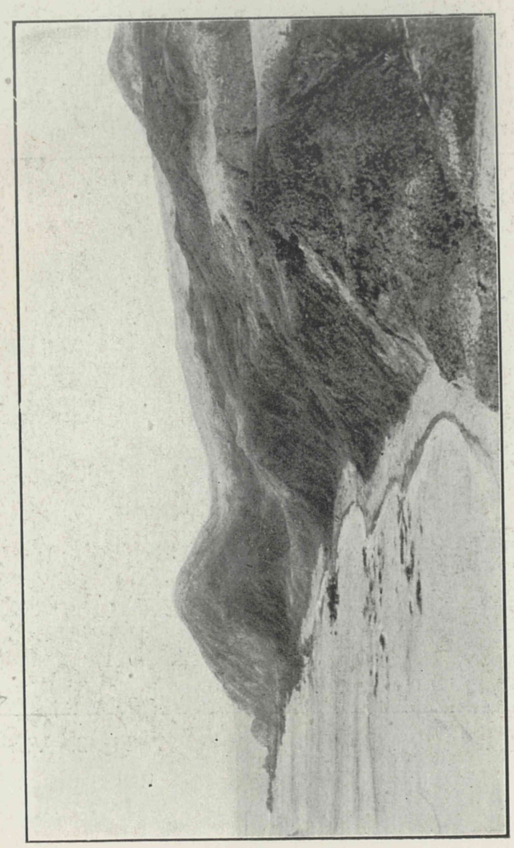


Fig. 3. The East Coast north of Lusitania Bay.

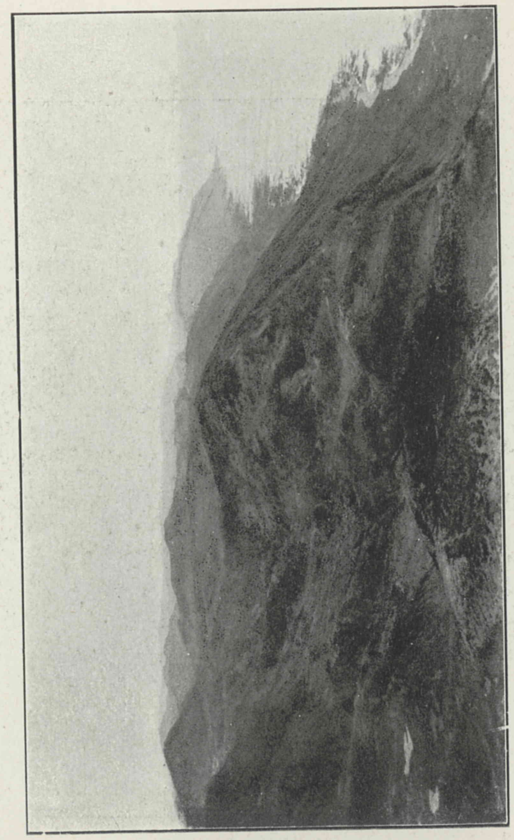


Fig. 4. The East Coast. Victoria Point in distance.

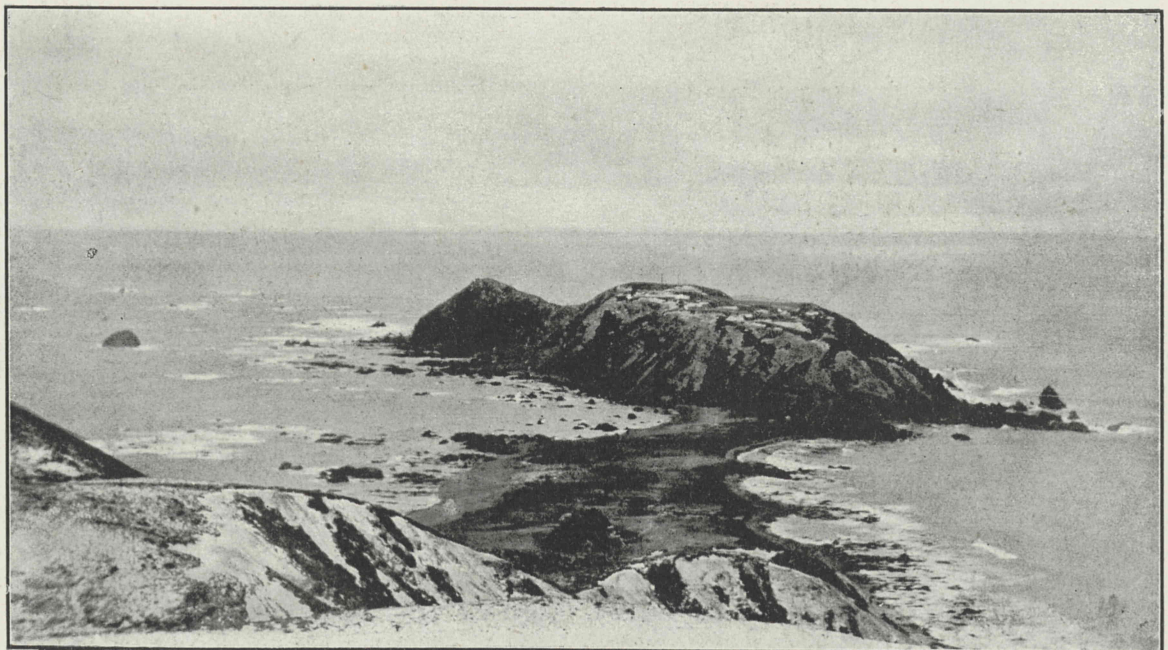


Fig. 1. Looking North over the Isthmus to Wireless Hill.

Fig. 2. The Expedition Hut and Isthmus.

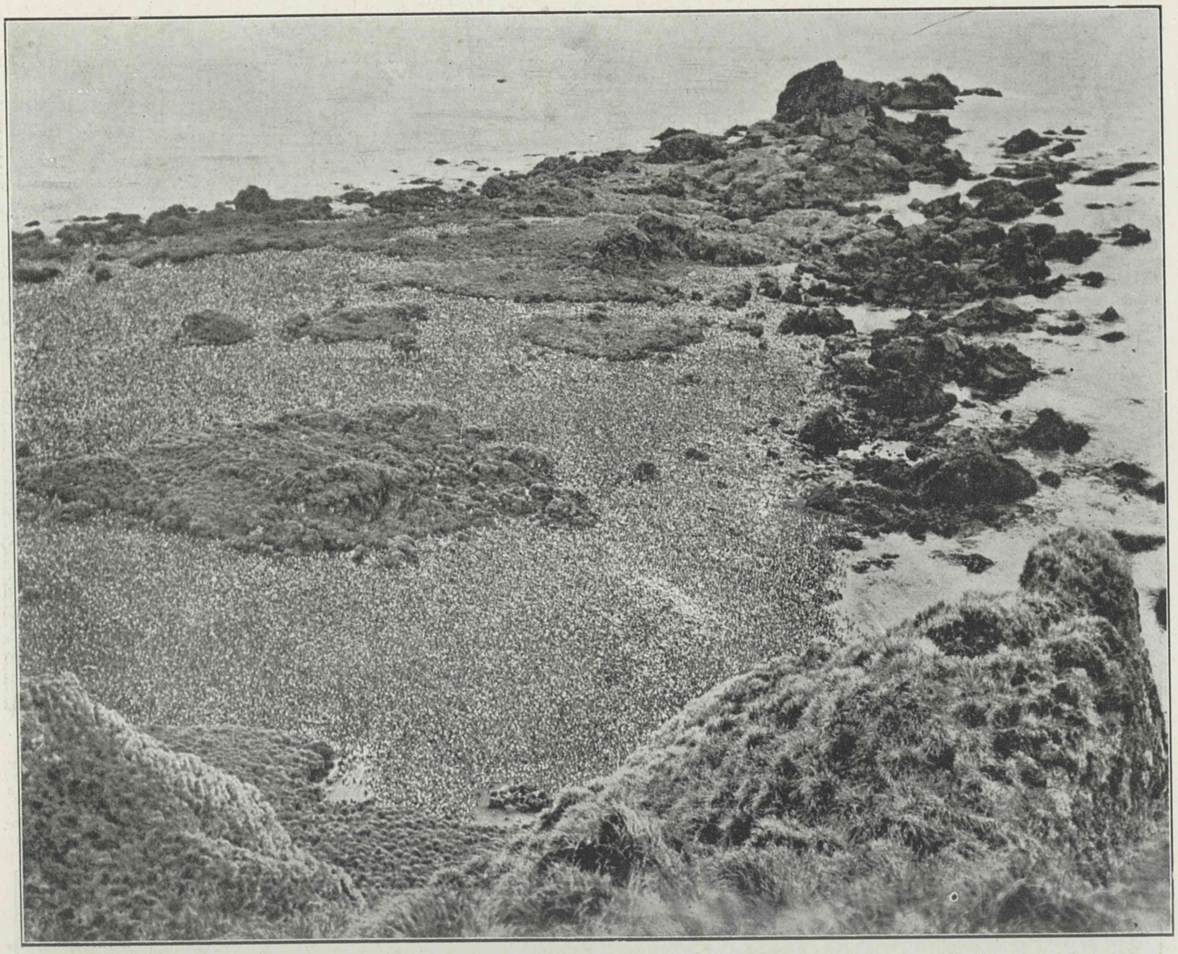


Fig. 1. Hurd Point and Penguin Rookery from the Cliff.

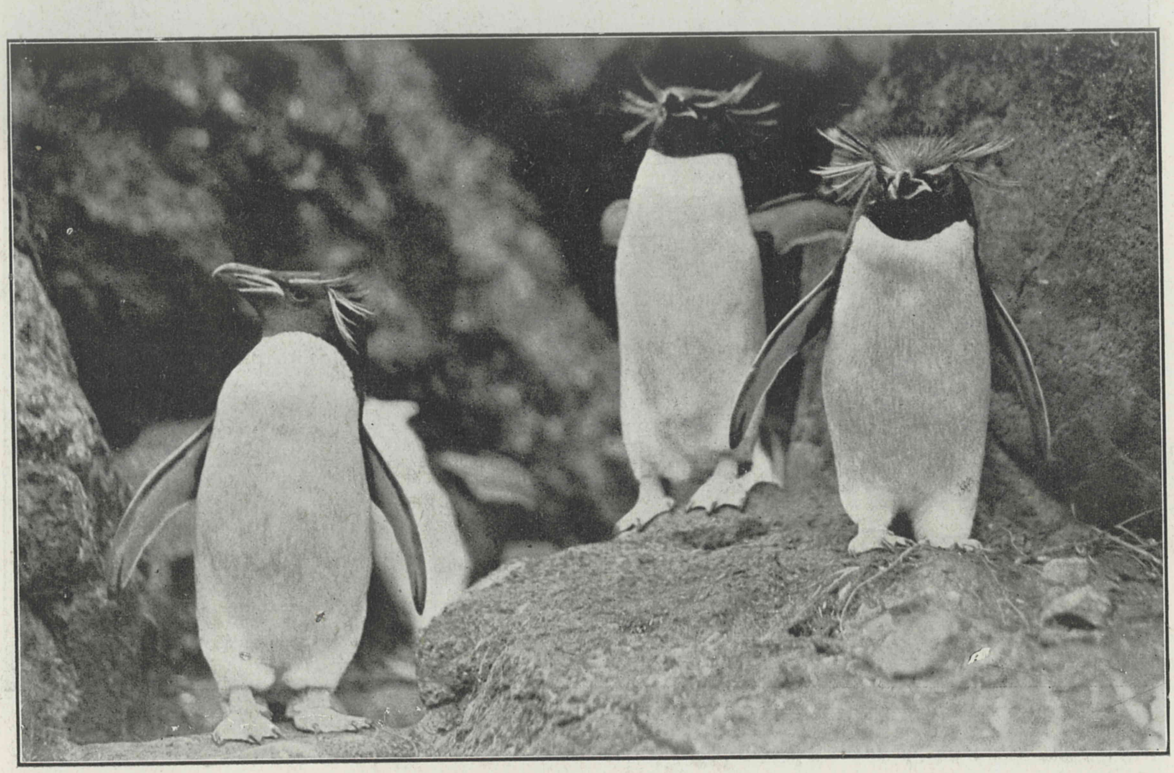


Fig. 2. Rock-Hopper Penguins.

Fig. 1. The King Penguin Rookery at Lusitania Bay.

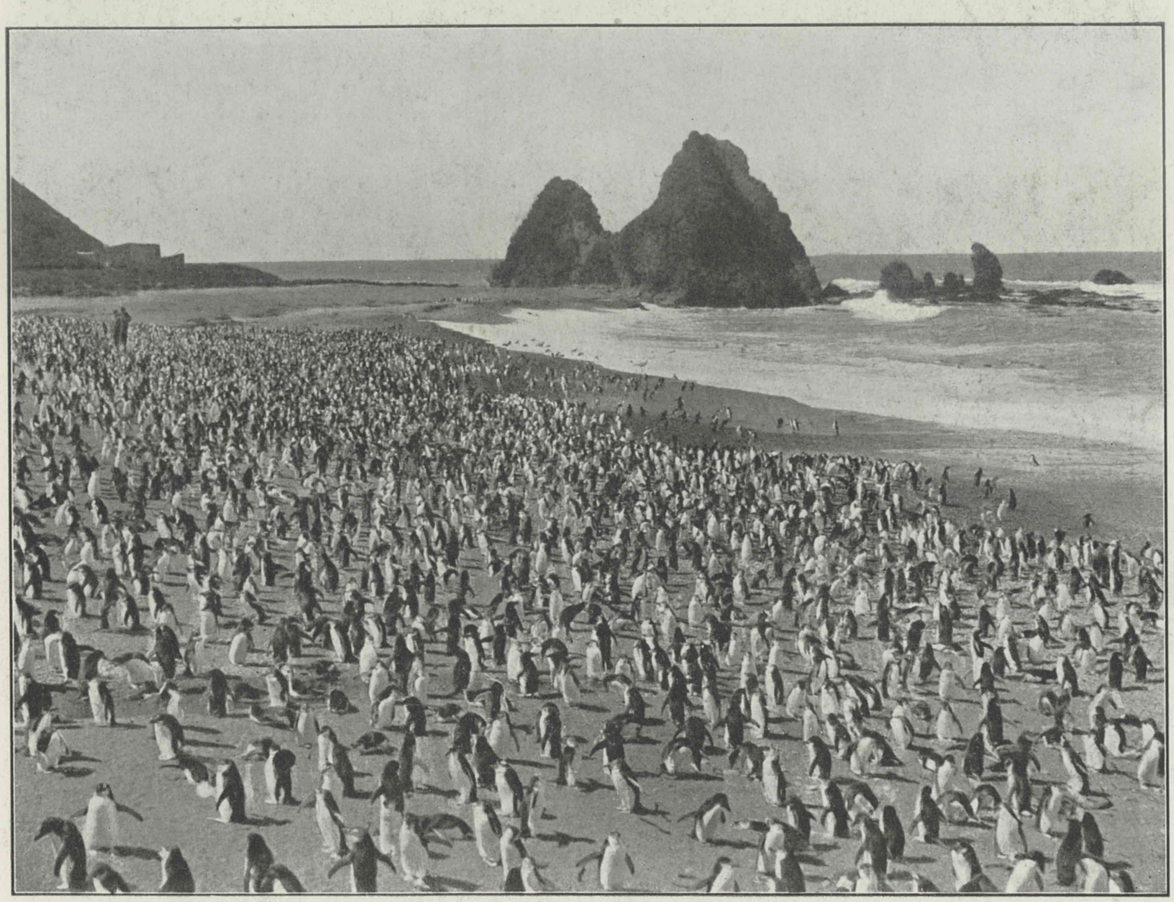


Fig. 2. Nuggets Point and Beach.

The Glaciated Surface of the Highlands to the West of Lusitania Bay.

Fig. 1. Raised-Beach Terrace on the South Side of Hasselborough Bay.

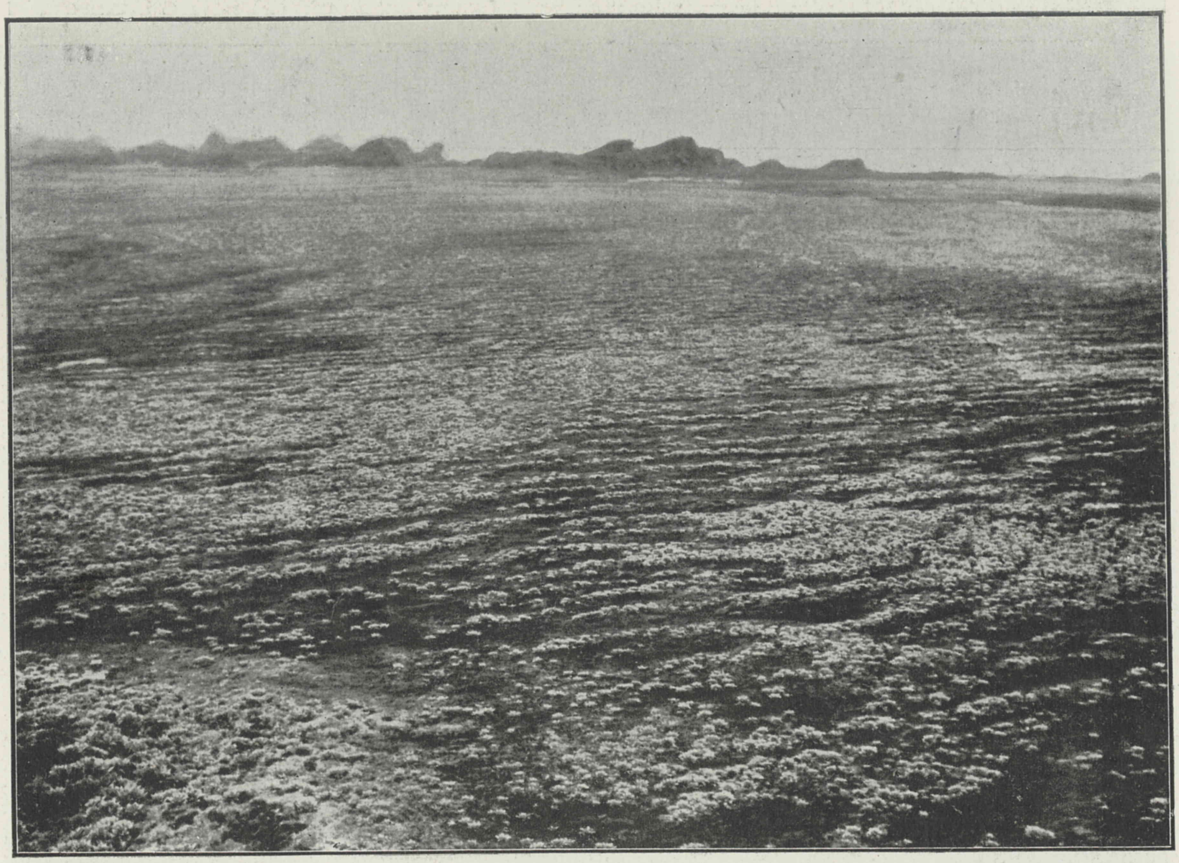


Fig. 2. *Pleurophyllum* Wind Rows on the Raised-Beach Platform.

Fig. 1. Looking North from Caroline Cove.

Fig. 2. Looking West over the Wave-Cut Terrace at Half-Moon Bay.

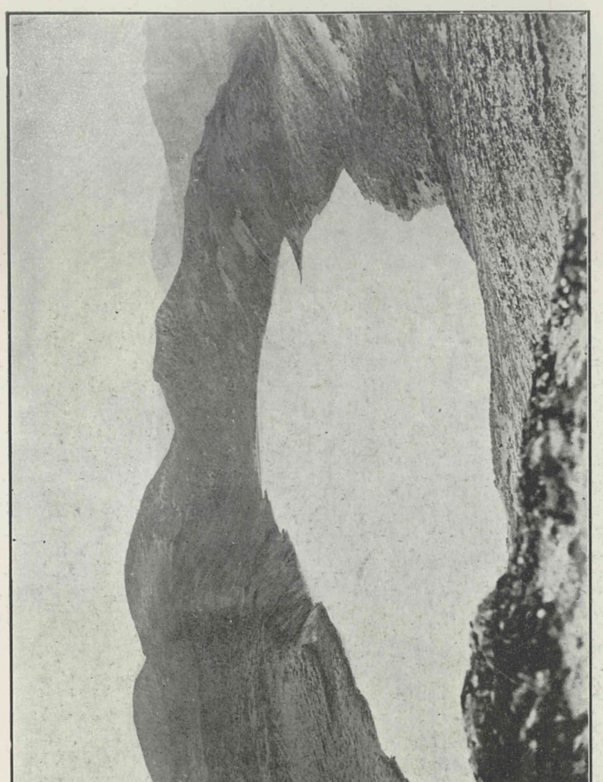


Fig. 1. Lake two miles West of Victoria Point.

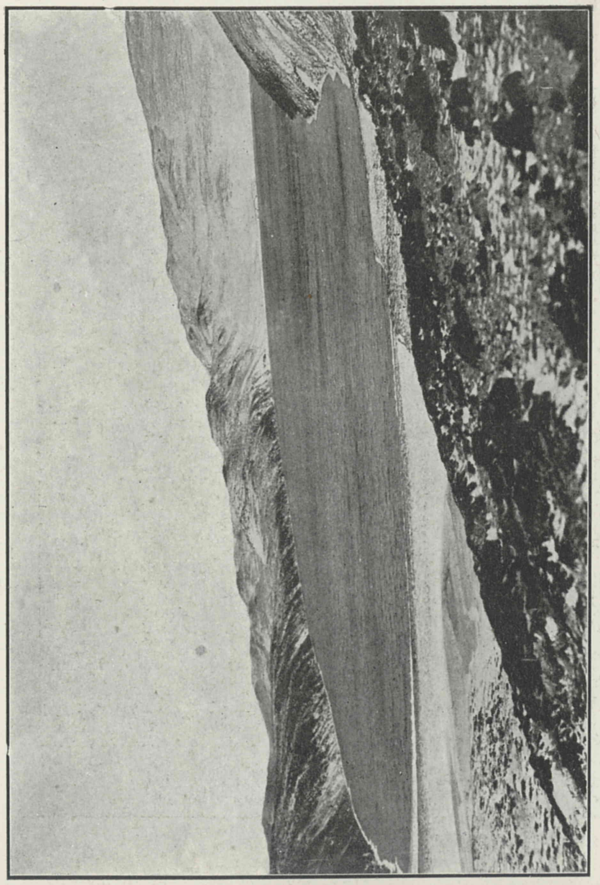


Fig. 2. Prion Lake.

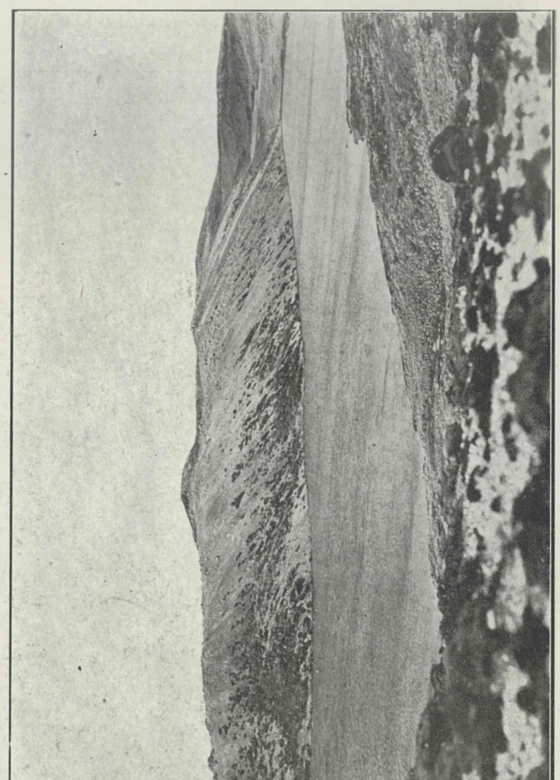


Fig. 3. Lake one mile South-South-West of Mt. Elder.

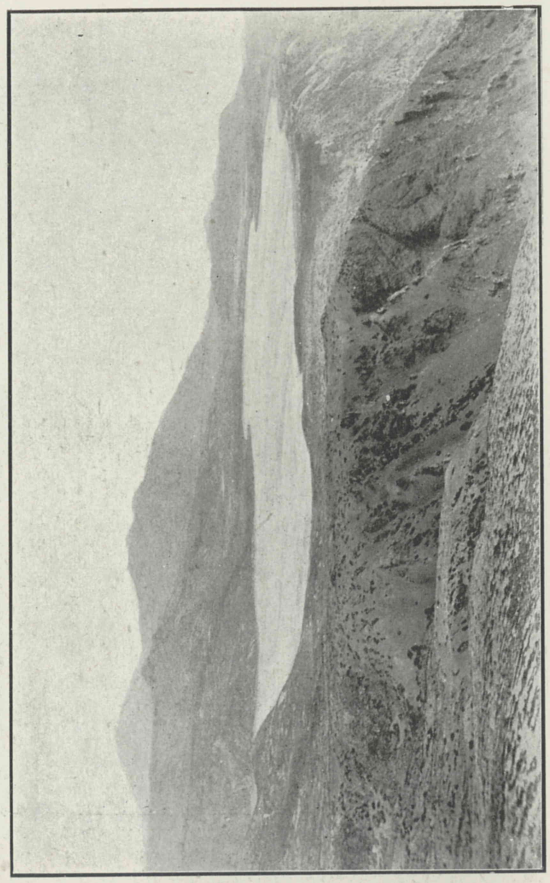


Fig. 4. Major Lake.

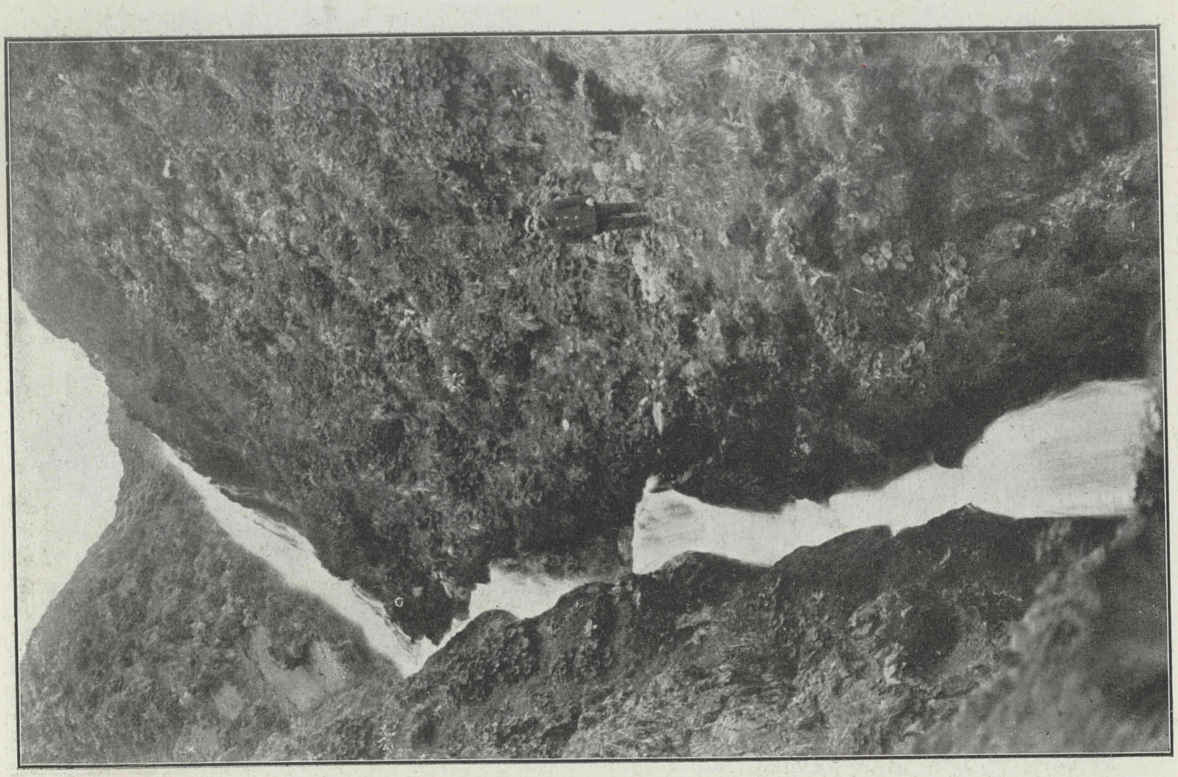


Fig. 1. A Waterfall on the West Coast.

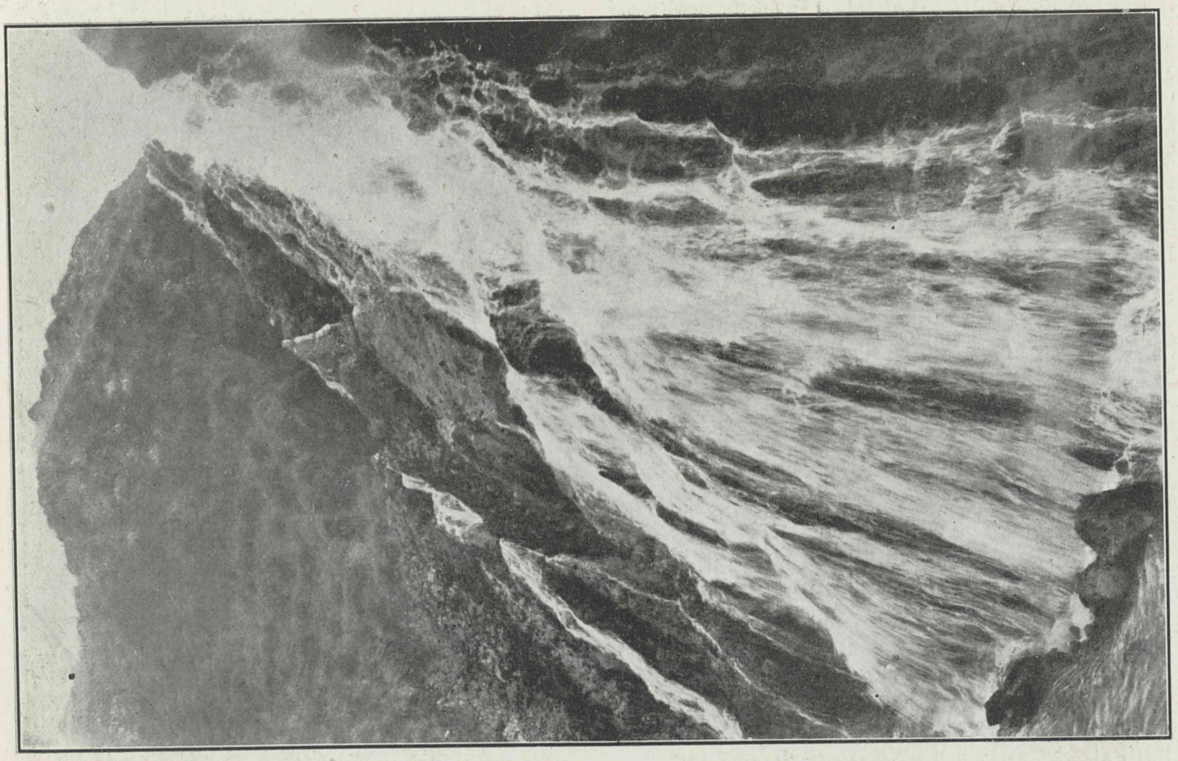


Fig. 2. A Waterfall on the West Coast.

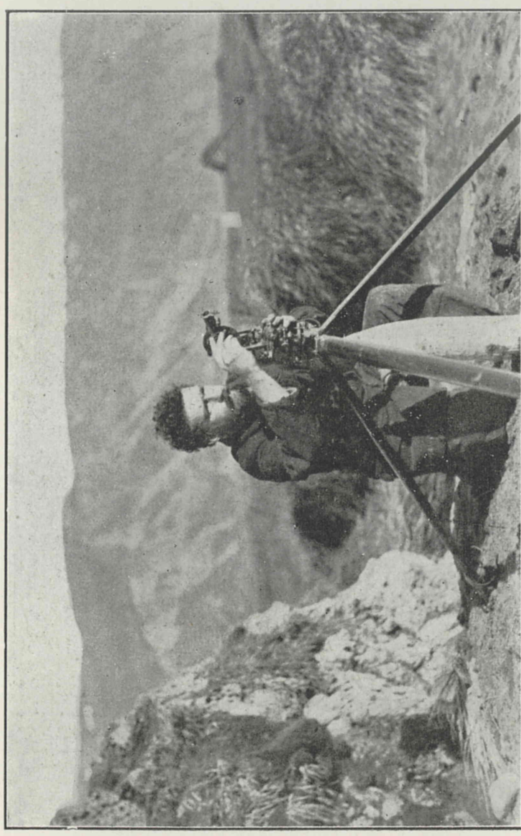


Fig. 1. Blake.

Fig. 2. Blake's Bench-Mark.


Fig. 3. A Cushion of *Azorella Selago*.

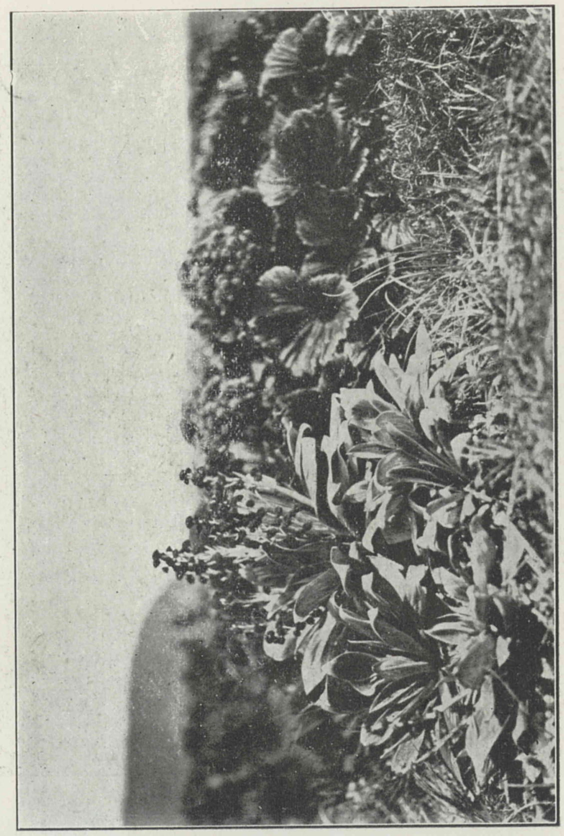


Fig. 4. *Pleurophyllum Hookeri* and *Stilbocarpa polaris*.

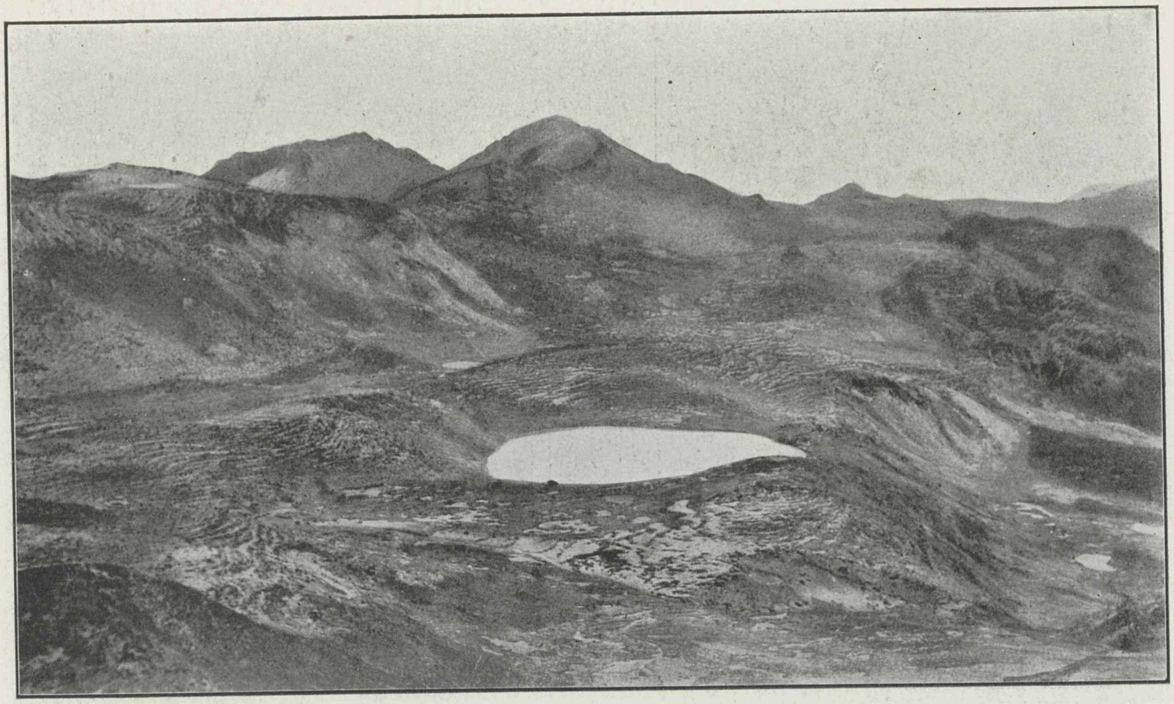


Fig. 1. A Rock-Basin Lake West of Lusitania Bay.

Fig. 2. The Highlands South-West of Mt. Aurora.

Fig. 1. Peat overgrown with Turf.

Fig. 2. A Vegetated Moraine on the Highland.

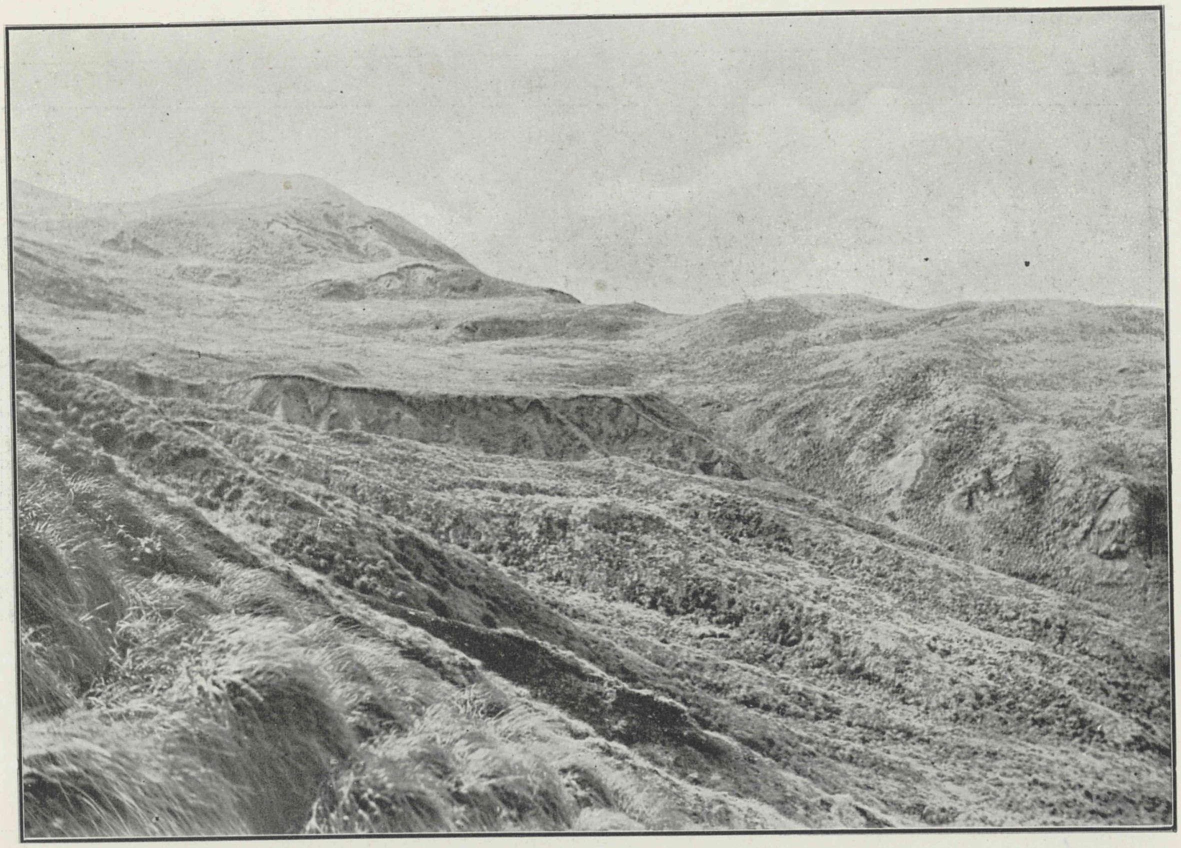


Fig. 1. Valley choked with Till North-North-West of the Nuggets.

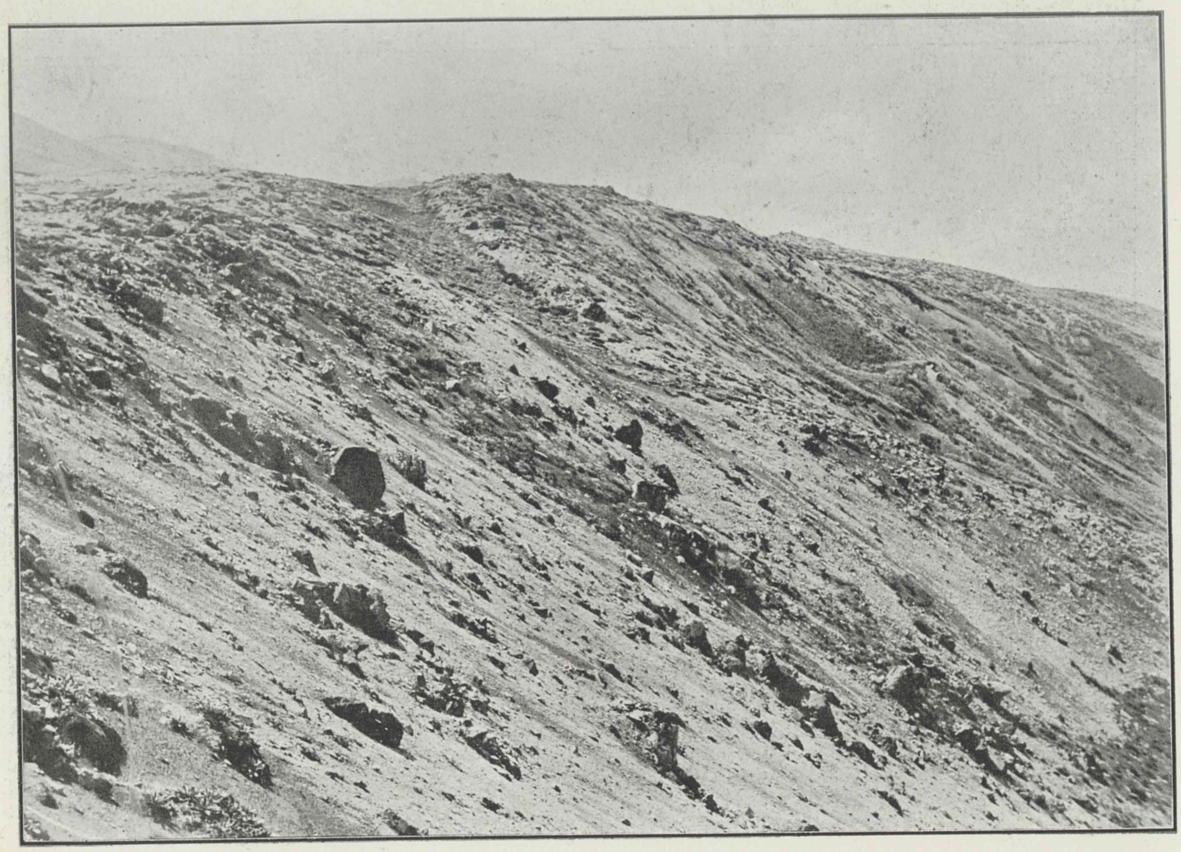


Fig. 2. A Face of Boulder-Clay 1,000 feet above Sea-level.

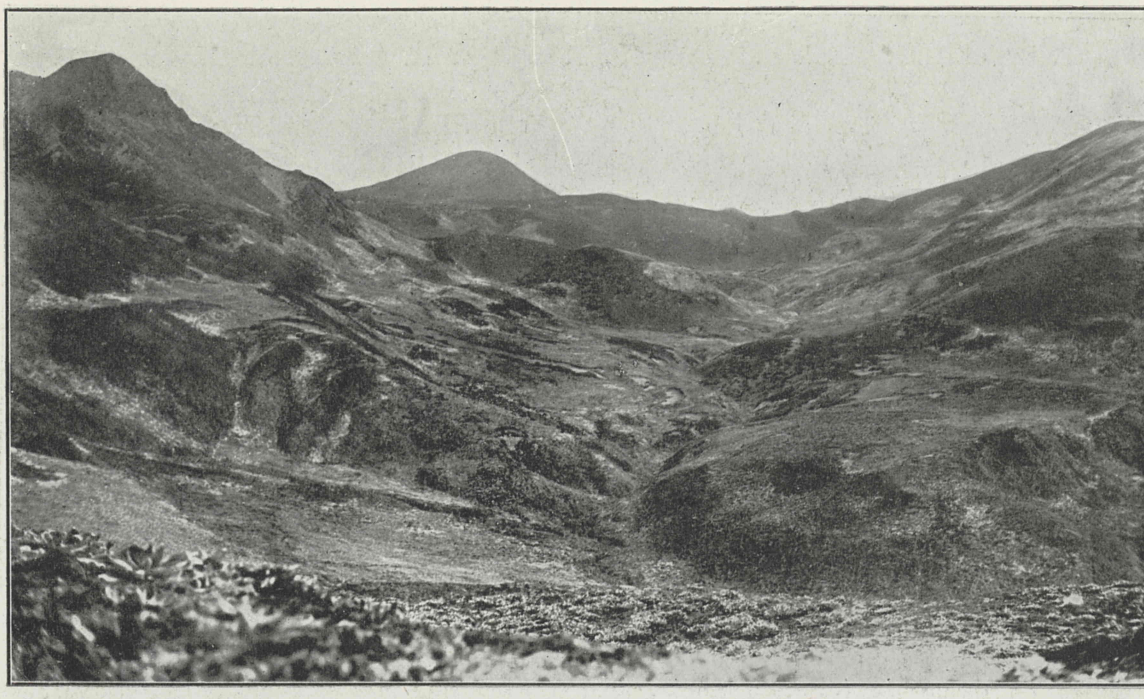


Fig. 1. A U-shaped Valley West of Lusitania Bay.

Fig. 2. Unconformity between Older and Younger Basic Series.

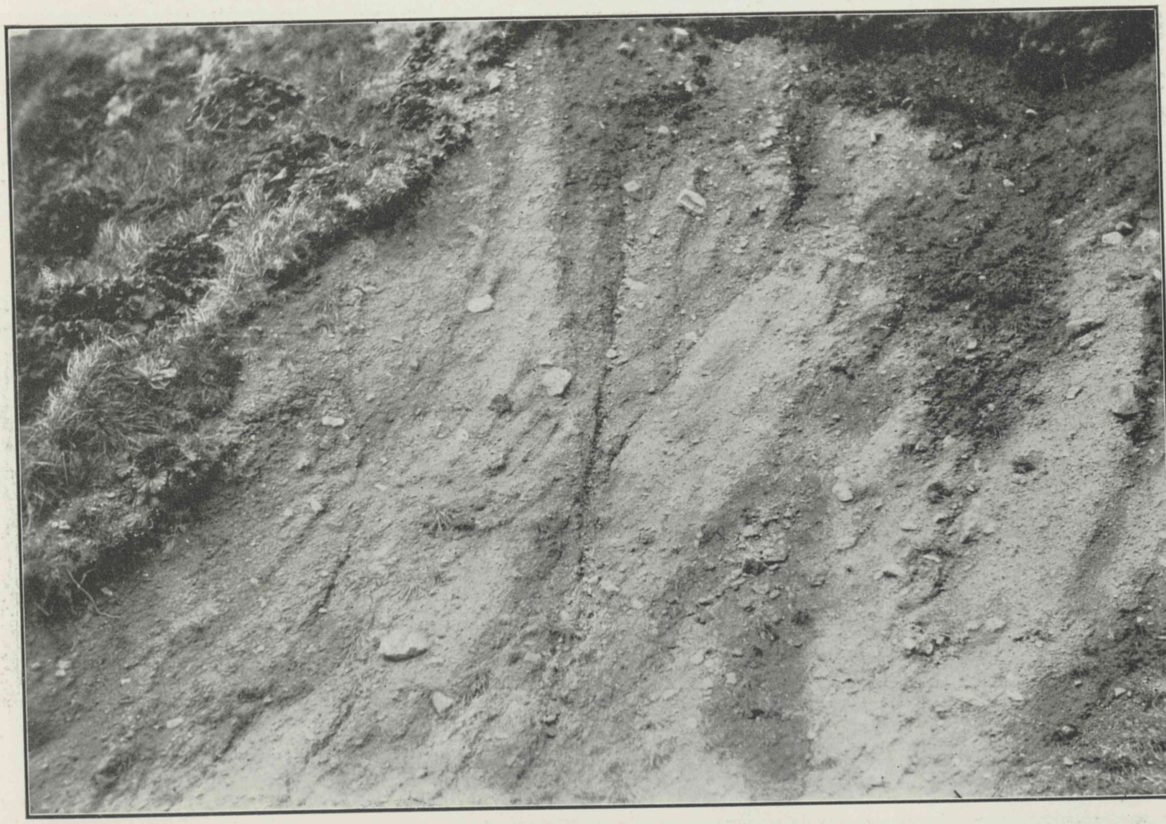


Fig. 1. A Face of Till exposed on Nuggets Creek.

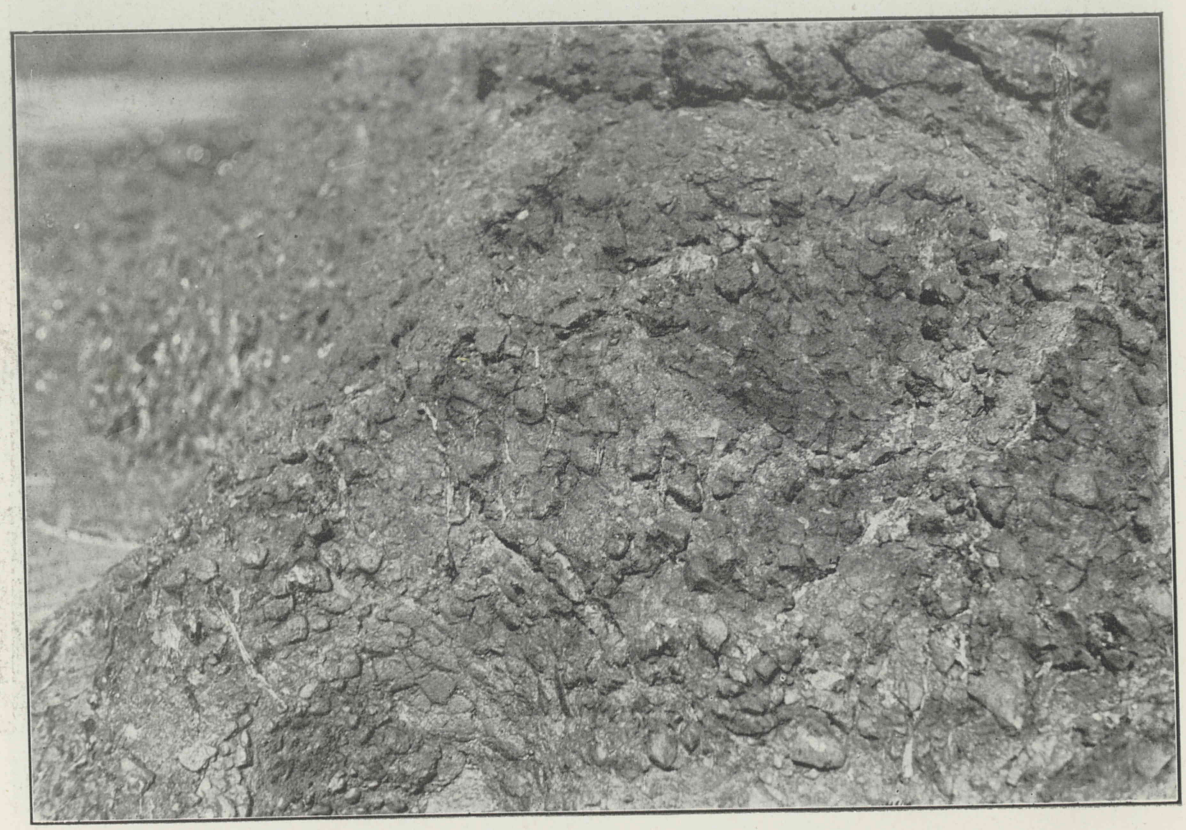


Fig. 2. Volcanic Agglomerate: Wireless Hill.

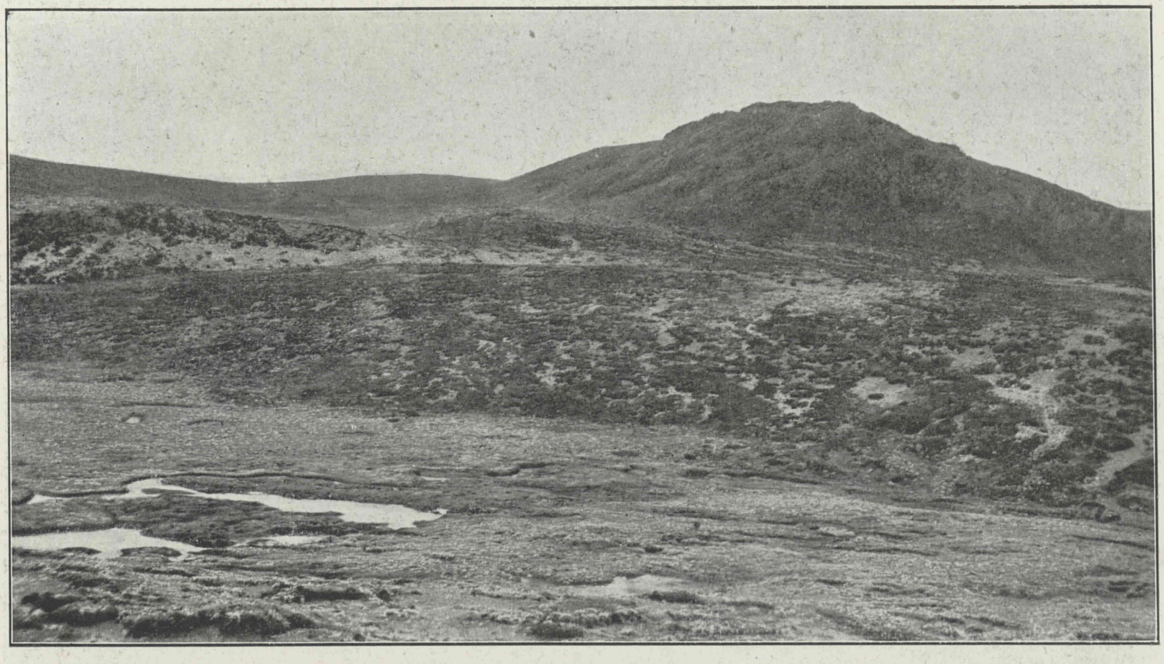


Fig. 1. Gabbro Outcrop on Northern Highlands.

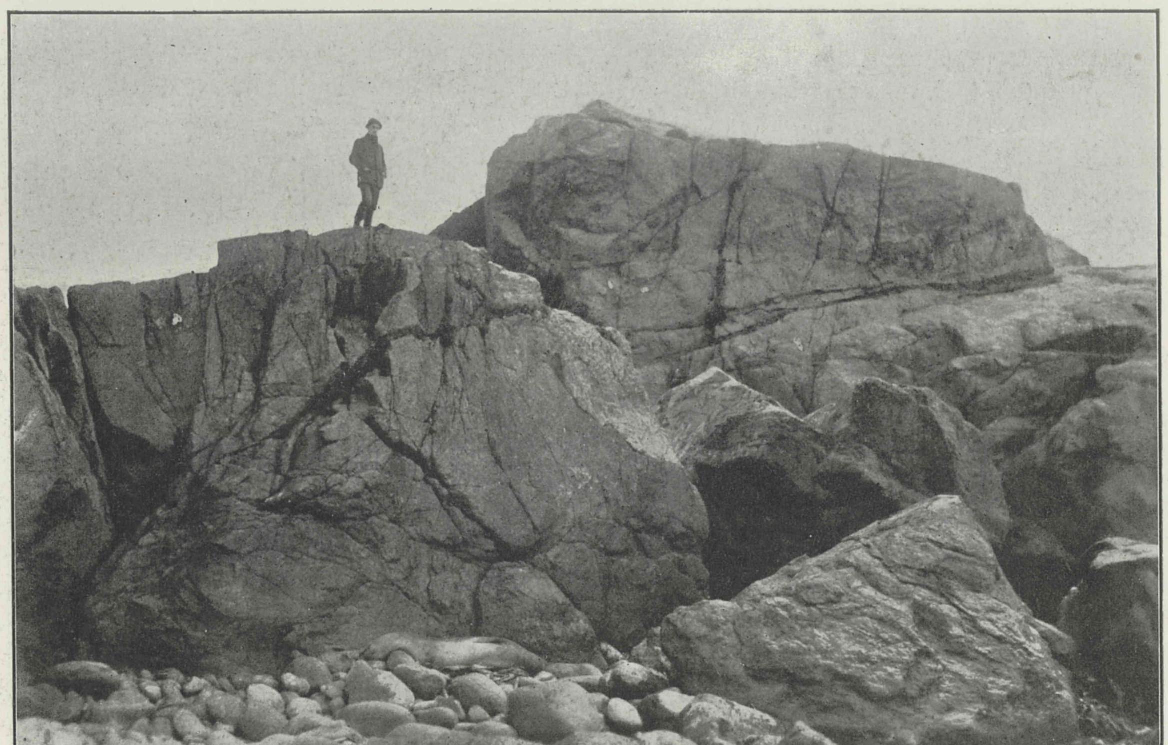


Fig. 2. Harzburgite Outcrop at Handspike Point.

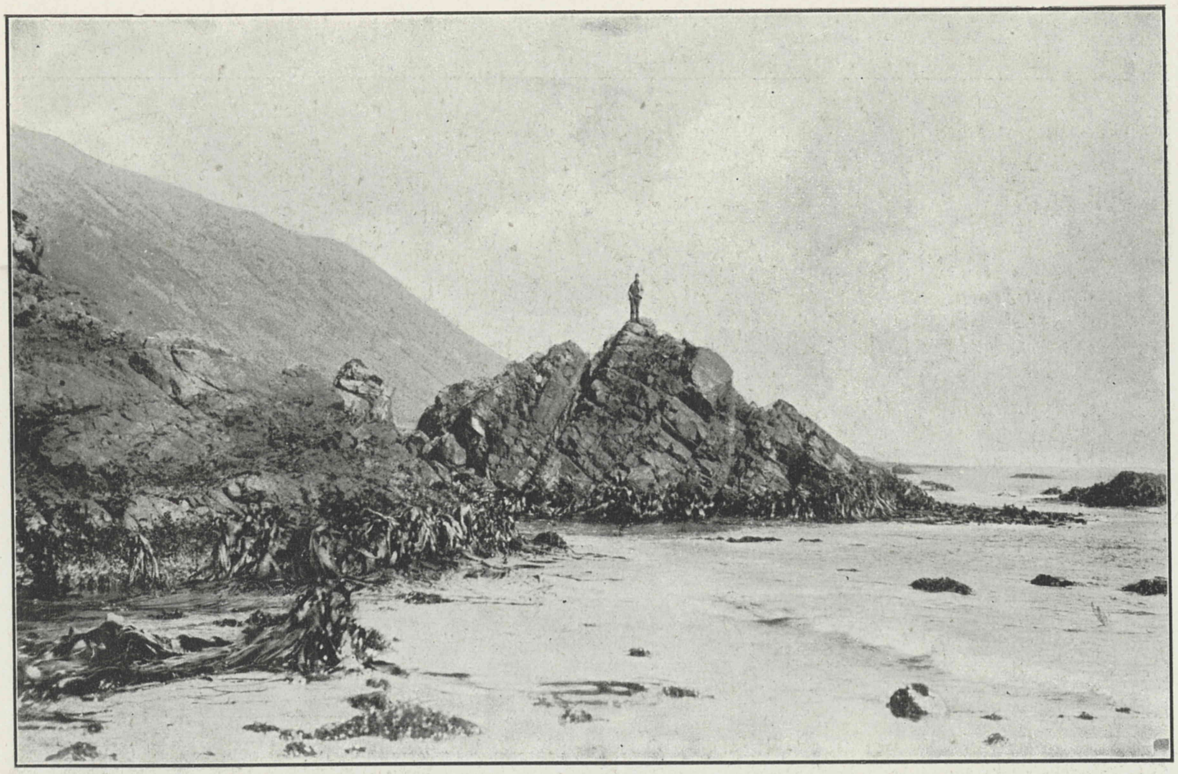


Fig. 1. Rocks of the Older Basic Series on the East Coast.

Fig. 2. Pseudo-Stratification in Gabbro at Half-Moon Bay.

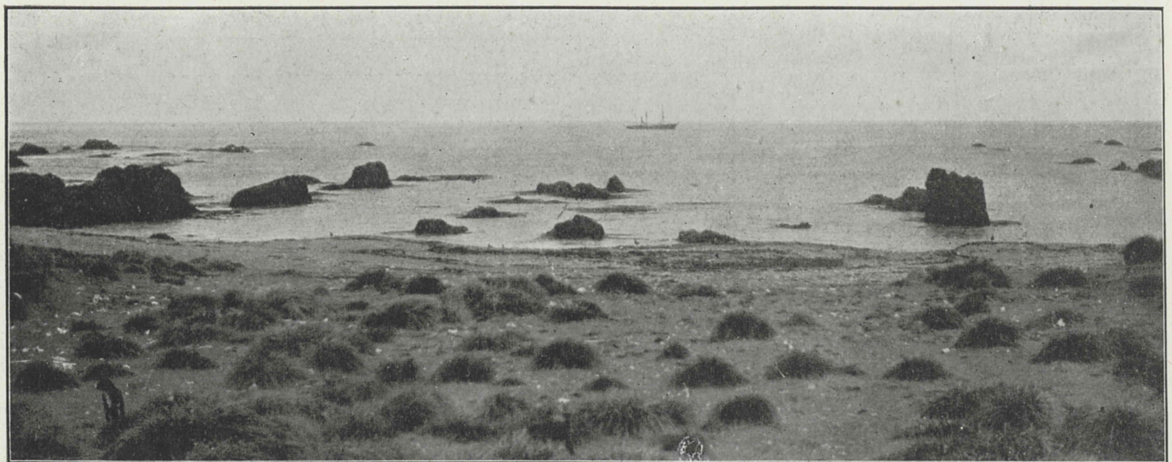


Fig. 1. Foreshore of Hasselborough Bay, with parallel Rock Outcrops.

Fig. 2. Sand Bar at the Lee End of Island Lake.

Fig. 3. Roche Moutonnée Gabbro Outcrop West of Nuggets Point.

Fig. 1. Pillow-lava of the Younger Basic Series.

Fig. 2. Volcanic Agglomerate with Glassy Bombs.

Fig. 1. Penguin-scored Face of Serpentinized Harzburgite.

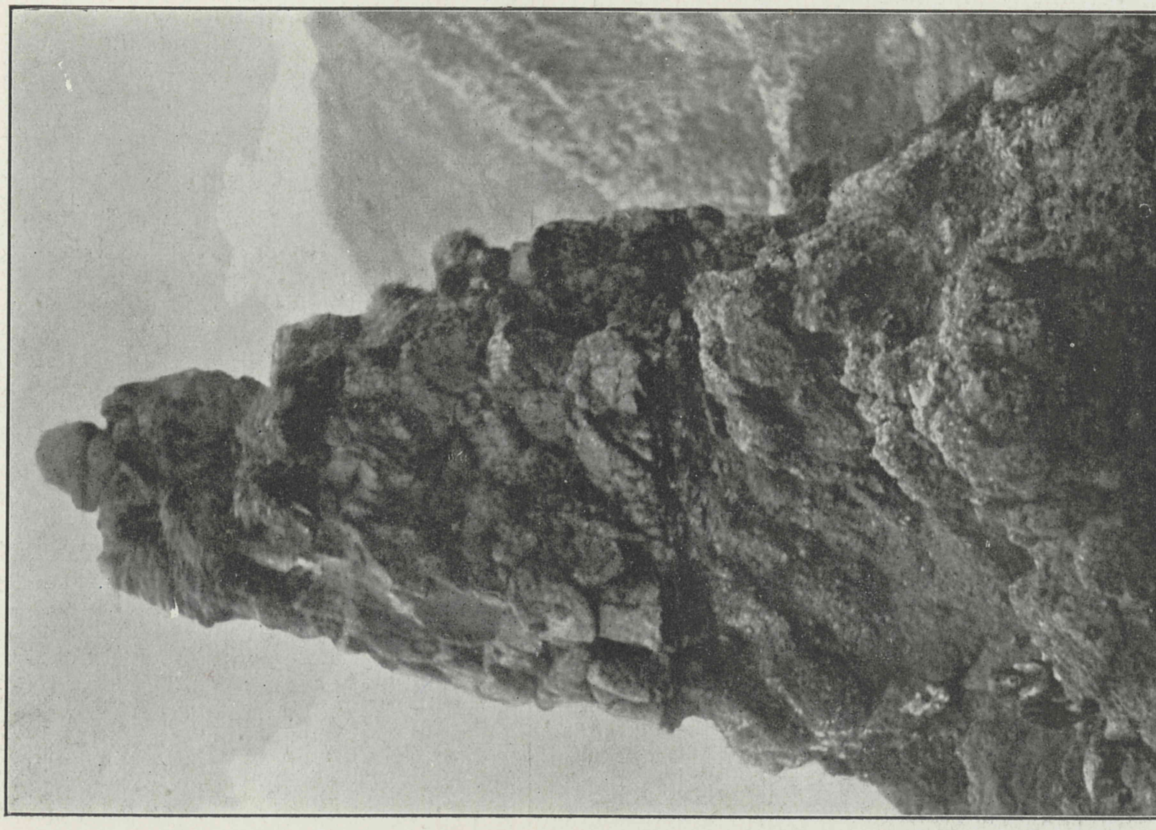


Fig. 2. Pillow-lava above and Younger Volcanic Breccia below.

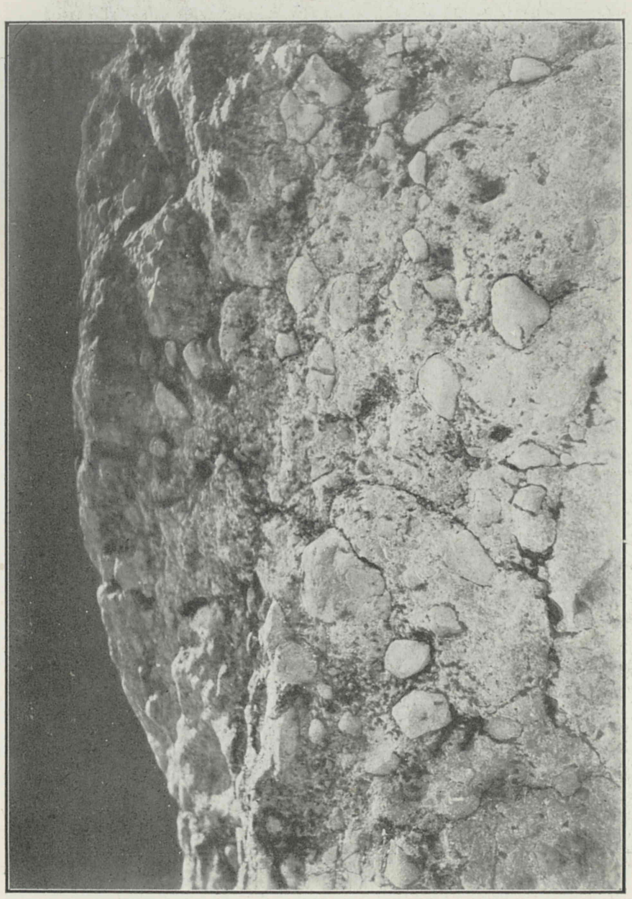


Fig. 1. Volcanic Agglomerate of Younger Basic Series.

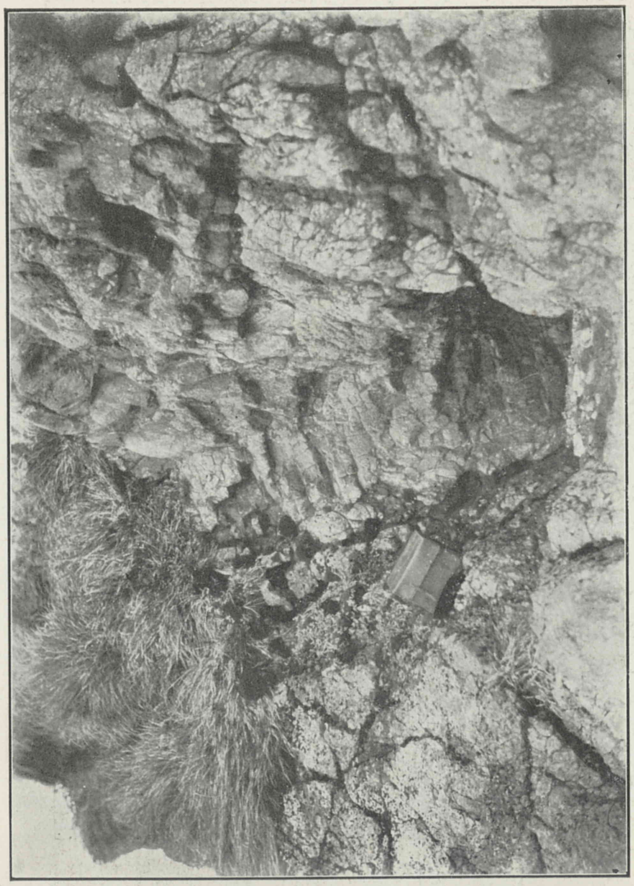


Fig. 2. A Dyke intersecting Volcanic Agglomerate.

Fig. 3. A Dyke intruding Volcanic Breccia.

Fig. 4. A Large Wind-weathered Erratic.

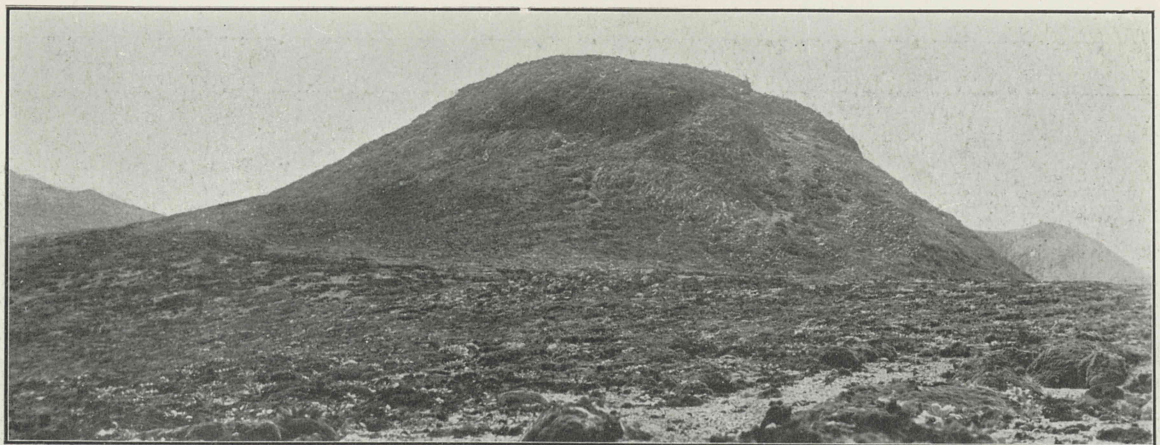


Fig 1. A Hill of Pillow-lava West of Victoria Point.

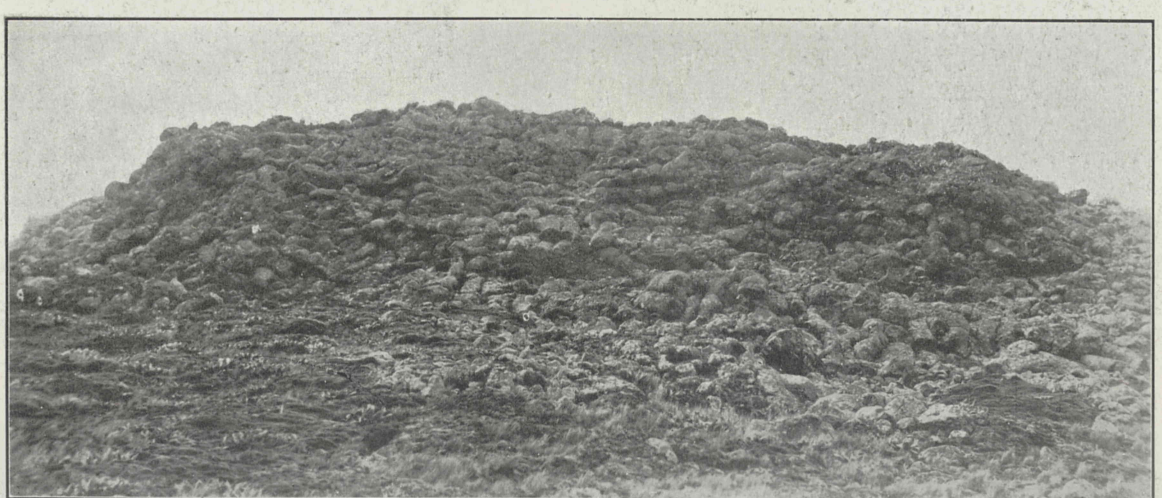


Fig. 2. Close View of Pillow-lava West of Victoria Point.

Fig. 3. Cross-section of Pillow-lava at Nuggets Point.

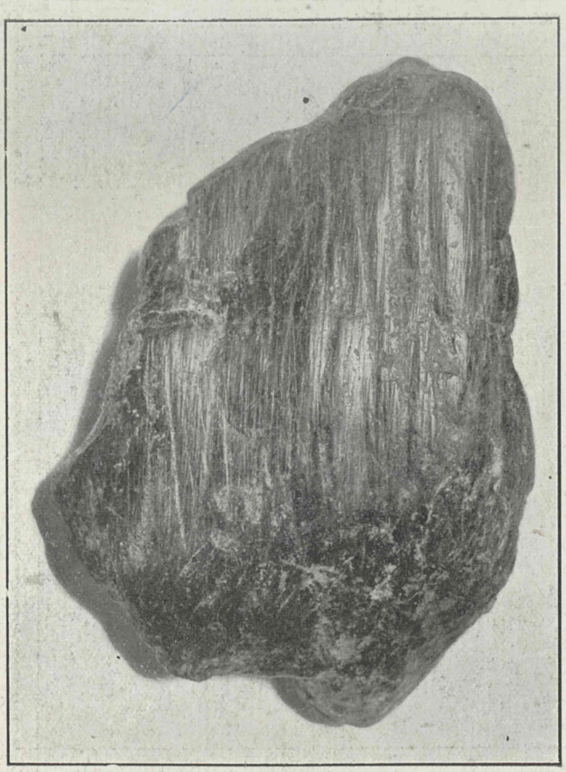


Fig. 1. A Serpentinized Harzburgite Erratic.

Fig. 2. A Dolerite Erratic.

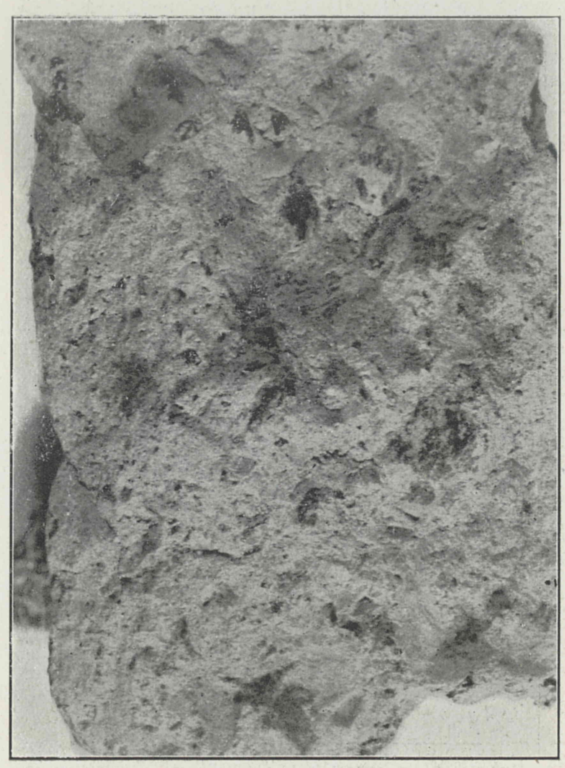


Fig. 3. Boulder-Clay.

Fig. 4. Globigerina Ooze Rock with Tachylite Bombs.

Fig. 1. Penguin-scored Rock Face.

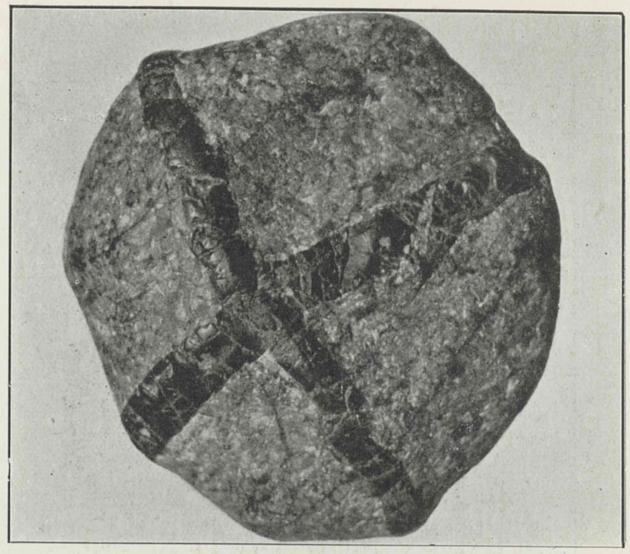


Fig. 2. Basaltic Veins in Gabbro.

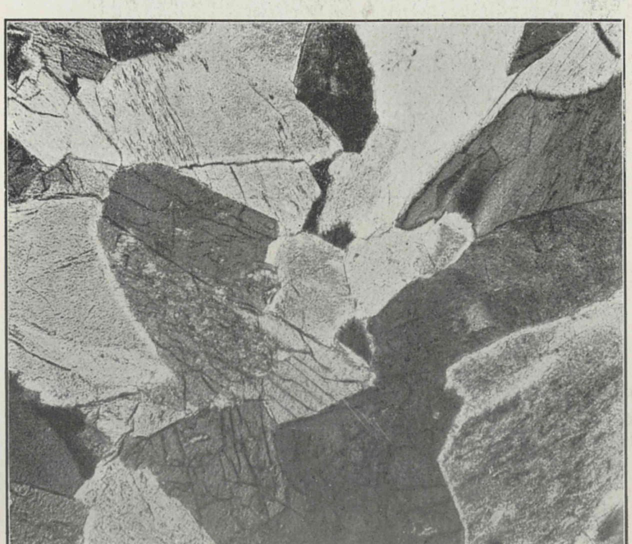


Fig. 3. Aggregate of Prehnite Crystals.

Fig. 4. Prehnite Veins in Dolerite.

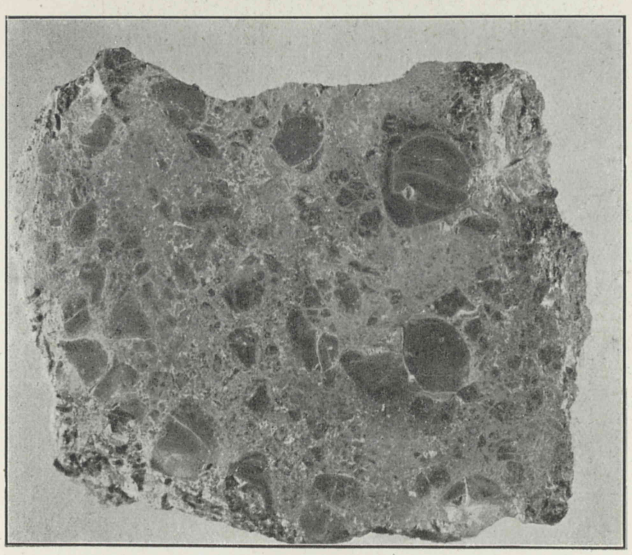


Fig. 5. Tachylite Kernels in Palagonitized Base.

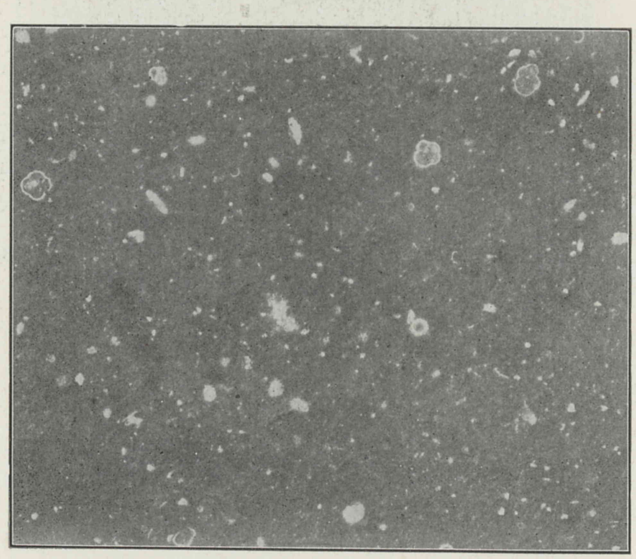


Fig. 6. Section of Globigerina Ooze Rock.

Fig. 1. A Gabbro Contact.

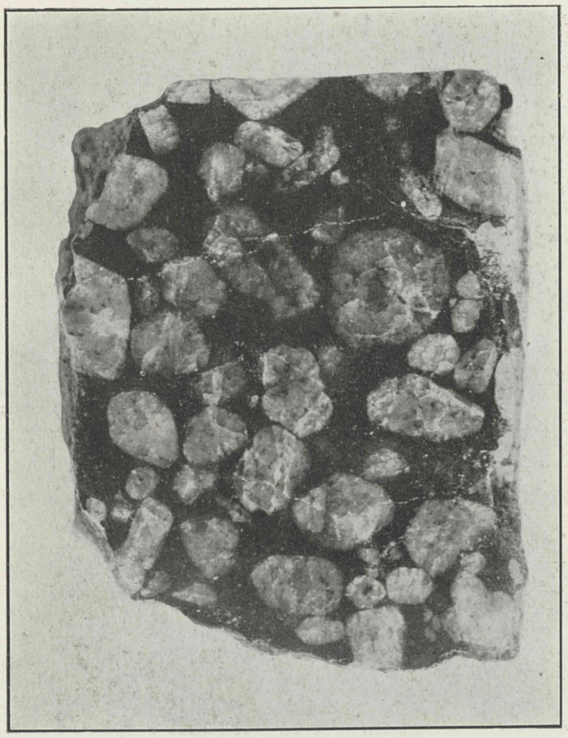


Fig. 2. Megaphyric Bytownite-Basalt.

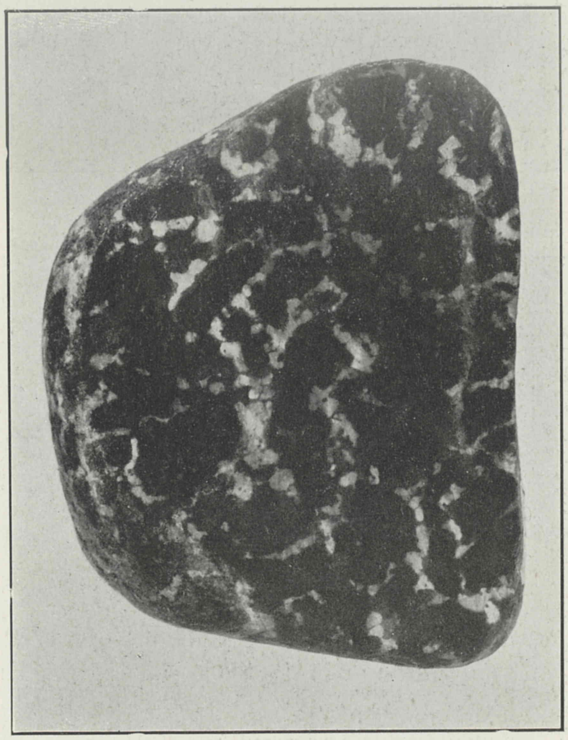


Fig. 3. Serpentinized Harrisite.

Fig. 4. Analcite ramifying through Bytownite.

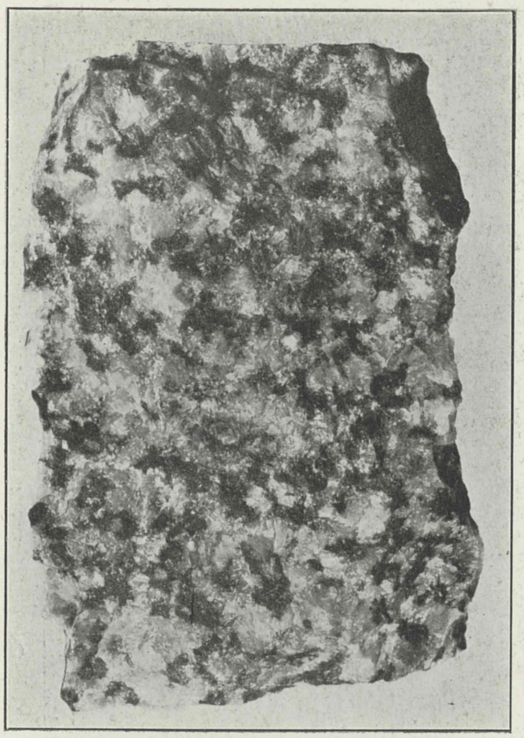


Fig. 2. A Face of Allivalite.

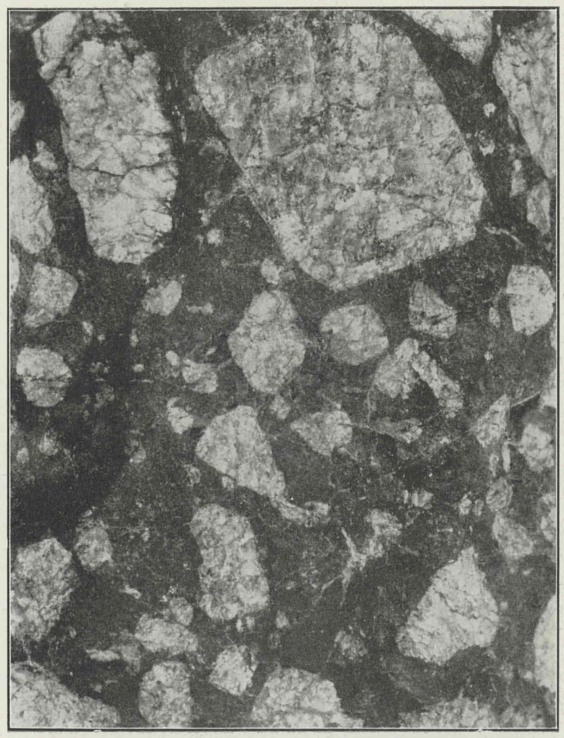


Fig. 4. Megaphyric Bytownite-Basalt.

Fig. 1. A Boulder of Troctolite.

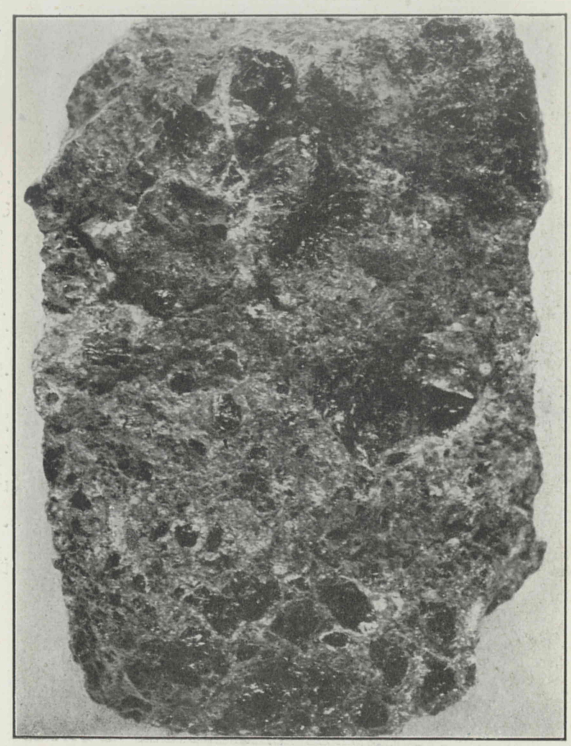


Fig. 3. Brecciated Tachylite Glass.

Fig. 1. Fossil Moss in Diatomaceous Shale.

Fig. 2. Micro-photo of Analcite-Basanite.

Fig. 3. Analcite Veins in Bytownite.

Fig. 4. Analcite Veins in Bytownite.

Fig. 2. Megaphyric Bytownite-Basalt.

Fig. 4. Micro-photo of Analcite-Basanite.

Fig. 1. Megaphyric Bytownite-Basalt.

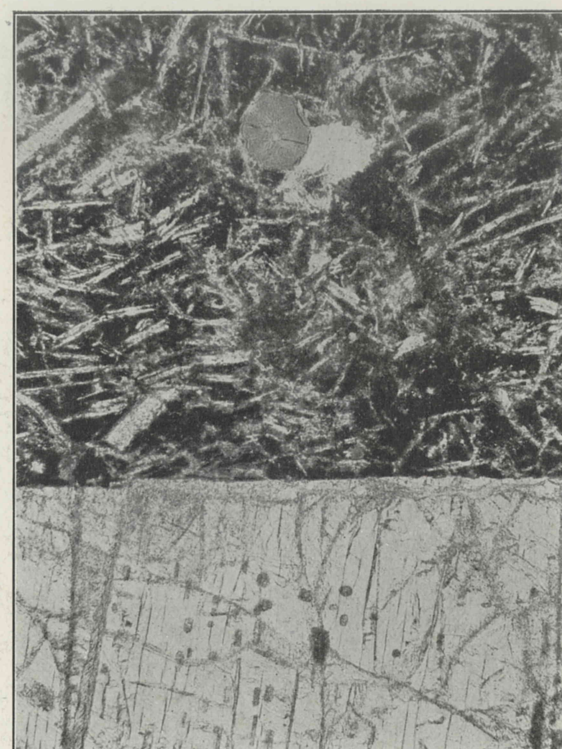


Fig. 3. Megaphyric Bytownite-Basalt.

Fig. 2. Megaphyric Olivine-Dolerite.

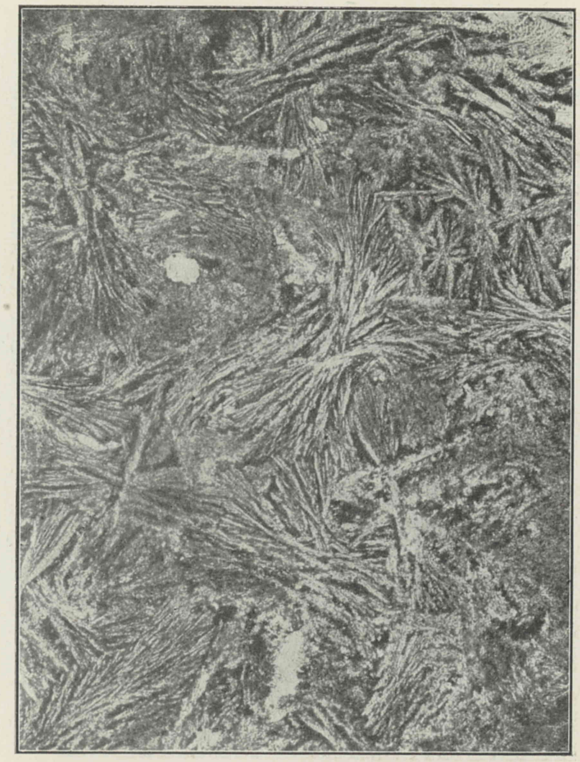


Fig. 4. Micro-photo of Variolitic Basalt Glass.

Fig. 1. Ophitic Dolerite.

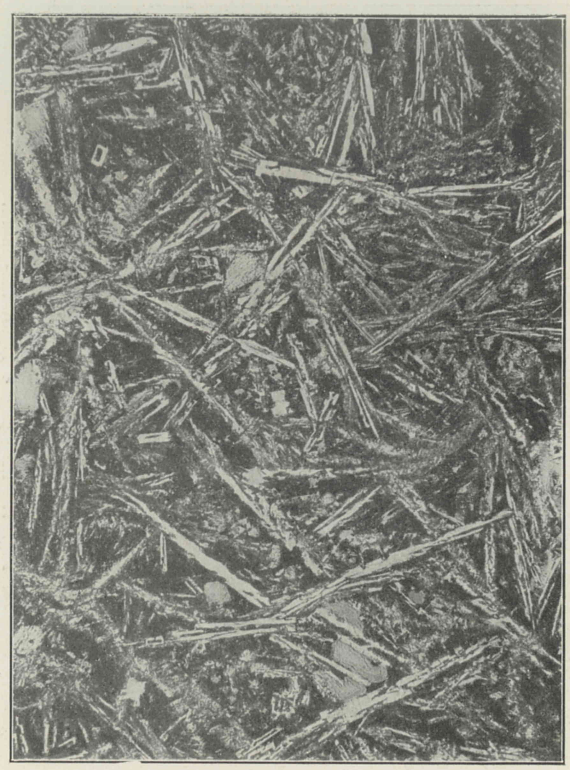


Fig. 3. Tachylitic Basalt.

GAZETTEER

AERIAL COVE is located on the north side of Hasselborough Bay. It is a useful boat landing, sheltered by long parallel reefs of kelp-covered rocks which help to break the swell. It is, of course, useful only during easterly weather.

AINSWORTH, MT., is a peak 1,190 feet in height, situated at the southern extremity of the island, named after G. F. Ainsworth of the Macquarie Island party.

AURORA, MT., 1,258 feet in height, named after the S.Y. " Aurora " of the A.A.E.

AURORA POINT is figured on the west coast in the 1917 Admiralty chart. Possibly named after the sealer " Aurora," notable among the earliest vessels visiting the island.

BALLAST BAY is the same as Sandy Bay of the sealers. This new name was adopted in the 1917 chart.

BAUER BAY, named by the A.A.E. after Otto Bauer, who, until his death and burial on the island in 1918, was for some years headsman of the sealers.

BISHOP AND CLERK ISLETS.—These are an off-lying group of rocks 20 miles distant from the south end of Macquarie Island.

BLAIR, MT., is 1,140 feet in height; named after J. H. Blair of the A.A.E.

BLAKE, MT., is 1,250 feet in height, located south of Waterfall Lake; to commemorate L. R. Blake of the Expedition Staff.

Flynn

BROTHERS POINT (Tom Ugly Point).—A point on the east coast just south of Sandy Bay, named by the sealers after the sealing vessel " Brothers " which was engaged in the Macquarie Island trade in the early days.

BUCKLES BAY (North-East Bay).—This is the most useful anchorage at the island, for the winds come from the west during the greater part of the year. Should the wind swing to the east a vessel can quickly proceed around North Head to the alternative anchorage in Hasselborough Bay. In 1911 it was known to the sealers as North-East Bay and the Expedition members adopted their name. However, on the Admiralty chart of 1917 it is distinguished as Buckles Bay which is perhaps preferable as being more distinctive. A plan of the anchorage is given on page 20.

CAROLINE BAY is an ill-defined bay at the south end of Macquarie Island, situated on the east side of Green Point. Early maps of the island depict a better defined bay than now exists. It may be that in the days of the early sealers there existed a protective arm of the land referred to by them as South Reef.

CAROLINE COVE is a small, picturesque cove (text, fig. 9) near the south-west corner of the island, where the sealer " Caroline " was wrecked in 1825. The real cove is the southern extremity only of the wide embayment indicated on the 1917 chart.

CATCH-ME is a rocky point on the north side of Hasselborough Bay, where the passage at sea-level around the coast from Aerial Cove to the Isthmus is rendered hazardous. At that place there is an almost entire absence of rock-cut platform between tide limits; consequently it has to be negotiated in the interval between the breaking of successive waves.

DAVIS POINT on the west coast appears in the 1917 chart. Named after Captain J. K. Davis of the A.A.E.

DOUGLAS POINT.—This is the name of a feature on the west coast of the 1917 chart, possibly named after the Hydrographer.

DRUMMOND, MT., of 1,217 feet in height, is located south of Flynn Lake; named after D. H. Drummond, Minister for Education, New South Wales, associated with the printing of these Reports.

EAGLE BAY.—See Half-Moon Bay.

EAGLE POINT.—A notable rocky point on the west coast where the vessel "Eagle" was wrecked about the year 1870. This name appears on the 1887 chart.

EITEL, Mt.—An eminence 1,119 feet in height named by the A.A.E. after the Expedition's secretary.

ELDER, Mt.—This is one of the high summits reaching 1,218 feet above sea-level. It was named by the sealers after the principal of a New Zealand sealing firm operating at Macquarie Island about the year 1880.

ELLIOTT REEF, a reef of rocks almost entirely submerged extending in a northerly direction immediately beyond the north end of the island. This feature, dangerous to shipping, was named after the Master of the Hobart sealing vessel "Emerald" which traded with Macquarie Island about the year 1821.

FINCH CREEK (New Finch Creek).—So named by Blake after sighting there a small finch-like land bird foreign to the island.

FINGER AND THUMB POINT is the name appearing in the 1917 Admiralty chart substituted for Nugget Point of the 1887 chart. As the name Nugget Point appeared in the earlier published chart, and as the Sealers have long known it as Nuggets Point, it would seem better to adopt the latter, especially as it is then distinguished from Nugget Point on the New Zealand Coast.

FLAT CREEK drains the area just north of Prion Lake and reaches the west coast south of Bauer Bay.

FLETCHER, Mt., 1,406 feet in height, commemorates F. D. Fletcher of the A.A.E.

FLYNN LAKE named by the A.A.E. after the biologist of the second sub-antarctic cruise of the "Aurora." The spelling in the 1917 chart is incorrect.

GADGET GULLEY descends steeply from the highland to the beach at a point less than a half mile south of the sealers huts at North End.

GARDEN BAY.—A small embayment at the northern end of Buckles Bay. Hut Hill lies on its western side. Here tidal observations were conducted for some time. Here also Blake cut a bench-mark into the rock for future reference.

GREEN GORGE (or Green Valley) on the east coast refers to the notable green vegetation of the locality. In their later chart the Admiralty changed this name to Stars Gulch.

GREEN POINT is a point on the coast at the southern end of the island. This appears in the 1887 chart.

HALF MOON BAY is a sweeping bay on the west coast near its northern end. It was known to the sealers in 1911 as Eagle Bay but appears in the 1917 chart as Half-Moon Bay.

HALF-WAY HILL, an eminence 430 feet in height, is located on the east coast half-way between the isthmus and Nuggets Point.

HAMILTON, Mt., 1,421 feet, is named after Harold Hamilton of the A.A.E.

HANDSPIKE POINT is the north-western corner of the main mass of the island. The name was introduced in the 1917 chart. This was known to the sealers as West Point.

HARRISSON, Mt., is a summit 933 feet in height, west of Prion Lake; named after C. T. Harrisson of the A.A.E., who perished on the "Endeavour" when visiting Macquarie Island, in 1914.

HASSELBOROUGH BAY.—A large open bay which is a good anchorage in suitable weather. It borders the North End Isthmus on its western side. For a plan of the anchorage, see text, fig. 8. In weather coming from north-east to south this is the best anchorage available. It was thus named by Captain J. K. Davis after the Master of the "Perseverance," the discoverer of the island.

HASWELL, Mt., is an eminence 1,111 feet in height, lying immediately east of Caroline Cove; named to commemorate Professor W. A. Haswell who assisted in the organisation of the Expedition's biological programme.

HJORT RISE is a notable elevation of the ocean floor located by the B.A.N.Z.A.R. Expedition 120 nautical miles south of Macquarie Island and named after the Norwegian oceanographer. It is doubtless in some way related to the Macquarie Island Ridge (see text, fig. 15).

HURD POINT is a low extension of the land at the south-east corner of the island. This name first appears on the 1917 chart. The largest Royal Penguin rookery of the island is located on this low spit. Generally referred to as South-East Point or South-East Spit by members of the A.A.E.

HUT HILL.—A small peaked hill 97 feet in height at the north end of the isthmus. It shelters the Expedition Hut from easterly winds.

IFOULD, MT., is a prominence 1,227 feet in height in the centre of the island, west of Green Valley. It is named after W. H. Ifould, Chief Librarian to the New South Wales Government and member of the A.A.E. Publications Committee.

ISLAND LAKE, one of the highland lakes; named thus by Blake on account of the fact that its waters enclose a small island.

IVERSEN SHOAL is located north-west by north of the Judge and Clerk Rocks. Detailed reference is given on page 28.

JEFFRYES, MT., 1,309 feet in height is named after S. N. Jeffryes of the A.A.E.

JUDGE AND CLERK.—A group of small rocky islets located 9 miles from North Head. This danger to shipping was known to and named by the early sealers.

JUDGE ISLAND.—This is the principal islet of the Judge and Clerk group. Its position has been well fixed by Blake based on observations from the land.

LANGDON BAY is a feature of the west coast appearing on the 1917 chart.

LANGDON POINT.—Also a feature of the west coast in the 1917 chart.

LEWIS, MT., is a peak 1,197 feet in height located just east of Major Lake; named after Sir Elliott Lewis of Hobart, Premier of Tasmania, when the Expedition departed south.

LORD, MT., a feature of the landscape, 1,223 feet in height, is located south of Major Lake; named to commemorate Clive Lord, one-time Director of the Tasmanian Museum.

LORD NELSON REEF is a line of partly submerged rocks lying close off-shore at the north-west corner of the main mass of the island. So named after the vessel "Lord Nelson" which was wrecked on this reef in 1830.

LUSITANIA BAY was named by the early sealers after the vessel "Lusitania" which traded with the island about 1822. For details of the anchorage, see text, fig. 9.

LUSITANIA CREEK enters the sea at Lusitania Bay.

MAJOR LAKE.—Thus named by Blake on account of its being the largest lake on the island.

MAWSON POINT.—A feature of the west coast in the Admiralty chart of 1917.

NORTH-EAST BAY.—See Buckles Bay.

NORTH END.—The term North End was used by the A.A.E. to indicate the Isthmus and terminal rocky headland which the former joins to the main body of the island.

NORTH END ISTHMUS is a low, flat, pebbly and partly vegetated connecting link between Wireless Hill and the mainland. Its flat top is 20 feet above sea-level. In very severe westerly weather seas may break across it where narrowest (see text, fig. 16). Frequently referred to as The Isthmuth.

NORTH HEAD, so designated by the A.A.E., is the most northerly point of the island.

NORTH MOUNTAIN is a prominence 937 feet in height near the north end of the eastern highlands; named by Blake.

NUGGETS (or Sisters) is the name applied by the sealers to the remarkable rocks located at Nuggets Point. The name appears in the 1887 chart.

NUGGETS CREEK enters the sea on Nuggets Beach, just south of Nuggets Point.

NUGGETS POINT (Finger and Thumb Point) is a feature of the east coast easily recognizable owing to its tip ending in a double peaked rock. One of the main anchorages lies on the south side of Nuggets Point. This name, which was applied by the early sealers, appears as Nugget Point in the 1887 chart. The anchorage is shown in text, figure 9.

PETREL PEAK is a conspicuous hill, 814 feet in height, just south of Caroline Cove.

POWER, Mt., 1,070 feet in height, lies to the west of Mt. Blair; commemorating H. Power, who was in charge of the Island Party during 1914, and subsequently perished on the " Endeavour."

PRION LAKE.—Thus named by Blake on account of the occurrence nearby of a nesting ground of prions.

PYRAMID PEAK, 928 feet in height, was thus named by Blake on account of its shape.

RAINES POINT appears on the chart of 1917. It is the northern end of Lusitania Bay.

ROOKERY CREEK is the branch of Nuggets Creek along which the Royal Penguins proceed to their highland rookery.

SADDLE POINT of the 1917 chart is the same as Victoria Point of Blake's map.

SANDELL BAY on the west coast, named after C. A. Sandell of the A.A.E.

SANDY BAY (see Ballast Bay).—This name, in use by the sealers in 1911 for a sandy bay on the east coast, was adopted by the A.A.E.

SAWYER CREEK is a well-defined stream valley entering Green Gorge, named after A. A. Sawyer of the A.A.E.

SOUTH REEF which figured prominently on early maps, is now represented only by a group of sea-stacks located between South-East Bay and Caroline Bay.

SOUTH-EAST BAY is a slight embayment at the south-east corner of the island, located immediately to the west of Hurd Point.

SOUTH-EAST REEF is an off-shore reef at the south-eastern extremity of the land, figured in the 1887 chart.

SOUTH-WEST POINT is the name applied by Blake to the south-west corner of the island.

STARS GULCH (see Green Gorge).—This name on the 1917 chart is the same as Green Gorge of the 1887 chart.

STONEY CREEK rises in a large lake west of Sandy Bay and reaches the west coast at Bauer Bay.

STRAHAN, Mt., is a peak of 1,217 feet in height just south of Flynn Lake. It is named after F. Strahan of the Commonwealth Prime Minister's Department, a member of the B.A.N.Z.A.R. Expedition Committee.

TAYLOR SHOAL is reported as located north-north-west of the Judge and Clerk Rocks. Detailed reference is given on page 28.

TOM UGLY POINT (Brothers Point).—This name appears on the 1917 chart.

TOUCHER, CAPE, named after N. C. Toucher of the A.A.E.

TULLOCK, Mt., is 959 feet in height; named after A. C. Tullock who was in charge of the party which carried on the meteorological station during 1915.

VICTORIA POINT of Blake's map is the same as Saddle Point of the 1917 chart.

WAITE, Mt., 1,384 feet in height, is one of the high points. It was named after the biologist of the first subantarctic cruise of the " Aurora."

WATERFALL BAY is a small embayment in the coast where a large stream enters the sea south of Saddle Point.

WATERFALL LAKE is one of the more notable lakes of the highlands. The stream of effluent water, in its steep descent to the sea, cascades over a waterfall.

WIRELESS HILL is the 336 feet high flat-topped hill at the North End upon which the Expedition's wireless installation was established.

CATALOGUE OF THE ROCK COLLECTION

Spec. No.	Description.	Origin and Locality.*	Page. Ref.
1	Hornblendic injected hornfels	Beach boulder, S. side Hasselborough Bay.	71
2	Dynamically metamorphosed granite	Erratic, beach boulder, Buckles Bay.	81
3	Olivine-eucrite	*In situ* at Handspike Point	99
4	Allivalite	Dyke at Half-Moon Bay	102
5	Enstatite-peridotite (serpentinized)	Dyke, Half-Moon Bay and Eagle Bay.	103
6	Striated gabbroic erratic	*Ex* Till, N. of The Nuggets	—
7	Megaphyric bytownite-dolerite	Dyke, Buckles Bay	110
8	Propylitized basalt	Beach boulder, Buckles Bay ...	126
9	Allivalite	Dyke, Half-Moon Bay and Langdon Bay.	101
10	Aphyric dolerite	*In situ*, from The Isthmus	116
11	Tachylite and tachylite basalt agglomerate ...	*In situ*, North Head	73
12	Glaciated erratic of fine-grained dolerite	*Ex* Till, Wireless Hill	—
13	Aphyric dolerite	Dyke, Hasselborough Bay	118
14	Megaphyric picritic dolerite	Dyke, Hut Point	113
15	Megaphyric bytownite basalt	*In situ*, Hut Hill	123
16	Arkosic sandstone	Beach pebble erratic, N. of Nuggets Point.	81
17	Aphanitic basalt, chloritized	*In situ* at the Gap, S. end Isthmus ...	126
18	Gabbro endolith in basalt	Beach pebble, Buckles Bay	—
19	Contact of gabbro and basaltic aphanite	do do	—
20	Basaltic aphanite vein intersecting gabbro	do do	—
21	Basalt	do do	—
22	Contact of gabbro and basaltic aphanite	do do	—
23	Ditto	do do	—
24	Schliers of micro-gabbro in olivine-gabbro	Dyke on the Isthmus	108
25	Injected hornfels	Beach pebble on the Isthmus ...	71
26	Talc and chlorite vein in enstatite-peridotite ...	*In situ*, Eagle Point	—
27	Do do	do do	—
28	Do do	do do	104
29	Do do	do do	—
30	Do do	do do	—
31	Striated erratic, serpentinized enstatite-peridotite ...	*Ex* Till, N. of The Nuggets	104
32	Basic igneous rock	Beach Pebble, Buckles Bay	—
33	Micro-gabbro intersecting gabbro	do do	—
34	Tuffaceous greywacke grit	*In situ*, First Gully	84
35	Aphanitic basaltic vein intersecting gabbro... ...	Beach boulder from the Isthmus ...	—
36	Do do	do do	107
37	Do do	do do	107
38	Do do	do do	—
39	Aphanitic basaltic vein intersecting gabbro... ...	do do	—
40	Ropy tachylitic basalt partly palagonitized ...	*In situ*, North Head	—
41	Scoriaceous tachylitic basalt	do do	127
42	Foraminiferal limestone (Globigerina ooze)... ...	*Ex* volcanic breecias, North Head ...	74

*Blake refers the locality of occurrence of some of these rocks to the temporary flag stations which he adopted during his topographical survey of the Island. Unfortunately he left no record of their localities in relation to his finished map. Therefore, when station numbers are quoted we cannot give their specific locations in relation to the map except in the case of four of the stations as herewith :—

Station 1 was a hill 718 feet high at 10,000 feet S.W. of the Expedition Hut.

Station 2 was a rise a little more than 650 feet in height on the north side of Gadget Gully at 5,000 feet S.W. of the Expedition Hut.

Station 3 was located on the highland immediately overlooking the West Coast to the W. of Station 1.

Station 42 was a hill 815 feet high, located 7,000 feet S.S.W. of Brothers Point.

Spec. No.	Description.	Origin and Locality.	Page Ref.
43	Harrisite, partly serpentinized	Erratic *ex* Till, N. of The Nuggets ...	103
44	Basalt partly albitized and chloritized	do do ...	126
45	Aphanitic basaltic vein in gabbro porphyry ...	Beach pebble from the Isthmus ...	—
46	Do do	do do ...	—
47	Do do	do do ...	—
48	Aphanitic basaltic vein intersecting gabbro... ...	do do ...	107
49	Do do	do do ...	—
50	Basaltic vein in porphyritic bytownite-dolerite ...	Erratic *ex* glacial drift, Wireless Hill	—
51	Basaltic vein intersecting gabbroic rock	Beach boulder from the Isthmus ...	—
52	Do do	do do ...	—
53	Do do	do do ...	—
54	Do do	do do ...	—
55	Do do	do do ...	—
56	Do do	do do ...	—
57	Do do	do do ...	—
58	Basaltic vein intersecting gabbroic rock	Boulder from the Isthmus	—
59	Submarine basic agglomerate	*Ex* volcanic breccia, Aerial Cove ...	73
60	Basaltic vein intersecting gabbroic rock	Beach boulder from The Isthmus ...	—
61	Do do	do do ...	—
62	Contact of gabbro and hornfels	do do ...	70
63	Lamprophyric vein intersecting gabbro	do do ...	107
64	Globigerina-ooze rock with embedded palagonite ...	*Ex* volcanic breccias, Aerial Cove ...	76
65	A banded pyritic quartz reef	Intersects basalt on the Isthmus ...	90
66	Gabbro	*In situ* on the north-western highlands.	96
67	Lamprophyric vein intersecting gabbro	Beach boulder, Buckles Bay ...	107
68	Dolerite (soda rich)	Beach pebble, Garden Bay	120
69	Quartzose vein-breccia...	Mineralized reef, W. side of Isthmus	90
70	Basalt, propylitized	Beach boulder, Hasselborough Bay...	125
71	Tachylite	*In situ*, North Head	127
72	Tachylite with semi-palagonite	do do	129
73	Tachylite	Beach pebble, Aerial Cove	—
74	Megaphyric labradorite dolerite	Dyke, W. side of Isthmus	113
75	Basalt	Beach pebble, Buckles Bay	—
76	Glacial Till	*In situ*, $\frac{1}{8}$ m. N. of The Nuggets ...	77
77	Prehnitized pegmatitic gabbro	*Ex* Till, near Station 20	105
78	Diatomaceous lacustrine shale	Overlying Till, N. of The Nuggets ...	84
78A	Do do	do do ...	84
79	Laminated peat	do do ...	84
80	Peat	Overlying Till, Wireless Hill ...	86
81	Basalt	*Ex* Till from N. of The Nuggets ...	—
82	Basalt	do do ...	—
83	Serpentinized dunite (striated erratic)	do do ...	—
84	Serpentinized troctolite erratic	do do ...	—
85	Serpentinized enstatite-peridotite erratic	do do ...	—
86	Glaciated basaltic erratic	do do ...	—
87	Chloritized basalt (glaciated erratic)	do do ...	—
88	Serpentinized dunite	do do ...	104
89	Serpentinized dunite	do do ...	104
90	Peat	Overlying Till on Wireless Hill ...	82
91	Olivine-gabbro	*In situ* near Station 2	98
92	Fine-grained diallage-enstatite-gabbro	do do	97
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95	Do do	do do ...	—
96	Do do	do do ...	104
97	Do do	do do ...	—
98	Do do	do do ...	—
99	Do do	do do ...	—

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100	Glaciated erratic (serpentinized peridotite)... ...	*Ex* Till, north of The Nuggets ...	—
101	Do do	do do	—
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147	Sheared gabbro (recrystallized and prehnitized) ...	Beach Boulder, Half-Moon Bay ...	106
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350	Do do do do	do do	—
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368	Crushed serpentinous rock	Beach pebble, Aerial Cove	—
369	Olivine-gabbro	do do	98
369A	Troctolite	do do	99
370	Olivine-gabbro	do do	98
370A	Eucrite	Erratic from Aerial Cove	99
371	Megaphyric bytownite-basalt	do do	123
372	Marble (recrystallized Globigerina ooze)	Beach pebble, Buckles Bay	—
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* Description of these soil samples appears in B.A.N.Z.A.R. Expedition Reports, Series A, Vol. II, Part 7.

BIBLIOGRAPHY

1. " Murihiku and the Southern Islands," by R. McNab : Invercargill (N.Z.), 1907.
2. " The Sub-Antarctic Islands of New Zealand " : 2 vols. pub. by the Phil. Inst. of Canterbury, N.Z. (1909).
3. N.Z. Parl. Paper, App. to Journal of House of Reps., Session II, 1891, A—5 in cont. A—5 of 1890.
4. Two Voyages of Exploration in the Antarctic Ocean and a Circumnavigation of the World in the Years 1819, 1820, 1821, carried out in the Corvettes " Vostock " and " Mirny," under the Command of Captain Thaddeus Von Bellingshausen : 2 vols., St. Petersburg, 1831.
5. " Narrative of the United States Exploring Expedition," by Charles Wilkes : 5 vols., Philadelphia, 1845.
6. " Macquarie Island," by J. H. Scott : Trans. N.Z. Institute, Vol. XV (1882).
7. " Notes on a Visit to Macquarie Island," by A. Hamilton : Trans. N.Z. Institute, Vol. XXVII (1895).
8. " The Voyage of the ' Discovery,' " by R. F. Scott : London, 1905.
9. " The Heart of the Antarctic," by E. S. Shackleton : London, 1909.
10. " The Home of the Blizzard," by D. Mawson : London, 1915.
11. " With the ' Aurora ' in the Antarctic," by J. K. Davis : London, 1919.
12. " The B.A.N.Z. Antarctic Research Expedition, 1929–31, by D. Mawson : Geog. Jour. Vol. LXXX (1932).
13. Australasian Antarctic Expedition, 1911–14, Reports, Series B, Vol. 1.
14. Commonwealth of Australia, Dept. of Defence, Notice to Mariners, No. 8 of 1924.
15. Aust. Ant. Exped., 1911–14, Repts., Series B., Vol. III.
16. B.A.N.Z.A.R. Expedition, 1929–31, Reports, Series A, Vol. II., p. 82.
17. " Icebergs in the Southern Ocean," by H. C. Russell : Proc. Roy. Soc., N.S.W., Vol. 31 (1897), pp. 221–251.
18. " Voyages and Wanderings in Far-off Seas and Lands," by J. Inches Thomson : London, 1912.
19. " The Vascular Flora of Macquarie Id.," by T. F. Cheeseman : A.A.E. Repts., Series C., Vol. VII.
20. " Birds," by R. A. Falla : B.A.N.Z.A.R. Exped. Repts., Series B, Vol. II.
21. " A Southern Metropolis," by D. Mawson : Lady Galway Belgium Book. Adelaide, 1916.
22. " Macquarie Island," by D. Mawson : Proc. Roy. Geog. Soc. of Australasia (S. A. Branch), Vol. XX, pp. 1–15.
23. " Macquarie Island and Its Future," by D. Mawson : Trans. Roy. Soc. Tasmania, Vol. (1922), pp. 40–54.
24. " The Home of the Penguins of the World," by W. H. Bickerton : Pall Mall Magazine, Vol. XIII (1897).

25. "Report on Macquarie Island," by A. C. Tullock: Parl. Paper, No. 7, Hobart, 1916.
26. Tasmanian Fisheries Act of 1889: Tas. Govt. Gazette of 21st April, 1891.
27. "Reflections with Respect to Macquarie Island, our most Southerly Dependency," by Sir W. L. Allardyce: Rept. to Premier of Tasmania, 1920.
28. "Macquarie Island," by Sir Ernest Clark: A memorandum forwarded to the Govt. of Tasmania in 1935.
29. B.A.N.Z.A.R. Expedition Reports: Series A, Vol. 2, Part 7.
30. Scientific Reports of the Deutschen Südpolar-Expedition, 1901–03: Die Grundproben, by E. Philippi (see pages 441, 445, 525 and 543).
31. "Some Rocks of Macquarie Island," by P. Marshall. A.A.A.S. Reports, Vol. X (1904), pp. 206–217.
32. National Antarctic Expedition, 1901–04: Natural History, Vol. I (Geology).
33. "The Geology of the Small Isles of Inverness-shire," by A. Harker. Mem. Geol. Survey (Scotland), 1908.
34. "Geology of the Southern Half of the Bay of Islands Igneous Complex," by John R. Cooper. Bull. No. 4, Geol. Sect., Dept. Nat. Resources, Newfoundland, 1936.
35. Notes on the Geology of Three Kings and other Outlying Islands of Northern New Zealand, by J. A. Bartrum. N.Z. Jour. Sci. and Tech., Vol. 18 (1936), pp. 520–530.
36. Pillow-lavas, Peridotites and Associated Rocks of Northernmost New Zealand, by J. A. Bartrum and F. J. Turner. Trans. N.Z. Inst., Vol. 59 (1928), pp. 98–138.
37. Pillow-lavas and Associated Rocks of North Cape Area of New Zealand, by J. A. Bartrum. N.Z. Jour. Sci. and Tech., Vol. 16 (1934), pp. 158–159.
38. Geology of the Tapapuna-Silverdale District, Waitemata County, Auckland, New Zealand, by F. J. Turner and J. A. Bartrum. Trans. N.Z. Inst., Vol. 59 (1929), pp. 864–902.
39. "Geology of the Dun Mountain Subdivision," by J. M. Bell and others. Bull. 12 (1911), N.Z. Geol. Survey.
40. "The Geology of Campbell Island and the Snares," by P. Marshall. The Subantarctic Islands of New Zealand; Wellington, 1909, pp. 680–704.
41. The Volcanic Beds of Oamaru, with special reference to their position in the Stratigraphical Sequence, by G. H. Uttley. Trans. N.Z. Inst., Vol. 50 (1917), p. 106.
42. "Zoizite-Prehnite Alteration of Gabbro," by Kenneth de P. Watson. The American Mineralogist, Vol. 27 (1942), p. 638.
43. Tasmanian Govt. Gazette, 23rd May, 1933, p. 844.
44. Fisheries Act of 1889 (53 Vict., No. 11): Govt. Gazette, Hobart, 21st April, 1891.
45. "A Correlation of the Tasmanian Pleistocene Epochs and Deposits," by A. N. Lewis. Roy. Soc. Tas., year 1933, pp. 67–76.
46. "Das Klima von Adélieland (Südpolargebiet) und der Macquarieinsel," by Fitz Loewe: Meteorologischen Zeitschrift, Heft 2, 1935.

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