Recent glacier retreat on Heard Island

BY

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ABSTRACT

A survey of glaciers on Heard Island in 1963 showed that general major retreat had recently occurred. Re-survey in 1965 suggested possible readvance in two glaciers.

Photographic and other records from expeditions visiting the island in 1974, 1902 and 1929, and from the ANARE occupation of 1947–1955, show no apparent changes until 1947 but general minor recession by 1955.

Meteorological records show a rise in air temperature since 1948, which seems to be the major cause of the retreat. Possible movement of the Antarctic Convergence cannot be demonstrated and volcanic activity is discounted as a general influence.

Introduction

Heard Island (Fig. 1) is a mountainous island south of the Antarctic Convergence. It is 27 miles long, 12 miles wide, and 9000 feet high. The

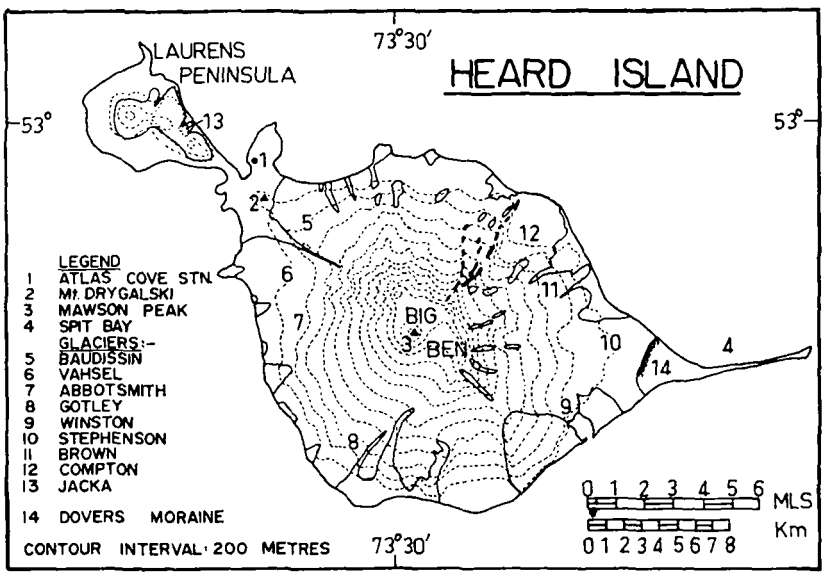

FIG. 1. Topographical features, Heard Island.

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main bulk of the island consists of Big Ben, a composite volcanic cone with an extensive plateau at 7500 feet. Four-fifths of the island is ice covered, and about half the coastline consists of glacier cliffs. The mean annual temperature is 1°C, mean wind speed is 8 m/sec, and snow or rain falls on 300 days of the year. A comprehensive description of the island has been published by Law and Burstall (1953).

The island's history has been described by Roberts (1950). Discovered in 1833, it was occupied by sealers for some decades after the first landing in 1855. Sketches or photographs, and general descriptions of the glaciers were made during brief visits by the *Challenger* expedition in 1874 (Thomson and Murray, 1885), the *Gauss* expedition in 1902 (Drygalski, 1908), Aubert de la Rue in January 1929 (Aubert de la Rue, 1929), and the BANZARE expedition in December 1929 (Mawson, 1932). The island was continuously occupied by the Australian National Antarctic Research Expeditions (ANARE) from 1947 to 1955, and was revisited by an ANARE summer party in 1963 (Budd, 1964*a*, *b*). A further visit was made in 1965 by a private expedition, the South Indian Ocean Expedition to Heard Island (SIOEHI) (Anon., 1965). The geography, glaciology and geology of the island have been described by Lambeth (1950, 1952) and by Stephenson (1964).

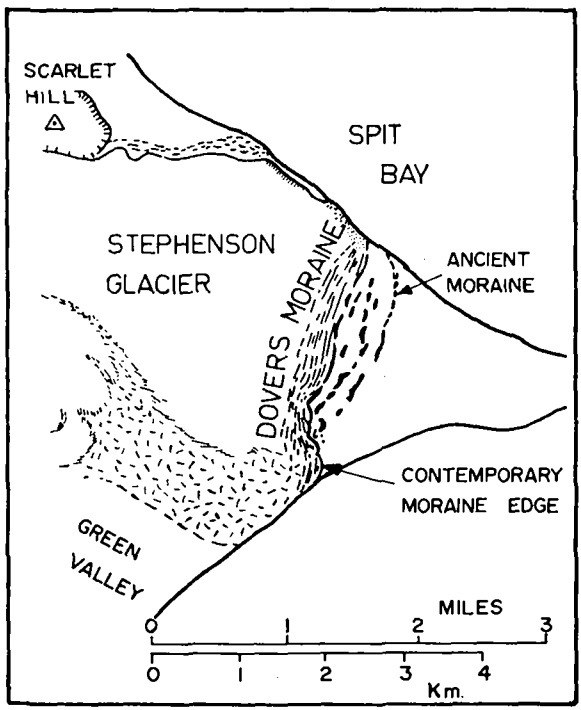

FIG. 2. Sketch map, Dovers Moraine.

Ancient glacial features. There is widespread evidence for the former greater extent of glaciers. The young moraines flanking Winston Lagoon (Plate 2: 1965) show that until comparatively recently Winston Glacier was some 300 feet thicker than it is now. Lambeth (1950) considers that terminal moraines of Vahsel Glacier indicate a loss of at least 200 vertical feet of ice, with little horizontal retreat, and Mellor (1967) describes a trim line some 100 feet above the surface of the Baudissin Glacier. The Dovers Moraine (Fig. 2) near Spit Bay contains some of the oldest glacial deposits. Recent and contemporary terminal moraines of the adjacent glacier are discordant to three groups of ancient, fully vegetated moraine forming rounded hills.

Glacier changes before 1955. The available records show no apparent change between 1874 and 1902, nor between 1902 and 1929. However, minor recession was apparent in a few places by 1947 and was fairly widespread by 1954. Marked changes occurred in the ice formations above 5000 feet on the southwestern slopes of Big Ben between 1949 and 1954, possibly as a result of volcanic activity (Padang, 1963).

Changes since 1955. In 1963 major recession was obvious below 2000 feet on almost all glaciers, and minor recession was evident as high as 5000 feet, although the changes previously seen above this height were no longer apparent. The extent of general recession between 1947 and 1963 is summarized in Fig. 3.

The most remarkable retreat was shown by Winston Glacier (Plates 1 and 2, Fig. 4) which retreated approximately one mile between 1947 and

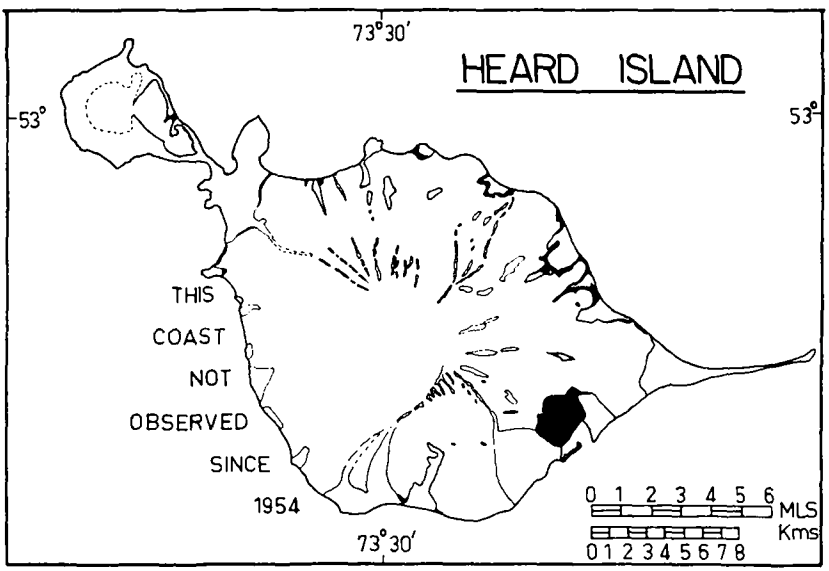

FIG. 3. Heard Island, showing (as black areas) known recessions, 1947–63.

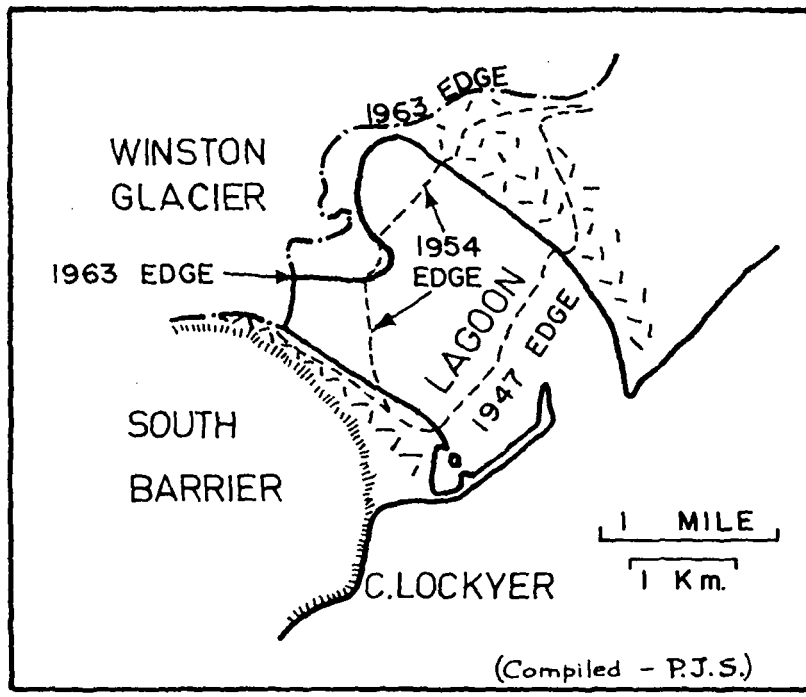

FIG. 4. Sketch map, Winston Glacier and Lagoon, showing successive positions of the glacier front.

1963, and thus appears to be the most sensitive indicator of glacier change on the island.

Striking retreat also occurred on the coast north-west of Spit Bay (Plates 3, 4 and 5). The coastal ice cliffs of Brown and Stephenson Glaciers, which in 1954 were over 50 feet high, had disappeared by 1963 when the glaciers terminated as much as 100 yards inland, behind a beach and a lagoon.

Other glaciers showing marked recession since 1955 were Baudissin on the north coast, Vahsel on the west coast, and Jacka on the east coast of Laurens Peninsula.

Possible readvance. Observations made in 1965 suggested a possible readvance of two glaciers. Winston Glacier had increased in thickness at its terminus, and some moraine overthrust was apparent at the north-eastern seaward edge of Stephenson Glacier. Similar overthrusts had been seen in 1963 on the north lateral moraine of Baudissin Glacier, which could not be revisited in 1965.

Possible causes of glacier changes

Volcanic activity. Volcanic activity at Heard Island has been summarized by Padang (1963). A major eruption was observed in 1910, and

PLATE 1. Winston Glacier and Lagoon with Big Ben from the east. Dec. 1947. (Air photograph, ANARE, P. Swan.)

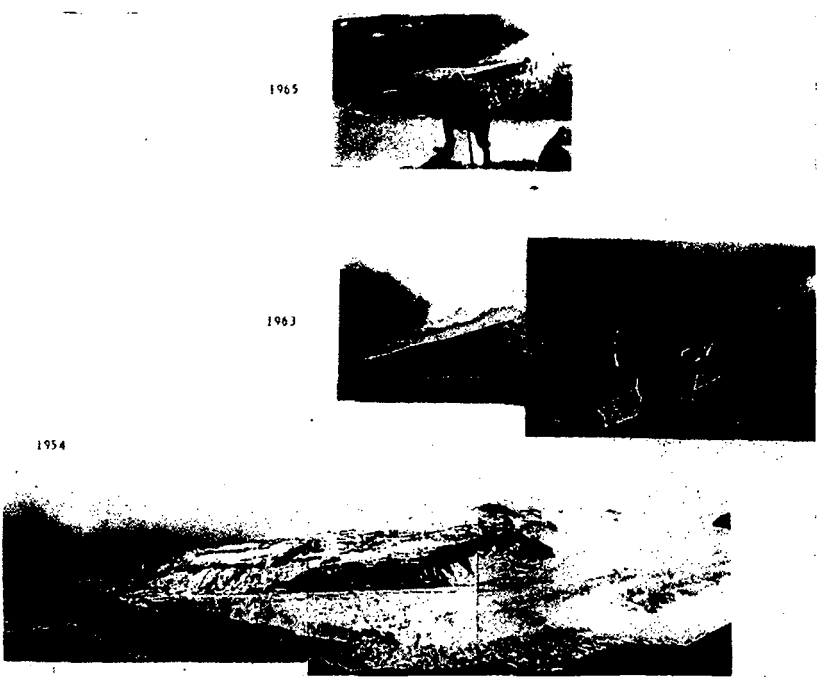

PLATE 2. Winston Glacier front from the north-east, similar viewpoints. Dec. 1954; Feb. 1963; Feb. 1965. Note high lateral moraine above south arm in 1965 photo. (ANARE photos, J. E. Walsh and G. M. Budd; SIOEHI photo, G. M. Budd.)

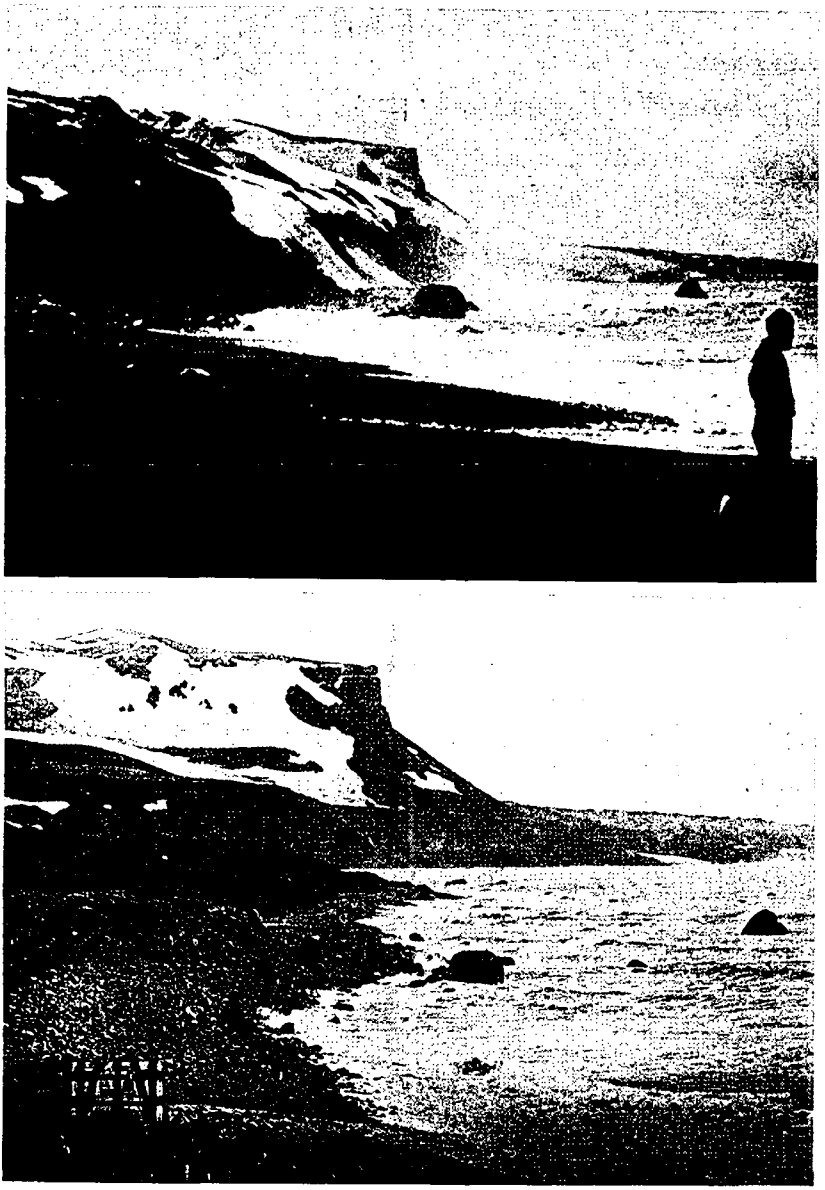

PLATE 3. Views north-west from Spit Bay. Upper: Feb. 1954. Lower: Feb. 1965. Upper photo shows Stephenson (above l.h. rock) and Brown (above r.h. rock) Glaciers with high sea cliffs, both vanished in lower photo. Round Hill behind. (Upper, ANARE photo, J. E. Walsh. Lower: SIOEHI photo, with longer focus lens, and from slightly higher viewpoint, G. M. Budd.)

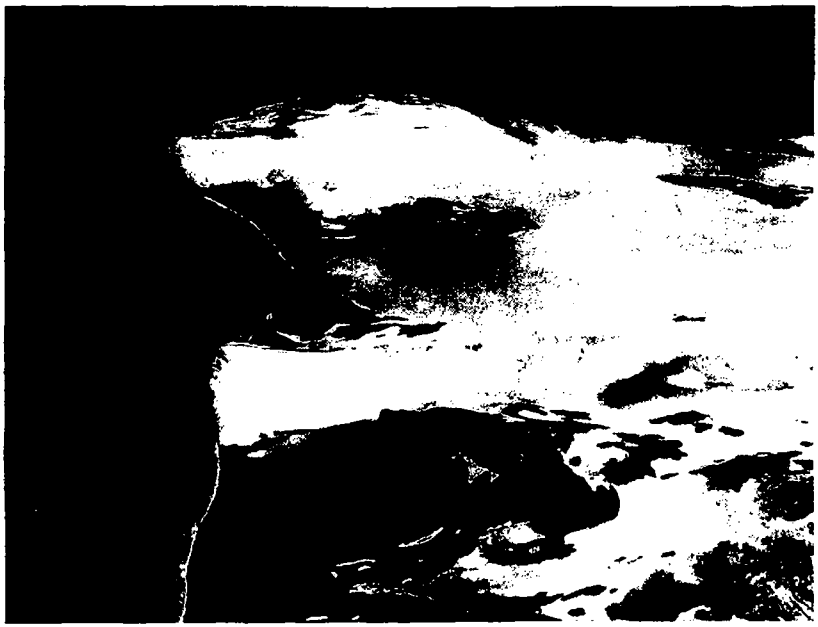

PLATE 4. Air photograph, south-east corner Heard Island, Dec. 1947. Brown Glacier with sea cliffs and Round Hill in foreground. (Stephenson Glacier and Scarlet Hill beyond, and Winston Lagoon background right.) (ANARE photo, P. Swan.)

PLATE 5. Snout of Brown Glacier from Round Hill, Feb. 1963. Compare terminus with Plate 4. Lagoon is over 100 yards wide. (ANARE photo, P. J. Stephenson.)

incandescent lava was reported in 1950. New fumaroles seen above 5000 feet on the south western slopes of Big Ben in 1949 were still active in 1954, but were not seen in 1963 or 1965. Crevasse stratigraphy at 7000 feet in 1963 gave no indication that any ash eruptions had occurred for many years, and when the summit crater was visited for the first time in 1965 it showed only fumarole activity. Although volcanic activity might have caused the glacier changes above 5000 feet between 1949 and 1955, such activity seems to have been minor and localized, and it cannot explain the widespread glacier retreat that occurred after 1955.

Southward movement of the Antarctic Convergence. Such a movement conceivably might cause glacier retreat through a rise in sea and air temperatures. Although changes in air temperature have occurred (see below), there is no evidence of a change in the Antarctic Convergence's mean position. The Antarctic Convergence in the ile Kerguelen region is not well known and its position there is the subject of considerable disagreement (Meinardus, 1923; Mackintosh, 1946; Ostapoff, 1965; Soviet Antarctic Expedition, 1966). While these disagreements could be the result of fluctuation, elsewhere in the Southern Ocean the Antarctic Convergence seems to be in much the same position as in 1946 (Gordon, 1967).

Climatic change. Loewe, Radok and Grant (1952) have presented evidence of a probable change in the wind regime at Heard Island within the past century. Sealers' observations between 1856 and 1859 showed fewer south-westerly and more northerly winds than did those made by ANARE between 1948 and 1955. Loewe *et al.* (1952) also noted a similar contrast in 1855–1861 for waters north of ile Kerguelen (280 miles north-west of Heard) compared with 1855–1943. That the overlap of the two periods did not obscure the contrast suggests the wind regime of 1855–1861 could not have persisted very long. The *Gauss* observations at ile Kerguelen in 1902 (Meinardus, 1912), which show far more southwesterly than northerly winds, support this interpretation. Even if this change in wind regime had occurred recently, could it account for the present retreat? Southwesterly winds at Heard Island bring colder and clearer weather than northerly ones. The consequent reduction in snowfall would favour glacier retreat, but this effect could have been countered, or even outweighed, by the reduction in ablation resulting from lower air temperatures and less rainfall.

Temperature records on Heard Island from 1948 through 1954 (Commonwealth Bureau of Meteorology 1950–1957) show that the yearly mean values rose by 1·8°C between 1948 and 1951, and in 1954 were still 1·3° higher than the 1948 value. Observations at ile Kerguelen show a similar pattern, since the mean air temperature of 4·6°C for the decade 1951–1960 was 1·3°C higher than the 30-year mean for 1902–1931 (Départements et terroroires d'outre-mer, 1959–1967; Aubert de la Rue, 1954). Since 1960 it has fallen again, roughly halfway to its previous level.

The timing of these changes in air temperature, and their magnitude,

would seem to be very suitable for explaining the variations in the Heard Island glaciers. They also agree with Aubert de la Rue's impression (1967) that the rate of glacier retreat at ile Kerguelen has accelerated greatly since 1952.

Recommendations

The Heard Island glaciers appear to have been very sensitive to recent weather changes. Unfortunately they are not under regular observation and have never been adequately described. The general interest of Heard Island—its glaciology, its recent faunal changes (colonization since 1955 by King Penguins and fur seals), and its incompletely-known geology—warrants a series of summer survey expeditions and an automatic weather station.

Acknowledgements

We are grateful for the considerable help and information given by many people—particularly our fellow expedition-members—who cannot all be acknowledged personally. Exceptional help was given by G. McKinnon, Dr. F. Loewe, Dr. U. Radok, N. Lied, and Professor E. Aubert de la Rue. The Sydney University Department of Illustration, and H. L. J. Lamont of the University College of Townsville, carried out a great deal of painstaking work on photographic reproduction.

Postscript

In March 1969 the glaciers of the north and north-west coast were resurveyed. Major readvance was obvious in the glaciers of Corinthian Bay, although the termini of other glaciers had retreated further from their positions of 1963 and 1965. The glaciers of Corinthian Bay now closely resembled their 1954 appearance. Little Challenger Glacier—the small glacier between Challenger and Baudissin glaciers—had spread laterally and had again developed sea cliffs 20 m high, where in 1963 there had been a sloping terminus behind a broad beach. Photographic comparisons between the eastern part of the Baudissin sea cliffs and the known height of the adjacent Church Rock showed that the ice-cliffs were now 30–40 m high, where in 1963 their height had varied from 15–25 m.

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