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The REYDARFJORDUR acid volcano centre of eastern Iceland

THE REYDARFJORDUR ACID VOLCANIC CENTRE OF EASTERN ICELAND

A thesis submitted for the degree of Doctor of Philosophy in the University of London

by

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September 1963.

Reydarfjordur from Raudafell

"Why were the Gods angry, and
the lava flowed, where we
now stand?"

Kristnisaga. Kr.XII (14)

ABSTRACT

The mountainous Reydarfjordur area of Eastern Iceland is composed of at least 25,000 ft. of gently dipping Tertiary lavas.

A part of this westerly dipping succession, averaging 2,000 ft. in thickness, and containing a considerable portion of acid rocks, has been studied in detail and mapped for 25 miles North/South along the strike. It has been shown that volcanicity during the eruption of this 2,000 ft. unit - The Reydarfjordur Acid Volcanic Succession - was rhythmic and six separate phases of volcanicity have been recognised. Each phase reaches its maximum development in or near the Reydarfjordur Acid Centre where there were usually eruptions of acid lavas often preceded by large scale pyroclastic eruptions initiating each phase.

Contemporaneously, basic and intermediate lavas were extruded from north-south fissures to form the Flank Succession. In the Reydarfjordur/Faskrudsfjordur area acid-intermediate, rhyolitic andesite lavas form a considerable proportion of the succession, but in the peripheral regions tholeiite and basaltic andesite lavas predominate, and in regions distant from the centre the lavas erupted at this time were normal flood basalts. The significance of this is discussed and comparisons are drawn between the Reydarfjordur area and other areas of acid volcanicity in Eastern Iceland.

A detailed description is given of four rhyolite basalt composite lavas (the previously undescribed extrusive products of composite dykes) while the Appendix contains petrographic and some chemical data on the commonly occurring lava types and some notes on flow structure in acid lavas.

TABLE OF CONTENTS

INDEX TO TEXT-FIGURES

APPENDIX

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CHAPTER I.

General Introduction.

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(i) Iceland - General Tectonic Setting

Iceland, an oceanic island lying on the northern continuation of the Mid-Atlantic ridge, between the Continent of Europe and the "continental" mass of Greenland, occupies a position of considerable geological importance. Here one can study one of the major areas of Tertiary volcanicity, with the certainty that the large-scale volcanic features are not determined by structures in any underlying basement. This important "continental" complication is avoided, the island being a separate entity composed entirely of Tertiary and Quaternary volcanic rocks.

However, similar Tertiary lavas occur in other areas, e.g.:-

(a) East Greenland (Backlund & Malmqvist 1934, Wager 1934)

(b) West Greenland (Noe-Nygaard 1942, Drever & Game 1949)

(c) Faeroes (Walker & Davidson 1930, Noe-Nygaard 1962)

(d) N.W.Scotland & Antrim (Harker 1904, Bailey et al. 1924, Tyrrell 1928, Richey et al. 1930, Charlesworth et al. 1960)

These, together with Iceland and the rather anomalous island of Jan Mayen (Tyrrell 1926, Fitch, in press) have been grouped together to form the North Atlantic Province (fig. 1.) Large thicknesses of Tertiary flood basalts exist in all the areas except Jan Mayen, and these may be associated with intense dyke swarms (Wager and Deer 1938, Richey 1935, p.111) and intrusive masses of gabbro, granite and granophyre. Olivine basalts and tholeiitic types occur as the major constituents of the flood basalts in all the areas, which are broadly similar. Tyrrell

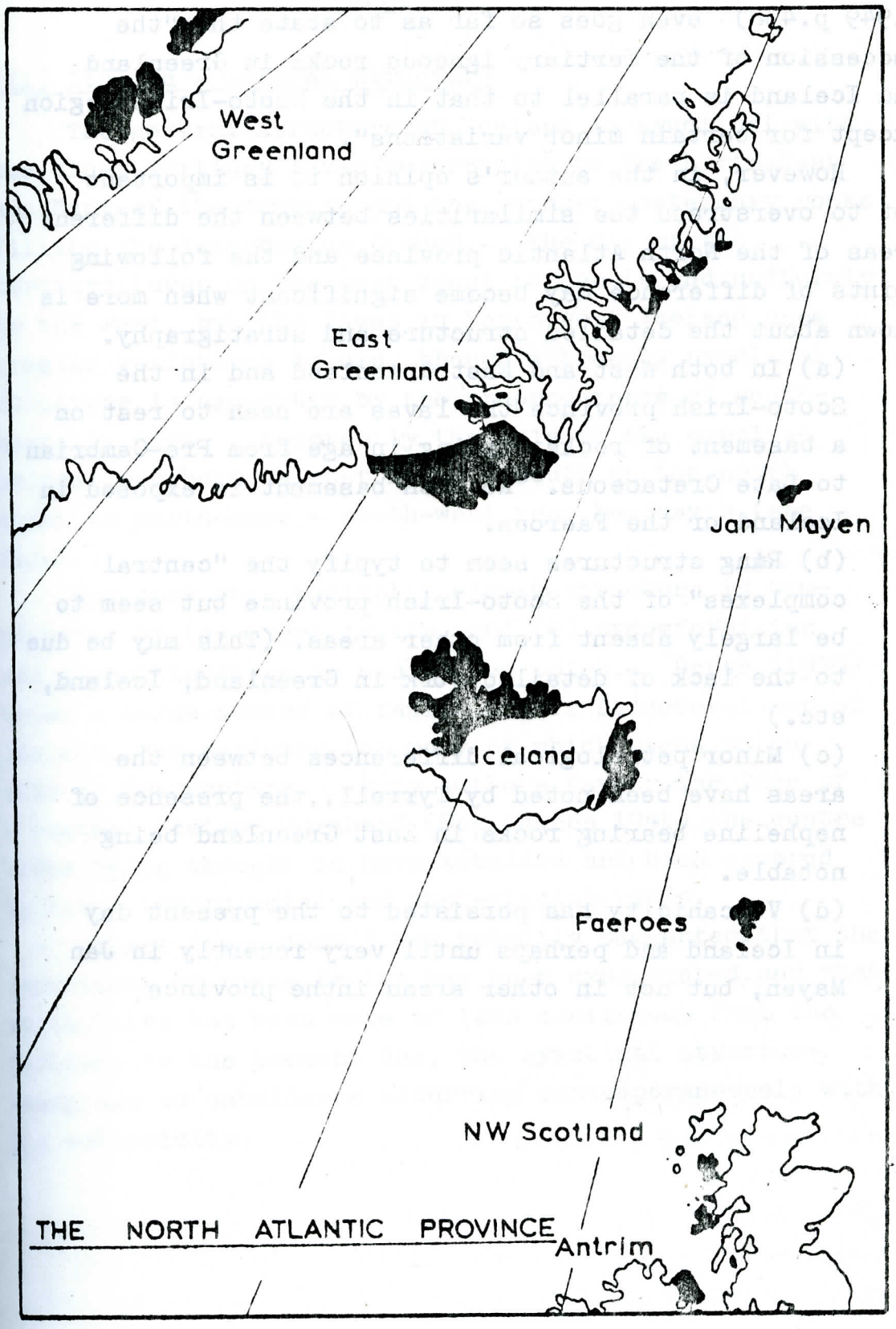
West
Greenland
East
Greenland
Jan Mayen
Iceland
Faeroes
NW Scotland
THE NORTH ATLANTIC PROVINCE
Antrim

Fig. 1.

(1949 p.438) even goes so far as to state that"the succession of the Tertiary igneous rocks in Greenland and Iceland is parallel to that in the Scoto-Irish region except for certain minor variations".

However, in the author's opinion it is important not to overstress the similarities between the different areas of the North Atlantic province and the following points of difference may become significant when more is known about the detailed structure and stratigraphy.

(a) In both West and East Greenland and in the Scoto-Irish province the lavas are seen to rest on a basement of rocks varying in age from Pre-Cambrian to Late Cretaceous. No such basement is exposed in Iceland or the Faeroes.

(b) Ring structures seem to typify the "central complexes" of the Scoto-Irish province but seem to be largely absent from other areas. (This may be due to the lack of detailed work in Greenland, Iceland, etc.)

(c) Minor petrological differences between the areas have been noted by Tyrrell, the presence of nepheline bearing rocks in East Greenland being notable.

(d) Volcanicity has persisted to the present day in Iceland and perhaps until very recently in Jan Mayen, but not in other areas inthe province.

(ii) Iceland - General Structure

The general structure of Iceland is synclinal with the older Tertiary lavas outcropping to the North-West and East of the country and the younger Quaternary rocks filling the intervening trough. The dip of the Tertiary lavas on the east coast is gentle and uniformly to the west, but the lavas in North West Iceland show greater variations in dip, though a broadly synclinal structure is supported by the preponderance of south-easterly dips. Apparently the axis of the syncline swings from being almost north - south on the north coast to north-east - south-west near Reyjkavik (see fig.2.)

How much this basically simple structure is complicated by (a) major faults, and (b) uncomformities and discontinuities is a disputed point. Barth (1950) shows a large number of faults on his structural map of Iceland, the evidence for many of which seems to be slim or fragmentary. Many authors favour the idea of a central Iceland "graben" (See Hawkes 1941) the centre block being thought to have subsided and been covered by later interglacial and post-glacial rocks.

Walker (pers.comm.) has recently suggested that the importance of these faults has been exaggerated and that volcanicity has been more or less continuous from the Tertiary to the present day, the synclinal structure being due to subsidence occurring contemporaneously with the volcanicity.

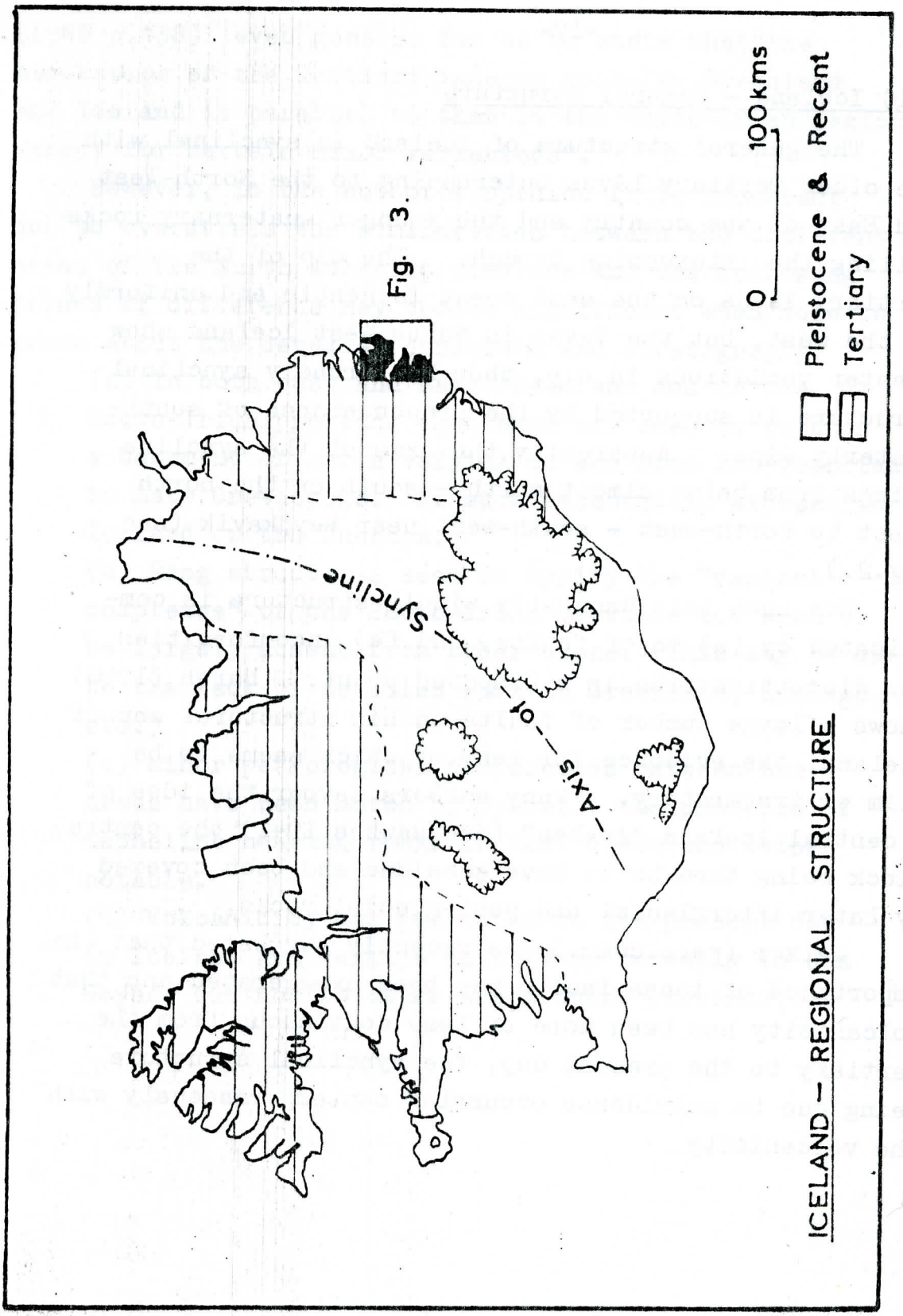
ICELAND — REGIONAL STRUCTURE
Pleistocene & Recent
Tertiary
0
100kms
Fig. 3.
Syncline
Axis of

Fig. 2.

(iii) Eastern Iceland

As already stated, the structure of the area is essentially a series of conformable basic lavas dipping steadily to the west at between two and fifteen degrees. Walker (1959) has estimated that at least 25,000 ft. of lavas are exposed in the eastern fjordlands.

Thoroddssen recognised the existence of "liparite" in several localised areas, while Hawkes working in the 1930s continually stressed the widespread occurrence of acid rocks. Later work by Walker confirmed that acid lavas and intrusions were confined to a limited number of well defined areas including the following:-

(a) A large area to the west of Reydarfjordur near Thingmuli.

(b) An area at the head of Breiddalur and extending south into Berufjordur.

(c) An area on the north and south sides of Reydarfjordur with minor development of acid rocks on both sides of Faskrudsfjordur.

(d) A small area on the Bardnes peninsula.

(e) A small area on the headland between Seydisfjordur and Mjoifjordur, which is probably related to the large area of Acid rocks north of Lodmundarfjordur (Dearnley 1954)

Walker's study (1959) of the north side of Reydarfjordur showed that the acid and intermediate lavas were restricted to "acid Volcanic Episodes" which apparently occurred at intervals throughout the Tertiary volcanic history. He also realised that the acid lava groups did not continue indefinitely along the strike (as apparently do some of the flood basalt groups) and that they were thus restricted spatially as well as in time. However, it was still far from clear structurally how the acid

rocks fitted into the flood basalt environment and it was with this problem in view that the present work was undertaken in the Reydarfjordur area. It was decided that the greatest benefit would be obtained by surveying all the rocks associated with one of the "acid igneous episodes", thus studying a stratigraphic unit rather than one defined by geographical boundaries. Walker named one such acid division the "Sellatur acid group" and it was decided to map, as far as possible, all the rocks in this group (This corresponds to area (c) on page 19.)

The main reasons for choosing this particular acid area were as follows:-

(a) the top and bottom of the group are exposed.

(b) exposures in the area are very good, excellent cross sections through the whole thickness of the group occur on both sides of Reydarfjordur and Faskrudsfjordur.

(c) it was already known how this group fitted into the general stratigraphy of eastern Iceland.

(d) the area of acid rocks was not too great and it seemed possible that concrete results might emerge after three years field and laboratory work.

Since the beginning of detailed work in the Reydarfjordur area in the summer of 1960, descriptions of two other acid volcanic areas in Eastern Iceland have become available. The Breiddalur area has been described in detail by Walker (1963) who was able to demonstrate the contemporaneous and contrasting nature

of flood basalt and acid volcanicity, the latter producing a large volcanic cone, some 5,000 ft thick and 10 miles in diameter. Carmichael (1962A carried out field and laboratory work on rocks from the Thingmuli area which suggested that the acid rocks were differentiates from a basaltic parent. Further discussion of these two detailed accounts is given later.

The area mapped by the present author is shown in fig. 3. As explained above it is delineated by geological rather than physiographic features and the boundaries of the survey cut across the topography. The area involved consists of mountainous country, deeply dissected by fjords and glacial valleys. The mountains reach a height of approximately 3,400 ft. and there are clear indications of two erosion levels, one at about 2,700 ft. and the other a summit level peneplane at about 3,400 ft. Exposures generally tend to be very good, especially on the south sides of the fjords, and evidence of glaciation is almost everywhere apparent, though the amount of drift is not excessive.

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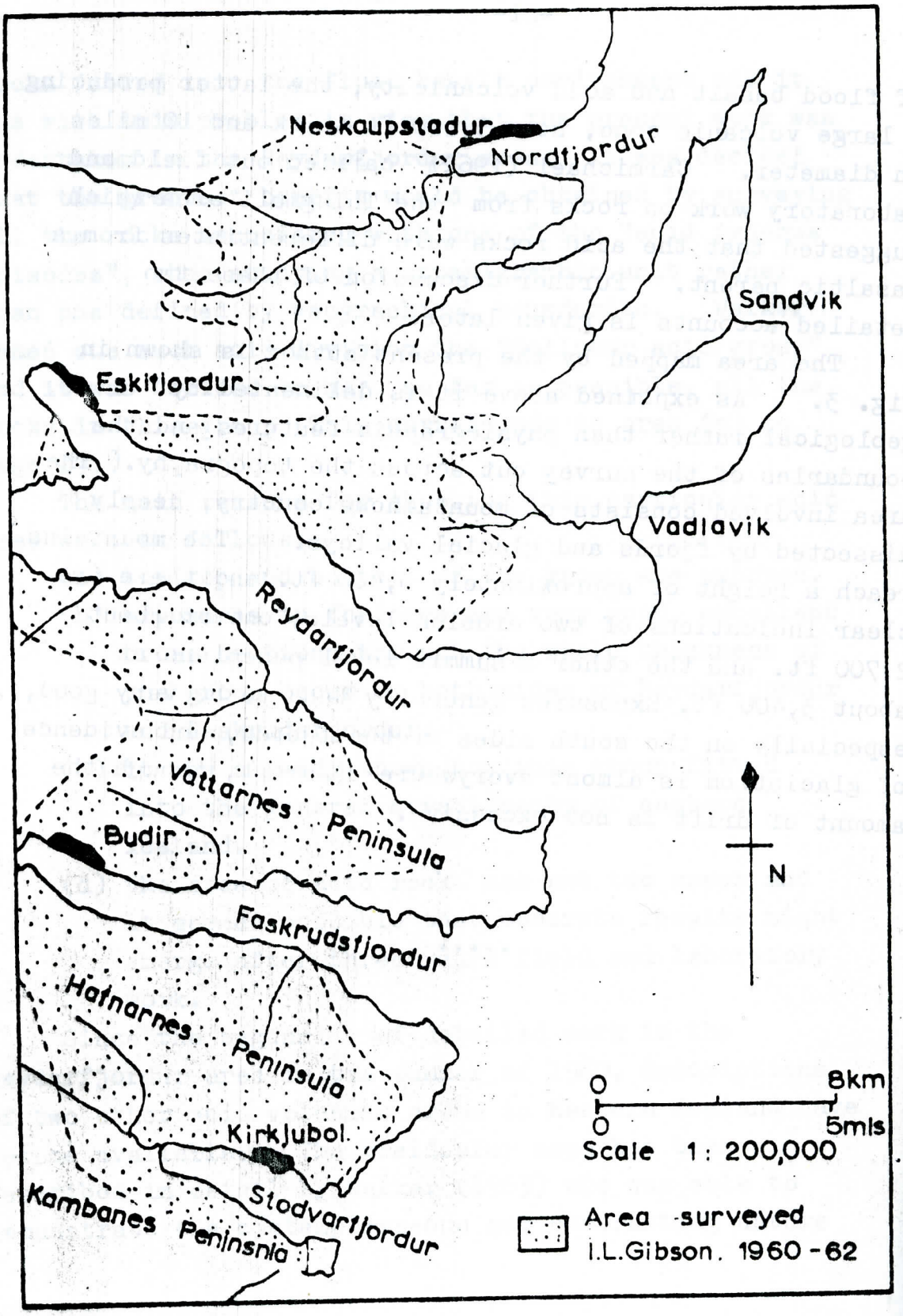
Neskaupstadur
Nordfjordur
Sandvik
Eskifjordur
Vadlavik
Reydarfjordur
Vattarnes Peninsula
Budir
Faskrudsfjordur
Hafnarnes Peninsula
Kirkjubol
Stodvarfjordur
Kambanes Peninsula
N
0 8km
0 5mls
Scale 1: 200,000
Area surveyed
I.L.Gibson. 1960-62

Fig. 3.