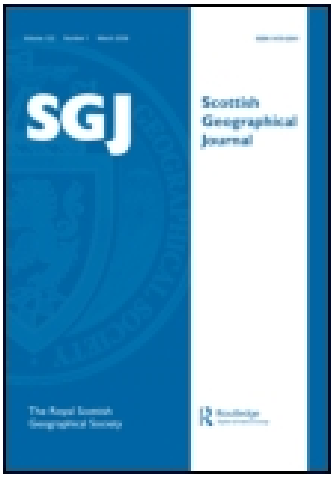

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The physical geography of Iceland

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THE PHYSICAL GEOGRAPHY OF ICELAND.[1]

UNDER the auspices of the "Carlsberg" fund of Copenhagen there is at present being published a monograph on the botany of Iceland. Section 2 (1) of Part I. describes the physical geography of the island with the special purpose of exhibiting the main features of plant distribution. This task has been entrusted to Professor Thoroddsen, himself an Icelander, who has travelled over practically the whole country, and who has acquired a knowledge of it unequalled and indeed unapproached by any one else. His geological and topographical maps attain a very high standard, and his whole work is a striking example of what can be done with far from unlimited resources by one imbued with patriotic zeal.

The pamphlet—it is really a book though bound in brown paper—consists of 152 pages. Chapter I. deals with general topography, glaciers, the snow-line, rivers, lakes, geology, and volcanoes and lava-streams. The next discusses conditions pertaining to surface and soil. Then follows a description of the climate. In the fourth and fifth chapters we have an account of the general distribution of the plant life, and a sketch of the chief plant formations. The whole is illustrated by 27 photographs, a diagram, and 8 maps. Unfortunately there is no index, and no table of illustrations. We should like to have seen a large map of Iceland, but possibly this is added to one of the other volumes.

The area of Iceland is about one-fourth greater than that of Ireland. The island forms a dissected plateau with an average height of about 3000 feet above sea-level. Rather less than one-fifteenth of the country is lowland. More than two-thirds are so lofty as to be desert, and with very few exceptions only the coastal fringe and the lower courses of the rivers are inhabited. The west, north, and east coasts are much broken up by fiord-like inlets and bays; the south coast is almost featureless. Dr. Thoroddsen mentions that the huge streams from the snowfields have filled up the fiords and created dangerous shallows along the shore, but he does not refer to the lofty cliffs south-west of the Vatna Jökull and ten miles inland, which indicate a certain amount of crustal movement.

The account of the jökulls or snowfields or glaciers—for the word is applied indiscriminately to both—is all too short. In a tabular statement 23 snowfields are given from which descend 142 glaciers, the whole covering 5000 square miles, or one-eighth of the island. The largest is the Vatna Jökull in the south-east, where precipitation is greatest. Of the snowfields three are more than 500 square miles in area; many are quite small, the tiniest being less than half a square mile. Both Arctic and Alpine types of glaciers occur, but much work remains to be done in regard to these. Even the author has examined

[1] *The Botany of Iceland.* Edited by L. Kolderup Rosenvinge, Ph.D.; and Eug. Warming, Ph.D., Sc.D. Part I. 2. An Account of the Physical Geography of Iceland, with special reference to the Plant Life. By Th. Thoroddsen, Professor, Ph.D. (Published by the Aid of the Carlsberg Fund.) Copenhagen: J. Frimodt. London: John Wheldon and Co., 1914.

only the fringes of the Vatna Jökull, and very few measurements of the rate of glacier movement have been made. The height of the snow-line varies from about 1300 feet on the north-west peninsula to more than 4300 feet on the north side of the Vatna Jökull. A glacier on the south side of the latter—the Breithamerkur, we think—ends only 30 feet above sea-level.

Iceland contains many rivers whose volume is out of all proportion to their length. They are classified as mountain or clear streams and glacier or milky streams, the latter being much the larger. Very few bridges exist, and the rivers are crossed by fording, most of them being much too swift to permit of ferries. The position of a ford frequently changes from day to day, and a party crossing usually calls upon the services of a local expert as guide. Fortunately the island ponies are very sure-footed, and if left alone will faithfully follow their leader. It is truly remarkable what they will carry. On one occasion I saw in a remote region an American organ, and was informed that it had been conveyed for many miles slung between two of these ponies. The destructive action of the rivers is very great. South of the Vatna Jökull the low land has been largely covered with gravel and rendered quite unproductive.

Lakes are numerous in Iceland. The best known are the famous Thingvallavatn, formed by subsidence connected with geologically recent volcanic activity, and Mývatn, also in a volcanic region, but merely occupying a depression in the lava. The latter, from the abundance of wildfowl which frequent it, is a great resort of sportsmen; the former is intimately associated with the history of the people. Some of the snowfields have glacier-lakes on their margin, Graenalón at the edge of the Vatna Jökull resembling the Märjelen See. In most of the lakes and rivers salmon and trout fishing is of great importance, large sums being realised by letting the waters to foreign anglers.

The geology of Iceland is comparatively simple. In Tertiary times a row of volcanoes extended from Antrim by way of the Hebrides, the Faröes, and Iceland to Greenland. In mid-Tertiary times portions of this land-mass subsided, leaving things pretty much as they are now. The non-volcanic rocks of Iceland are insignificant, the most important being the product of the Glacial Epoch. Basalt is the commonest rock. It exists in layers, the result of successive flows, and beautiful columns are not uncommon. The famous Iceland spar, the only mineral of economic value, occurs in vesicular cavities. In some places lignite and remains of tree trunks are found embedded in clay and tuff. This points to the destruction of forests by lava-streams and pumice-eruptions. O. Heer states that in early Tertiary times the average annual temperature of the island was at least 50° Fahr., nearly 20° above the present mean. Oaks, pines, elms, and alder abounded—a great contrast to the existing "forests" of birch and willow.

Iceland is the home of volcanoes. In historic times 138 eruptions from 30 volcanoes have been recorded, but no fewer than 130 post-Glacial volcanoes are known. The most famous is Hekla, which has broken out 21 times in a thousand years. Enormous lava-fields extend

from it. From them sand is blown by the wind, overwhelming the grass-land. Owing to the foolish destruction by the inhabitants of a protecting belt of coppice, the sand is gradually advancing west of Hekla with most devastating effects. Volcanoes occasionally break out from under the snowfields. Huge quantities of ice are thus instantaneously melted, the water rushes down upon the lowland, and large areas are laid waste. The dust and scoriæ ejected have a deleterious effect upon vegetation, cattle and sheep die from eating it, and famine follows. After the terrible outbreak of the Laki crater-rows in 1783, apart from the live-stock and people directly killed, there died 11,500 cattle, 28,000 ponies, and 190,500 sheep. The resulting famine killed 9500 of the inhabitants, about one-fifth of the whole population at that time.

Violent earthquakes frequently occur in well-defined areas, some connected with volcanoes, others with lines of weakness. The worst in modern times took place in 1784 and 1886. As a rule the range of the shocks is small.

No account of Iceland would be complete without a reference to the hot springs. At present 677 are known. The great majority contain hot or boiling water, but only a few are spouting springs. The Great Geyser, 70 miles north-east of Reykiavik, is now in its old age, and often remains quiet for days together. Its neighbour, Strokkur, which used to respond to doses of turf or soap, was destroyed by the earthquake in 1896. Sulphur springs occur in several localities, but always in connection with the palagonite formation. Owing to scarcity of labour and lack of transport facilities, the export of sulphur, which was important from the thirteenth to the sixteenth centuries, and which has occasionally been spasmodically revived in recent times, has now entirely ceased. Alkaline springs are common in the basalt districts, but are not economically important.

The remaining portion of the monograph, devoted largely to plant distribution, is of much interest, not only in itself but as an aid to comparison with similar regions elsewhere, but we have space only for one or two outstanding points. The first is that we have now what seems to be a complete explanation of the mounds which have puzzled every traveller. They are commonest round the farms; that is exactly where one would not expect to see them, for they greatly hinder the cutting of the grass. The whole surface is composed of hummocks, usually oval in shape, 3 to 6 feet long and a foot or so high, with very narrow channels between. Professor Thoroddsen considers that they are caused by the phenomena of freezing and thawing which take place in spring, together with the presence of underground ice and the surface cracking which occurs in clay soils. If the soil is sand or gravel resulting in good drainage, or if the surface covering of snow remain well into the spring, then hummocks will not appear. But even if the farmers remove them in the case of clay soils, unless drainage operations be also undertaken, they will reappear in a short time.

The statistics of the upper limits of the various classes of vegetation are very complete and the comments illuminating. It would be most instructive to have these results plotted upon a map, and to compare it

with another map showing the distribution of population. In conclusion, we offer our hearty congratulations to the producers on this happy combination of Danish enterprise with Icelandic knowledge and devotion.

T. S. MUIR.

THE RELATIVE DISTRIBUTION OF FIORDS AND VOLCANOES.[1]

By Professor J. W. GREGORY, F.R.S., D.Sc.

(With Diagrams.)

The Tectonic and Erosion Theories of Valley Formation.—The question whether valleys are due to erosion or to earth movements has given rise to long controversy which, a generation ago, ended in the defeat of the advocates of the tectonic origin of valleys. Their failure to establish their case was probably due to the fact that they claimed too much. Both schools were right in part.

Valleys may be divided into three groups. The first group includes those in which eroding and tectonic agencies have co-operated, the forces of erosion having acted along lines of weakness due to fractures and joints. Such "joint-controlled drainage" is well known in most parts of the world. Such valleys have been wholly excavated by rivers; the structure of the country has only determined the lines along which the rivers have worked. Such valleys are due to erosion; and their attribution to the direct action of tectonic agencies prejudiced the claim for the tectonic origin of others.

The second group includes valleys due solely to excavation along lines due to the slope of the ground and the grain of the country. Earth movements have only affected these valleys by determining the slope of the ground.

The third group of valleys includes those due primarily to earth movements, which caused fissures or depressions that captured the drainage. The rivers may have widened their valleys so as to have destroyed the former walls and buried all traces of the original fracture or fractures; yet the valleys are of tectonic origin, though in time a valley due to denudation may cover the site of the earlier tectonic valley. The existence of tectonic valleys is now generally admitted. The Great Rift Valley of East Africa and the Red Sea, part of the Rhine Valley, and the middle part of the Hoang-ho in China are well-known examples. According to Mr. Bailey Willis the middle Hoang-ho "is a stream occupying a depression produced by normal faulting. It has taken possession of a channel, but has not made one." Those who, like Kinahan in this country, advocated the tectonic origin of valleys were therefore right in part. Their failure was due to their having applied

[1] Based on a lecture given to the Royal Institution, 30th May 1914. References and maps are given in the author's book, *The Nature and Origin of Fiords*, 1914, pp. xvi + 542.