1906

THE GRAG OF ICELAND

UM NOKKRA NÝJA FUNDARSTAÐI SKELJA Í JARÐLÖGUM Á ÍSLANDI

H.P.

Quart Journ Geol. Soc. Vol. LXII 1906

The CRAG *of* ICELAND—*an* INTERCALATION *in the* BASALT-FORMATION.

By Dr. HELGI PJETURSSON. (Communicated by Prof. W. W. WATTS, M.A., M.Sc., F.R.S., Sec.G.S.)

THE existence of fossiliferous deposits on the western coast of Tjörnes (Northern Iceland) has been known to science for nearly 160 years. They were first mentioned by the famous Eggert Olafsson in his book entitled 'Enarrationes historicæ de Islandiæ Natura & Constitutione,' etc., published at Copenhagen in 1749.

In 1871 the Danish conchologist O. A. L. Mörch published a paper 'On the Mollusca of the Crag-formation of Iceland,'[1] wherein he enumerated 61 species of molluscs, and arrived at the conclusion that in the Crag-period the temperature of the northern coast of Iceland must have been much milder than now, 'at least as at present on the west coast by Reikiavik' [Reykjavik], *op. cit.* p. 394.

Some years later, Mr. J. Starkie Gardner collected 33 species of Pliocene molluscs in Iceland, which were studied by Gwyn Jeffreys and Searles V. Wood. In the opinion of Wood, the deposits in question cannot be younger than Middle Red Crag, while Jeffreys thinks that they are somewhat younger. Gardner himself is, however (Quart. Journ. Geol. Soc. vol. xli, 1885, p. 97),

> 'inclined to assign a greater age to the deposit from its general appearance on the spot, than Dr. Gwyn Jeffreys may do, or even than Mr. Searles Wood.'

The most important paper in existence on the fauna of the Icelandic Crag dates from 1884, but only exists in a manuscript, which has been deposited in the archives of the Geological Museum of Copenhagen. It is written by C. M. Poulsen, and is in part founded on the investigations of Mörch. Poulsen, in this MS.—which was kindly lent to me for perusal by Prof. Ussing,—enumerates 117 species of molluscs from the Crag of Tjörnes; out of this number 20 species are new, while of the remaining 97 species 18 per cent. are extinct. Poulsen's somewhat startling conclusion is, that the Crag of Iceland is younger than even the youngest division of the English Crag.

It seems not improbable that the 117 species of molluscs recorded from Tjörnes in 1884 constitute a mixture of different faunas, and possibly the Icelandic Pliocene deposits, which, indeed, are very much thicker than has been generally assumed, fall into several divisions.

Thus Gardner and Poulsen may both of them be in part right. Looking at the percentage of extinct species, it seems not improbable that a portion of the Pliocene fauna of Tjörnes may go farther back

[1] Geol. Mag. vol. viii, p. 391.

than the Red Crag, while, on the other hand, a consideration of the number of Arctic forms makes us believe that perhaps the palæontological evidence of Tjörnes may lead up to the opening scenes of the Pleistocene.

As to the position of the Crag in the Icelandic rock-succession, Prof. Th. Thoroddsen thinks that the Pliocene beds are of later date than the eastern higher part of Tjörnes, which, according to that author, constitutes a projecting remnant of the old basalts ('horst') against which the Pliocene strata are resting.[1] According to Prof. Thoroddsen, the Icelandic Crag 'points to a level of the sea some 150 or 200 feet higher than the existing level.'[2]

The Crag-formation extends along the western coast of Tjörnes for more than 3 miles, forming a fine cliff up to 200 feet in height.

A glance at a topographical map of Iceland will at once show, by the existence of a comparatively-broad bay, what part of the Tjörnes coast is built up by the Pliocene deposits.[3]

It is not my intention here to enter upon a description of the Icelandic Crag, but only to mention a cardinal fact concerning it which has been too long overlooked. Following the Pliocene beds away from the coast up along the stream-courses, we find that, at a height of about 500 feet above the sea, they are overlain by the eastern basalts. The superposition of the basalts upon the fossiliferous series is very clearly seen, and at the contact the underlying sediments are indurated and otherwise altered. We thus find that, far from resting against an older Tertiary 'horst,' the Crag of Tjörnes is older than the eastern basalts, which in Búrfell—part of a denuded Pleistocene volcano—attain a height of 2500 feet.[4]

The Crag of Iceland, then, is a fossiliferous intercalation—exceeding in thickness 500 feet—in the basalt-formation, or rather between the two basalt-formations of Iceland, the Tertiary and the Pleistocene, which are separated by a great gap. Harmonizing with this, we find intercalated among the eastern basalts of Tjörnes indurated ground-moraines with striated stones.

As the majority of naturalists who have visited Iceland have examined the Crag of Tjörnes, it may seem almost incredible that the above-mentioned most important fact for the geology of the country should have remained so long undiscovered. This is, however, easily understood; no one ever doubted the Tertiary age of the rocks that build up the eastern, higher part of Tjörnes; and so investigators spent all the time at their disposal in studying the fine sea-cliff—as, indeed, was the case with myself, on my first visit to Tjörnes.

[1] 'Islandske Fjorde og Bugter' Geograf. Tidsskr. vol. xvi (1901) p. 67.

[2] 'Explorations in Iceland, etc.' Geograph. Journ. vol. xiii (1899) p. 34 sep. cop.

[3] [This has not, however, been remarked by Prof. Thoroddsen, whose map gives a very incorrect idea of the area occupied by the Crag.]

[4] See H. Pjetursson, 'Om Islands Geologi' Copenhagen, 1905, p. 44.

That there is a great unconformity between the two basalt-formations of Iceland is very well seen on the north side of Snæfellsnes (Western Iceland). Here the Pleistocene basalts, together with sedimentary intercalations in the lofty and precipitous Kirkju Fell, have a thickness of more than 1100 feet. The basal part of the fell is built up of decayed basalts, and cut by thick dykes which terminate against the base of the Pleistocene Series. In Stöð and the headland of Búlandshöfði we also find the basal parts cut by thick basalt-dykes; while thinner dykes, having another trend, traverse the Pleistocene formation to the top. In the two last-named localities the basal layer of the Pleistocene Series is fossiliferous, and has, in Búlandshöfði, yielded twenty-two species of mollusca, twenty of which (*teste* Ad. S. Jensen) represent a highly-Arctic fauna (with *Yoldia arctica*), such as at the present day is found living along the coasts of Spitsbergen.

It is a remarkable fact, looking at the very considerable thickness of the Crag of Tjörnes, that nowhere else in Iceland has there been found any trace of such Pliocene deposits. And yet the Pliocene sinking of the land can hardly be supposed to have been confined to the comparatively-limited area which is now Tjörnes.

We shall understand this fact, if we assume that the coast-line of Iceland has receded greatly since Pliocene times—as, indeed, in part can be demonstrated—so that a fringe of Pliocene deposits may have been abraded everywhere, except in a firth cutting exceptionally deep into the country.

Pliocene times would seem to have been, in Iceland, a period of—at any rate comparative—quiescence from vulcanicity. Volcanic accumulation was probably succeeded by subsidence, erosion, and sedimentation. Towards the close of the Pliocene, or at the beginning of the Pleistocene Period, there followed a revival of volcanic energy, which resulted in the building-up of the Pleistocene basalt-formation—a part of which is the palagonite—or 'tuff- and breccia-formation' of the older geologists.

Thus the Pliocene of Tjörnes affords most important complementary evidence as to the age of the much-discussed palagonite-formation. But, even from a more general point of view, the richly-fossiliferous Icelandic Crag is, in my opinion, eminently worthy of the attention of geologists.

I will conclude with the expression of the wish that Science may not have to wait another 20 years for further contributions to the knowledge of the interesting Pliocene fauna of Iceland.

Discussion.

The President referred to this remarkable evidence of the continuity of volcanic activity in Iceland throughout a long interval of geological time. The oldest basalts of that island no doubt dated from some early Tertiary period like those of our own Western Isles. The Crag-deposits noticed in the present paper, as intercalated among the volcanic sheets, furnished interesting and important

evidence of the persistence of the same type of eruptions in later Tertiary time. The occurrence of Glacial deposits between still younger lavas indicated that such eruptions continued during the Ice-Age, while the modern history of Iceland showed that the volcanic activity has persisted up to the present time. Notwithstanding the published writings and the excellent map of Prof. Thoroddsen, and the labours of the Author of the present paper as well as of other observers, much remained to be made known as to the details of this vastly-protracted volcanic history; and all interested in this department of geology must indulge the hope that the subject may be more fully illustrated before many years pass away.

Prof. Sollas remarked that the addition of 500 feet,[1] made to the sedimentary series by the discoveries of the Author, involved an addition of 50,000 years to the age of the earth, as calculated from the thickness of the stratified deposits.

[1] [The thickness of the sedimentary series considerably exceeds 500 feet.—*H. P., August 1906.*]