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1905.

ORDINARY GENERAL MEETING.*

MR. W. H. HUDLESTON, V.P., F.R.S., IN THE CHAIR.

The following election was announced :—

MEMBER :— Richard Bangay, Esq., M.D.

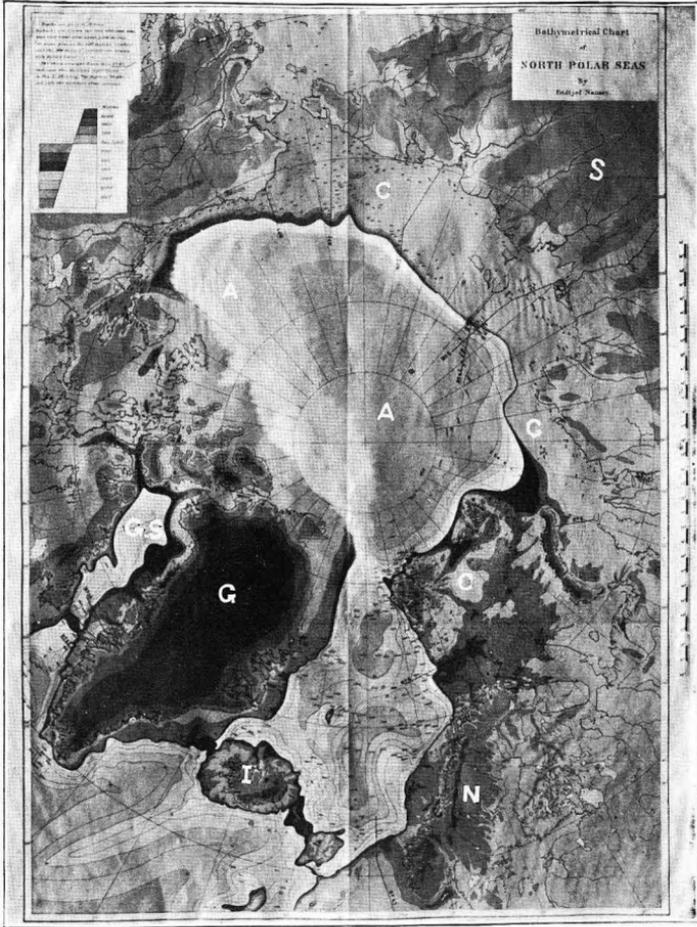
The CHAIRMAN then called on the Secretary, Professor HULL, F.R.S., to read his communication.

*ON DR. NANSEN'S BATHYMETRICAL RESEARCHES
IN THE ARCTIC OCEAN AS COMPARED WITH
THOSE ON THE ATLANTIC COAST OF EUROPE.*
By Professor E. HULL, LL.D., F.R.S., Secretary.

Professor HULL.—Mr. Chairman, ladies and gentlemen, I must ask your indulgence if I am not in very good condition for the address which I am about to give, because I am only just recovering from rather a troublesome and weakening malady. But I have also to explain why it is I address you at all this evening. On the programme for the Session a paper by Dr. Peebles of America was down, on a most important subject, that of *Immortality*, and Dr. Peebles intimated that he intended to be present to read it. We waited until the last day on which it was necessary to send out notices of the paper, for the paper of Dr. Peebles, but neither the paper or its author arrived until to-day. I believe Dr. Peebles is here, and I am sure as an old and respected Member of the Institute, we all welcome him from across the Atlantic. (Applause.) However, I had to fill the gap; and having had the pleasure of

* Monday, April 3rd, 1905.

MAP OF THE NORTH POLAR OCEAN AND BORDERING LANDS WITH THE CONTINENTAL PLATFORM INTERVENING.



- A. Arctic Ocean.
- C. Continental shelf with steep outer margin breaking off into the abyssal ocean.
- G. Greenland.
- I. Iceland.
- S. Siberia with rivers entering the sea.
- N. Norway.
- G. S. Greenland Sea.

listening to Dr. Nansen at the meeting of the Royal Geographical Society on Tuesday last, and hearing the statement of his discoveries in the Arctic Ocean and along the coast of Norway, it occurred to me that it might be interesting to you if I was to give you (in brief) some account of these discoveries in connection with those which we ourselves have already considered at the meetings of the Institute. I have therefore prepared this communication, which is entirely extempore, and which will be illustrated to a certain extent by lantern slides.

1. *The Atlantic border.*—Now for those present who have not previously had an opportunity of investigating the sub-oceanic physical features of the Atlantic, and the North Sea and Arctic Ocean, I have just drawn here on the board an outline of what these physical features are, in cross sections. They are really very simple in detail. They consist first of the sea margin of the Atlantic; then of a platform, the margin of which has generally a steep descent into the abysmal ocean; this is called "*the Continental Platform,*" on which the continent of Europe and the British Islands and Norway are practically built. This great platform extends along the sea coast and westward to Greenland, and southward along the coast of Europe and Africa. Then we come to the outer margin of the continental platform, where the descent of the sea-bed down into the abysmal ocean, to a depth perhaps of 6,000 or 7,000 feet below the present surface, becomes steep and abrupt. But when we come to Norway we find there, according to Dr. Nansen's views, instead of having one platform coming out from the coast, there are really two; one being "*the coast platform,*" which is just a little above or below the actual level of the sea, and which contains principally all the little islands which lie off the coast of Norway, between which and the coast cruisers and yachts can sail in smooth water, while outside there may be a stormy sea. This is the "*coast platform,*" which is different from the continental platform, and probably of more recent origin. The continental platform has been recognised by the soundings as far south as the Congo and on northward into the borders of Europe.

Then, we come to the coast of Europe; here we have most beautifully defined river valleys, as for example that of the Tagus, coming down across the platform, and with their channels descending to about 6,000 feet below the level of the ocean.

Then, the Adour, which also, according to my investigations, certainly comes down to a similar depth, about 6,000 feet. Dr. Nansen in his work on the Polar ocean (vol. iv) when describing the Adour river valley, says: "it is almost impossible to give any other explanation of its existence than that of a former river valley at a time when the whole region was elevated into land." This, you will admit, is very valuable testimony.

Then we proceed northwards and find that the channels of several of the rivers entering the ocean from Spain and France are also continued out into the ocean across the platform, and descend almost to a similar depth as the base of the platform itself.

Similar is the case with the British Isles. In the case of one of the old river valleys, we have an illustration of a submerged valley in the English Channel; and it is remarkably determined and represented on the Admiralty Chart under the term of the "Hurd Deep." It is 60 miles in length, running up the channel parallel to the coasts, along the centre between the coasts, and it terminates towards the Straits of Dover, gradually dying out where we may suppose the river had its origin; it also dies out towards the western margin of the continental platform, doubtless owing to silting. The floor of the English Channel itself, and of the Irish Channel, are only parts of the great submerged plain of the continental platform; but this is a river valley cut out and left open to the present day, so that the Admiralty surveyors have marked it as the Hurd Deep, after the name of the naval officer who carried out the soundings whereby the river valley was discovered.

2. *The Arctic Ocean.*—Nansen's great discovery, partly from actual soundings, partly by inference based thereon, is the occurrence of a profound Arctic basin which, unless abruptly terminated by the uprising of a mountain mass several thousand feet in height from its floor under the pole, of which there is no evidence, necessarily extends under the pole itself. (See Plate.) This view is strongly supported by Professor Spencer in an able paper which has opportunely reached my hands* in which the whole question is discussed—and which is illustrated by an excellent little map of the Arctic regions. In this map, which is to some extent based on that of Nansen, in his great work,† but also on original researches, it is shown how the continental platform

* No. 11 in the list of papers appended to this essay.

† *Bathymetrical Features of the North Polar Sea*, Christiania, 1904.

is in all probability carried right round the whole of the great polar basin from the coast of Norway, by Spitzbergen, Franz Joseph Land, the New Siberian Islands, the coast of Alaska, Prince Patrick and other Polar islands; then off Banks Land, by the north coast of Greenland and onwards by Iceland to the North Sea and the Scandinavian coast from which we started. On this platform or continental girdle, which seldom exceeds 600 feet in depth from the surface at its outer margin, are planted all the groups of Arctic and sub-Arctic islands, including Iceland, Spitzbergen, Franz Joseph, Nova Zemlia, New Siberia, those between Beaufort Sea and Baffin's Bay, and the British Islands themselves. The breadth of the platform is greatest between Spitzbergen and the Scandinavian coast, here inclosing the Barents sea; and off the coast of Siberia the average breadth is about 500 miles. On the other hand, off the coast of Spitzbergen and apparently adjacent to Franz Joseph Archipelago the shelf has a breadth of only about 30 miles; and is a little over 60 to 100 miles off the Archipelago of the Greenland sea, as far as can be conjectured from the few soundings available. But all the soundings made by Nansen and previous explorers go to show, that on reaching the outer margin of the shelf, the land descends rapidly to depths of about 6,000 to 7,000 feet and more. As is well known, Nansen's *Farthest North* was reached on the 7th April, 1895, in lat. $86^{\circ} 13' 6''$ where the depth of the ocean reaches 3,000 mètres (9,780 feet) a depth which may be presumed to extend to the pole itself;—much too near to allow of the uprise of land of 10,000 feet in height within so short a distance.

On this subject we have an interesting statement from Professor Spencer, in which he says, "I was in northern Norway when the Ziegler expedition sailed, and hearing of their expectation of finding polar land, I felt that disappointment was in store for them; for Dr. Nansen's great discovery of a profound Arctic basin, immediately beyond the border of the continental shelf, precluded the probability of finding land between Franz Joseph land and the pole, or indeed along this line for a thousand miles beyond." The members of this expedition were doubtless unacquainted with the physical conditions of the Arctic region as now brought to light by the restoration of the old marginal land indicated by the continental platform and its deep basin adjoining.

It now only remains to observe that these Arctic sub-oceanic features resemble those of the coasts of Europe and America in being intersected by the channels of former rivers crossing

the platform from the present lands seawards, and deeply indenting the continental slope. Of these important features, Nansen gives numerous instances; the Barents Sea and the platform off the coast of Siberia afford numerous examples. From all of which we learn, that the platform itself was formerly a land surface traversed by rivers draining out into the Arctic Ocean, and sometimes continuous with the streams which drain the adjoining lands of the present day. The discovery of such "drowned river-valleys" within the Arctic circle, as also along both borders of the Atlantic Ocean, when fully grasped in all their significance, cannot fail to convince us of the great changes which the crust of our globe and the enveloping hydrosphere have undergone within recent post-Tertiary times.

DISCUSSION.

Mr. HUDLESTON (CHAIRMAN).—I do not need to introduce Professor Hull to you. We are very much obliged to him for the interesting representation of these remarkable oceanic phenomena. I daresay that some of us remember the various papers we have had on these phenomena from the same author; but it is extremely interesting to me to be reminded of the existence of these features; and Professor Hull's object is to group all the features, all the sub-oceanic features, almost from the Equator to the Pole, as far as those features are known, and more especially on the eastern side of the Atlantic basin. It is in consequence of Dr. Nansen's visit to this country that Professor Hull has thought it desirable to reopen this subject, and it is a very useful opportunity for those who have not heard Nansen himself to have some idea of what he has been about of late.

Now I think that perhaps I might read one or two extracts from Nansen's remarks before inviting discussion upon the paper. It is the oscillation of the shore line which is the crux of the entire problem, and the amount of oscillation differs according to different views.

"It seems to be the common opinion that the continental coasts have been depressed at places and at other places elevated. I believe a thorough investigation must prove that this view is not correct. There are evidences that the mean level of the continental shore line has been very nearly the same for a long period.

"The coastal platform is a very characteristic feature, across the whole of the Norwegian coast, forming a belt of low islands. The coastal platform is situated about 100 mètres below present sea level and 100 mètres above . . .

"Its surface is nearly horizontal. It is a fact that a similar coast platform does not seem to exist along the coast of Finland. There it seems to be represented by raised terraces. Along the west coast of Scotland there is an imperfect coast platform.

"The continental shelf along the Norwegian coast varies greatly as to depth and width. It is in some places high and narrow, lying at a mean depth of 200-300 feet, while at other places it is very broad and deep, lying between 700-900 feet below sea level. The shelf must therefore have been in solid rock. . . ."

All these evidences prove that the shelf must be built up of rock and have only been cut by erosion. They are evidently built up by coastal deposition of waste.

(Other extracts read in full.)

Professor LOBLEY, F.G.S.—We owe our gratitude to the author for his interesting remarks. It is a question that he has paid great attention to for many years, and he has brought before the Institute several very interesting papers on the subject of submerged river valleys. The Chairman has also read some very interesting extracts from Nansen's writings, but it seems to me that Professor Hull's point of view is quite different from that of Nansen. Nansen in his statement dwells principally on the coastal platform and the continental platform. Professor Hull principally dwells upon the submerged valleys across these platforms, which Dr. Nansen does not refer to in the passages quoted.*

* Professor Loble only refers to the passages above quoted, but Nansen, in his work, repeatedly points to the existence of deep river channels crossing the continental platform below the surface of the Arctic Ocean.—E. H.

The deduction that Professor Hull draws from these submerged valleys is that there has been an enormous oscillation of the vast oceanic margins in comparatively recent glacial periods. If the valleys descend to 7,000 feet that would seem to indicate that the adjacent lands have been 7,000 feet higher than they are at the present time to give time and conditions for the surface denudation to produce these river valleys. That would raise the Pyrenees region and the whole of the Western Europe to a height a long way above the snow line; and that being so there would be glacial conditions existing over a vast area of the western portion of the European and African continents; and that might be recognised as the cause of the "glacial period." It would seem to be the most important part of the deduction that Professor Hull seems to draw from his examination of the sea bottom of the western coast of our Continent, and it would appear to be the point of greatest interest in this communication.

Mr. HOWARD.—I venture to express the interest which I feel in these investigations, because it is impossible these river valleys should be there without some cause. It is inconceivable that any modern current should cut in that way. It must be either the result of water or ice, more probably, I would venture to suggest, of glaciation, more like the cut of glaciers. That would entirely agree with the idea of an enormous elevation. If the mountains were all that number of thousand feet high it would involve the glacial period; but there has been a very great change of elevation within a comparatively short period of time. The difference of elevation has taken place within a comparatively short period of geological time.

APPENDIX.

Professor Spencer in his essay (No. 11 of the list below) has given a most useful list of papers dealing with the subject of sub-oceanic phenomena on the American side of the globe; and with the object of showing what has been written on the same subject on the European side, the following list, which though not quite complete, will assist in providing investigators interested in the references.

- (1) "Investigations regarding the Submerged Terraces and River Valleys bordering the British Isles," by Professor E. Hull, F.R.S. (with map). *Trans. Victoria Institute*, vol. xxx.
- (2) "Sub-Oceanic Terraces and River-Valleys off the Coast of Western Europe" (with three plates), by the same author. *Ibid.* vol. xxxi.
- (3) "Another possible cause of the Glacial Epoch" (with map), by the same author. *Ibid.* vol. xxxi.
- (4) "The Sub-Oceanic Depression known as 'La Fosse de Cap Breton,'" by Professor Lobley. *Ibid.* vol. xxxiii.
- (5) "Deep Sea Soundings in connection with Submarine Telegraphy," by Mr. Edward Stallibrass, F.R.G.S. *Jour. Soc. Teleg. Engineers.*, vol. xvi, p. 479.

In this paper the author describes the Sub-Oceanic channel of the Congo down to the 1,000-fathom contour, giving the length of the channel as 100 miles.

- (6) On the same subject:—"The Sub-Oceanic River-Valleys of the West African Continent, and of the Mediterranean Basin" (with map), by Professor E. Hull, F.R.S. *Ibid.* vol. xxxii.
- (7) "The Physical History of the Norwegian Fjords," by the same author. *Ibid.* vol. xxxiv.
- (8) "Submerged Platform of Western Europe." *Geol. Mag.*, Lond., vol. vi, pp. 16-18 (1899).
- (9) "Professor Hull's 'Sub-Oceanic Terraces and River-Valleys off the coast of Europe.'" A Review. *American Geologist*, vol. xxxv, March (1905). By Professor J. W. Spencer, Ph.D.
- (10) "Dr. Fridtjof Nansen's Researches into the Bathymetrical Features of the North Polar Seas." A Review, by Professor E. Hull, F.R.S. *Geol. Mag.*, Decade V., vol. i, No. 482, 1904.
- (11) Review of the same by Professor J. W. Spencer. *The American Geologist*, vol. xxxv, April, 1905.
- (12) "On the Physiographic Improbability of Land at the North Pole," by Professor J. W. Spencer. *American Journal of Science*, vol. xix, May, 1905.