The inland ice of Greenland

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To cite this article: H. Rink (1889) The inland ice of Greenland , Scottish Geographical Magazine, 5:1, 18-28, DOI: [10.1080/00369228908732340](https://doi.org/10.1080/00369228908732340)

To link to this article: <http://dx.doi.org/10.1080/00369228908732340>

Published online: 27 Feb 2008.

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of labourers, however, there is one whose name is of historical interest. They come from a district tributary to China, on the extreme north of the Shan country, on the upper waters of the Salwin, and are considered good and hardy labourers, and likely to be employed by us on public works in Upper Burma. They are called by the Laos "Thai Yai," *apropos* of which name it may not be out of place to say a few words in explanation of the various names Thai, Shans, Ngios, Laos, and Siamese, which are applied, sometimes in a confusing manner, to the different branches of the race which occupies the greater part of the Indo-Chinese peninsula. All these branches, we believe, without exception apply to themselves the name Thai, which means "free;" the term "Shan" is used only by the Burmese, being apparently a Burmese, or rather Peguan, translation of Thai, and possibly a kindred word (compare Ahom=Assam, and Sam, the Assamese equivalent to Shan; also Sien-lo, the Chinese name for Siam). The Shans were formerly a powerful kingdom or confederacy; their influence, which culminated about the fourteenth or fifteenth century, extended from the country on the Upper Salwin, about 26° N., to the southern extremity of the peninsula, and was felt even in Java. The Siamese, indeed, while speaking of themselves as Thai noi, *i.e.* "little Thai," call the Shans Thai yai, *i.e.* "great Thai," perhaps from having preceded them in their supremacy over the region now known as Siam.¹ It is specially interesting to find a "Thai yai" tribe in the extreme north of the Shan region, because this was precisely the site of the headquarters of the great Shan Confederacy, known as Ko Shan Pyi, *i.e.* "the nine Shan States" (a punning version of the Indian name Kaushambi), and called Muang Mau, from the name of its most prominent member. The term *Ngio* is local, and applied to some of the northern tribes of the Salwin valley formerly subject to Burma, and now semi-independent. The term *Lao* is applied by the Siamese to the Shans, who are under their sovereignty, but the latter do not use, and according to Mr. Archer, do not like the term, and apply it only to the "white-bellied" (*i.e.* not tattooed) inhabitants of the basin of the Me Khong, to the east of Müang Nan.

C. T.

THE INLAND ICE OF GREENLAND.²

FROM THE LATEST DANISH INVESTIGATIONS. BY H. RINK.

(Translated from the German by W. A. Taylor.)

THE results of the scientific explorations, carried on in Greenland since 1876 by the Danish Government, at the instigation of Professor Johnstrup, have from time to time been communicated to those interested in Arctic geography through various periodicals. A general survey of the investigations that have been made, particularly with regard to the formation of glaciers and to the inland ice (by which is meant the icy

¹ See *Encycl. Brit.*, arts. "Shan" and "Siam."

² *Zeitschrift der Gesellschaft für Erdkunde zu Berlin*, vol. 23, No. 5.

covering supposed to extend all over the interior of the main-land), may be welcome at the present time, seeing that one principal branch of these inquiries may be said to have been brought to a conclusion in 1887. It will be remembered that such an extension of the land ice as described above was considered to be an established fact by most, though certainly not all, Arctic authorities. The possibility of the existence, in the interior, of valleys free from ice and of a somewhat more luxuriant vegetation has indeed been discussed up to a quite recent date. But the origin of icebergs, the question by what means masses of ice more than 1000 feet thick can find their way from the land into deep sea, has given rise to divers theories, involving also the question, whether the so-called inland ice is, after all, different in character from ordinary glaciers. The same provisional answer has been given by all the researches instituted during a survey of the most northerly trading district on the West Coast. For the question whether the outer edge of the inland ice is continuous may be looked upon as settled as regards the coast examined by our travellers—that is, up to nearly 75° N. lat. on the west and 67° N. lat. on the east. It seems almost evident that, if such be the case—if this wall of ice leaves no opening free, through which rain water can reach the sea—on this ground alone valleys free from ice below the level of the wall can hardly be conceived to exist in the southern half of Greenland. Such depressions must, at any rate, take the form of lakes.

In the first place, as regards this outer limit of the inland ice, all the members of the expeditions have more or less assisted in determining its position, for this wall was also the natural landward boundary of the territory they had to survey and explore. The travellers, who in the last eleven years have gone out to explore the coast of Greenland, of which a distinctly defined section was assigned to each expedition, and the tracts they visited, are as follows:—K. J. V. Steenstrup (naturalist), with G. Holm (naval officer), and Kornerup (naturalist), traversed the district of Julianshaab (60° – 61° N. lat.) in 1876; in 1877, with A. Jensen (naval officer), the Frederikshaab district (61° – $62\frac{1}{2}^{\circ}$ N. lat.) In 1878, Steenstrup journeyed to North Greenland, where he spent two winters. In the same year Jensen, with Kornerup and Groth (draughtsman), travelled over the Frederikshaab and Godthaab districts (62° – 64° N. lat.) In 1879 Jensen, with Kornerup and R. Hammer (naval officer), inspected the coast from 67° – $68\frac{1}{2}^{\circ}$, after which Hammer passed the winter there. The summer of 1880 found Steenstrup and Hammer in North Greenland, while G. Holm, Groth, and Petersen (naturalist) continued the exploration of the southern promontory of Greenland. In 1881, Holm, with Sylow (naturalist), visited again the country round Cape Farewell. In 1883, Hammer, Sylow, and Larsen (naval officer) traversed the coast from 67° – 70° N. lat. Holm, W. Garde (naval officer), and Knutsen and Eberlin (naturalists) undertook the journey to the East Coast, which lasted till 1885, and necessitated the establishment of winter quarters twice. Meanwhile Jensen, in 1884, followed the coast from $65\frac{1}{4}^{\circ}$ – 67° N. lat., with Rüss-Carstensen (painter), while, at the same time, a cruise of the man-of-war *Fylla* was utilised for scientific purposes. In 1885, Jensen, Ryder (naval officer) and S. Hansen (anthropologist) traversed the coast from $64\frac{1}{2}^{\circ}$ – $65\frac{1}{2}^{\circ}$ N. lat. Lastly, in 1886, Ryder, Block (naval

officer), and Ussing (naturalist) went to Upernivik ($72\frac{1}{2}^{\circ}$ - 75° N. lat.), where the first two spent the winter, and the *Fylla* visited Davis Strait a second time.

If we assume that Greenland does not extend much further towards the north-east than the coast already known, and therefore may consider its northern boundary as lying, on the whole, between the extreme known points, Cape Kane¹ ($83\frac{1}{2}^{\circ}$ N. lat.) on the west, and Cape Bismarck ($76\frac{1}{2}^{\circ}$ N. lat.) on the east, the perimeter of Greenland ice may be estimated at 3600 nautical miles, if the line be taken through the extremities of the promontories. If, however, the line be drawn through the inner extremities of the fiords, cutting off the whole outer fringe of islands and peninsulas, the length of the perimeter will amount to 3200 miles, or thereabouts. The line will then be the boundary of the region we wish to denote as the inland region, and, it may be added, that it also coincides, on the whole, with the edge of the inland ice. As many as 1400 miles, or almost the half of these 3200 miles, have been sufficiently explored by the above-named expeditions, in order to determine whether the interior is icebound along the whole extent. Where ice was not actually observed, its presence was conclusively proved, partly from the appearance of icebergs proceeding from the interior, partly by information given by the inhabitants. Besides these inquiries and the mapping of the edge of the ice, the ice itself was occasionally climbed, and the exploration carried further into the interior. To the investigations on this subject must be added those carried out contemporaneously by foreigners, namely, by Nordenskiöld in 1883, and by Peary and his Danish companion, Maigaard, in 1886; both these expeditions, as is well known, penetrated further into the interior than any former traveller had done.

The result of all these researches is that, as has indeed been generally supposed, the edge of the ice is continuous, and all hope of discovering inhabitable land within it must be abandoned. On the contrary, whenever an incursion into the interior was attempted, it was found that the surface, instead of falling and rising to form valleys, rose continuously, and grew flatter and more uniform the further the traveller advanced. The ice also was covered with snow. Our travellers also climbed the high mountains of the coast more frequently than previous explorers: everywhere the interior presented the aspect with which we are acquainted through earlier descriptions of Greenland, namely, a boundless snow-covered plateau, above which here and there a very few solitary peaks rose like islands from a sea. Owing to this appearance of the surface, an opinion was formerly held that the interior of Greenland was a uniform plateau. But now, when the same phenomena have been observed on all parts of the long coast-line of Greenland, and there is little probability of the existence of a flat uniform table-land of such extraordinary extent, the question arises whether the horizontality may not be due to a levelling down of the surface by the glacial covering. The snow must, in such case, have passed at a slight depth into ice

¹ Cape Washington lies to the north-east of Cape Kane, *vide* Greeley's Address, vol. i. p. 605.—Ed.

which has filled all the hollows of the country. This theory is in harmony with the properties of glacier ice, which, in spite of its brittleness, behaves like a viscous fluid, only that its movements are exceedingly slow. If an ordinary glacier can not only slide down over its bed like a rigid body, but also flow like a cohesive paste, it is also possible that, if it attains the necessary dimensions, or unites with other glaciers, it may, on arriving at the foot of the mountain, spread itself out over the lower terrain. In other words, the movements of the immense mantle of ice, as now more accurately determined, confirm the fact that the inland ice of Greenland may be compared to a flood descending from the watershed of the interior.

Observations all tend to prove that, in proportion as new ice is formed in the inland districts, a propulsion of the older ice towards the edge of the field takes place. The consequences of this would be a general advance of the edge towards the sea, and the spread of the ice over the coast, were it not that the heights form a barrier against the inundations of the ice in some parts, and that elsewhere the movement of the edge is very variable. As a rule, this movement is only just sufficient to make good the loss caused by the thawing of the terminal surface in the summer heat of the coast, so that the edge, though advancing and retiring periodically, maintains the same mean position. Only sharply defined sections, the offshoots which descend from the edge into the so-called ice-fiords, are subject to a movement considerable enough to overcome the effects of this thaw, so that they force their way into the sea, where their extremities are broken off and carried away. Such outlets are certainly few and at long intervals, but their local energy is so much the greater, and the notion of an inundation alone—that is, the flow of ice from the most distant regions of a large continent—can explain the production of the immense mass of ice which the ice-fiords employ in the formation of icebergs. Before we examine this phenomenon, the formation of icebergs, more closely, let us first turn our attention to the structure of the surface of the ice.

Where the edge of the ice has low open land in front of it, it presents, as a rule, the appearance of a mighty stream of lava suddenly arrested and turned rigid. Then it rises in a steep, riven, and furrowed wall. If one succeeds in surmounting this wall, one finds that the surface ascends considerably up to an average height of 2000 feet. It is almost needless to mention that, in representing this surface as a level plateau, we take no account of certain inequalities, occurring even in this first tract, and only clearly perceptible at a short distance. Here crevasses, several hundred, or perhaps even a thousand, feet deep, constantly impede the progress of the wanderer, and inspire him with awe. The bluish colour of the walls which skirt these abysses disappears into the complete darkness of the fathomless depth below. Smaller fissures may be hidden under a covering of loose snow. Others are old, their edges have fallen in, and they are partly filled up; so that it is very tiring work to cross these channels and the ridges which separate them. Other irregularities of the ground are indistinctly marked terraces, shallow pools, and, lastly, foaming brooks, which speed along their icy beds until they pour in cascades over the sides of crevasses, and disappear.

Seen from a distance, these inequalities vanish, and do not at all alter the general level aspect of the country. It is the universal rule, that the rise of the ground is continuous; the inclination may vary at different points of the coast, but towards the interior it constantly decreases, as also do the inequalities of the surface, so that at length the snow lies before the traveller on an even surface of scarcely perceptible declivity. The greatest height which has been reached in this region may be estimated at 7000 to 8000 feet. The increasing frequency of crevasses as the coast is approached is evidently due to the unevenness of the ground and to the twofold nature of ice, in which the properties of a solid mass and of a viscous fluid are combined. At the watershed far away in the interior, where the conversion of snow into glacier ice takes place, its movement is guided chiefly by the laws of fluids; but the further it progresses towards the coast the greater the pressure which the hinder parts exert as rigid bodies on those in front. The water formed on the surface, which flows into the crevasses, may also exert an influence but slightly noticeable in ordinary glaciers. It is proved that the channels in the depths of the ice, in which this water collects and flows to the sea, alter in form. It may be that the streams, being dammed up, flow into new channels, where they freeze, and considerably increase the tension of the whole mass. All the influences that act on the ice are concentrated at the ice-fjords, where the motion caused by pressure becomes so overpowering that the ice is almost entirely urged forwards as a rigid mass, and its fluid properties have no time to produce a visible effect.

Along the stretch of 1400 nautical miles, mentioned above, the sea touches descending branches of the inland ice in numerous places. As a rule the movement of these branches is so slight, that the fragments (*calf ice*) launched into the sea scarcely deserve the name of icebergs. Only twenty-five or thirty of these branches produce real icebergs, so that the land-locked bays which receive them may be termed ice-fjords. These ice-fjords also vary considerably as regards the effects produced in them. We have accordingly divided them into classes. In the first and most important only six to eight fjords must be placed. Four of these, and one belonging to the second rank, have now been carefully examined. The land-ice which descends into these fjords has the appearance of an ordinary glacier, inasmuch as it is bounded on both sides by land. But from most mountain summits it is at once apparent that it proceeds from the great "Mer de glace" in the background. The depth of the sheet of ice, which is thus forced onwards, cannot indeed be measured directly, but it must be equal to the shortest diameter of the larger icebergs. The breadth from land to land may be measured, and, lastly, the velocity has been determined for points in a transverse line, and it has been shown that the velocity is greatest in the middle, and decreases towards the sides. The velocities of the same glacier at different seasons have also been partly determined. During this work, fluctuations have been discovered, of which the nature and cause remain completely unknown. Perhaps they may be due to the alteration above mentioned in the channels within the ice.

The measurements taken prove that the middle portions of all these

glaciers, at the period of their quickest motion, have an average velocity of 51 feet in twenty-four hours, or a little over 2 feet per hour. By means of these calculations of the dimensions we may arrive at a notion of the average magnitude of the mass, which is yearly detached from each of these glaciers and floated out to sea. Placed on dry land, it would form a mountain 14,000 feet long, 13,000 feet broad, and 900, or perhaps, even 1000 feet high, and would therefore contain a volume of 170,000 millions of cubic feet.

It can scarcely be doubted, in presence of such measurements, that these ice-fiords imply the existence of large areas corresponding to the river basins of other countries, from which they draw their supplies of ice, even from the most remote parts of the interior. We must remember that no glacier ice can move at all over land without being accompanied in the course of the year by a quantity of water several times as large, and we know from experience that streams do actually flow into the fiords beneath the ice. Then it must be borne in mind that this mass of ice, 1000 feet thick, is propelled over a bottom, which has but an insignificant inclination for the bed of a solid sliding mass. Whence, then, is the power drawn which forces it onward at the rate of 2 feet per hour? We must look for it in the concentration on single points, the ice-fiords, of the combined pressures of glacier masses, starting probably in the interior at an elevation of over 10,000 feet. Attempts have been made to account for the velocity and productivity of these iceberg-forming glaciers by a great inclination of the underlying ground close to the fiords. But this is contradicted by actual experience, and, besides, the question presents itself, how the supply, thus rapidly consumed, can be replaced from the immediate vicinity of the fiord. If, however, it can be conveyed from a distance, it does not require a bed specially adapted for the purpose to glide down the last part of its course.

Granted, then, that the region required to feed an ice-fiord may be compared to a river basin proportional in extent to the country, a glance at the map will show at once, that in North Greenland it is by no means improbable that fallen snow and rain may traverse in a solid state a distance of 400 nautical miles from the furthest point before reaching the sea. Accordingly, the process of ice-formation in that country may be applied to illustrate the glacial period of geologists. The transport of erratic blocks over low-lying land of great extent and the polishing of rocky slopes which lie below a certain level, find their counterparts in the phenomena which must be produced there. In the propulsion of a mantle of ice, certainly more than 1000 feet deep, over uneven ground, the projecting points and ridges of the latter must be broken off and reduced to a powerful polishing powder. A comparison of Greenland with the other known Polar lands will at once prove that in the former country only can be found such a counterpart to the glacial period.

With regard to the way in which icebergs become detached from the solid mass—the “calving,” as it is called—different opinions have hitherto been held by experts. The reason is not so much that only one observer has been fortunate enough to witness this magnificent spectacle, but that the process varies with the locality. It is affected by the form of the

coast and the structure of the sea bottom at the spot, where the glacier happens to have found an outlet, and therefore a fixed rule cannot be laid down. This much only may be said, that, where large icebergs are produced, the block remaining whole and not crumbling up into smaller pieces on breaking loose from the glacier, the sea-bottom must be comparatively even and slope gently from the coast, until the water becomes deep enough to raise the great sheet of ice from the bottom. It then forms a connected floating pier, until some accident breaks the connection. If, however, the sea-bottom falls suddenly to a considerable depth, before the ice can be raised from the ground, the sheet of ice splits up as it falls into pieces larger or smaller, according as they receive more or less support from the water. In this case the sheet breaks more like a frozen sea, for the severance is not effected directly by the force of gravity, but, on the contrary, the smaller fragments are violently swung round, so that their edges and points are turned upwards, and overtop the edge from which they have fallen. Of course the bottom of the sea, which determines the mode in which icebergs are formed, can hardly be examined at all. But, it must also be remembered, this question is at present of secondary importance in physical geography. The first question is, How large is the total quantity of ice yearly discharged from a fiord, irrespective of the larger or smaller dimensions of the fragments?

It may be expedient to pass from these general considerations to some particular cases. Let us, then, follow the observations of the individual expeditions from east to west.

The East Coast up to $66^{\circ} 8' \text{ N. lat.}$ was traversed (1884-5) by Holm, Knutsen, Garde, and Eberlin. The two former wintered in Angmagsalik ($65^{\circ} 37' \text{ N. lat.}$), while the other two did not get much further than 63° , but between them they travelled over the coast, from this point southwards, twice backwards and forwards in the two years, and therefore had a good opportunity of noting carefully the occurrence of glaciers and icebergs. It seems, from what is known of the most northern parts of East Greenland, that north of $70^{\circ} \text{ N. lat.}$ few icebergs are produced compared to those of the West Coast. These icebergs are said to drift from this latitude southwards along the coast. According to the observations made on the *Germania* (73° - $77^{\circ} \text{ N. lat.}$), indeed, and, in particular, the reports of the well-known journey over the pack made by the shipwrecked crew of the *Hansa*, the number of glaciers increases considerably towards the south. This is especially noticeable before the entrance of Scoresby Sound (70°), which is probably an ice-fiord. The inquiries of our East Coast expedition among the natives revealed the probable existence of a large ice-fiord at 68° . Between this and Cape Farewell the expedition discovered five ice-fiorde. The icebergs get stranded one after another, and are disintegrated, few reaching Cape Farewell, and hardly any entering the open sea to the south-east. The East Coast at this part is more inhospitable and covered with ice and snow than the West Coast in the same latitudes. Only about 63° (Tingmiarmut) and $65\frac{1}{2}^{\circ}$ are there fiords having stretches of low land covered with vegetation, such as are seen on the West Coast. According to Garde, up to 63° and a little beyond, no fewer than seventy glaciers 1600 mètres (1750 yards) broad, and more than one hundred

smaller glaciers were found, all terminating in the sea, of which more than one-half were prolongations of the inland ice. Here, too, the icebergs were piled up along the coast in extraordinary numbers, the largest of them being about 260 feet high.

Steenstrup and Holm have explored and described the southern part of the West Coast as far as 62° N. lat. The southern promontory is formed of a tableland which, in this direction, confines the inland ice like a dam. It has mountain peaks 5000 to 7000 feet high (those in the distance are probably 8000 to 10,000 feet), between which lie numerous isolated glaciers, in some places touching the inland ice, so that the limits of the latter cannot be clearly defined. It can be unmistakably recognised in two small ice-fjords at latitudes 61° and $61\frac{1}{2}^{\circ}$. One much more extensive is to be found at $61\frac{3}{4}^{\circ}$ (Narsalik). On the whole, the East Coast, up to 68° , seems to produce fewer icebergs than the corresponding part of the West Coast.

Between 62° and $68\frac{1}{2}^{\circ}$ the edge of the inland ice is almost stationary for a remarkably long distance. Except at Godthaab (64°), only one or two fjords of quite insignificant productivity occur. On this part of the coast is to be found the largest extent of low-lying land unencumbered by ice, and, formerly, it was seldom or never visited, except by natives when hunting reindeer. The whole area measures about 400 nautical miles from north to south, and generally 48 to 80 from east to west. We have to thank Captain Jensen and his companions, named above, for having performed the troublesome task of measuring this district. Here the longest known fjords of Greenland are to be found, and yet, long as they are, they often do not reach the inland ice, from which they receive the largest rivers of the country, if indeed they can be called rivers. The sources of these streams rush forth from caves, often magnificent vaulted galleries, in the rampart of ice. Where the ice encircling the isolated mountain groups spreads itself in huge streams over the lower country, signs frequently appear of periodical advance and retreat. In the former case abundant vegetation extends up to the edge of the ice, whereas in the latter case stones and rubbish have been left behind by it on receding. The soil, too, is thrown up into moraines, as though by an enormous snow-plough, and the rock is crushed into splinters. In other places the ice has closed outlets and formed lakes, which have dried up again on its retreat. Large patches also are seen of new land composed of glacier mud, in which vegetation spreads itself but slowly owing to the loose sand.

Jensen, Kornerup, and Groth proposed to investigate more closely the feeble motion here alluded to by making an excursion on the ice towards the interior at $62\frac{1}{2}^{\circ}$ N. lat. The "Frederikshaabs Eisblink"¹ here forms a continuation to the inland ice, the edge of which is separated from the sea only by a narrow strip of low sandy ground. During more than 100 years, passers-by have gazed at it without ever noticing any important change. This projecting tongue, bounded by high ground on both sides, is about 20 nautical miles broad and six long up to its junction with the inland ice. From this last point the travellers forced their way 16 miles further, as far as Jensen's *nunataks*. The whole

¹ Eisblink=edge of inland ice.—ED.

surface of ice thus examined is about 480 nautical square miles, and has about ten other *nunataks* besides the one just mentioned. This area is provided with fresh ice chiefly by the interior, while the old, towards the strand, melts away in the warmer air. The most distant *nunataks* rise from ice 4000 feet above the sea, and attain an additional height of 1000 to 1500 feet. Their further sides give a notion of the violence with which the ice advancing from the interior dashes against these rocks, set up like palisades to check its progress. Forced high up against the sides, its fragments fall like cascades upon the level surface previously mentioned. Here the whole is reduced to a level, though intersected by numerous crevasses, and winds like a stream between the other *nunataks* to the coast. As early as the middle of July the front part, up to an elevation of 2500 feet, and forming more than the fourth part of the whole plain, was free of snow. Considering, then, the amount of heat available during the summer to act on the ice thus exposed, it is easy to perceive how it has come to pass that the outer edge of the ice has kept the same position in spite of the strong impulse from the rear.

We come at last to the true home of icebergs, the coast between $68\frac{1}{2}^{\circ}$ and 75° N. lat., which contains all the large ice-fiords on the western side that are thoroughly known. The most southerly, the Jakobshavn Fiord, has been most minutely explored, and the observations extend over many years. The last were made by Hammer, who wintered at Jakobshavn, and has published a monograph on this remarkable locality. Here also the first measurements of glacier motion have been taken (by A. Helland), and here, too, the calving of a large iceberg was witnessed for the first and only time. Finally, in this fiord, the floating condition of the outermost part of the glacier was most clearly demonstrated. It has, for instance, been proved that its edge is pushed a mile further forward in some years than in others. This outer part is changeable in character also, and at different times may be split up by chance causes, and converted into detached icebergs. The icebergs which are launched forth from this fiord are seldom less than 300 feet high; one that was measured was found to be 403 feet, while the edge from which it had fallen away was only 200 feet high. The depth of the glacier in the centre probably amounts to considerably over 1000 feet. The breadth is 14,000 feet, and the middle part moves in July $63\frac{1}{2}$ feet in 24 hours (Helland, 1875). About 4000 feet nearer the side the speed in March and April (Hammer, 1880), was 33 to $51\frac{1}{2}$ feet. The declivity of the whole glacier was only $\frac{1}{2}^{\circ}$. With regard to the irregular occurrence of *calving*, it must be remembered that the original cohesion of the mass may be very different: as long as it moves through a narrow part of the valley or fiord it is held together by the pressure of the sides, but this support is lost where the fiord opens out.

The examination of the next section, from $69\frac{3}{4}^{\circ}$ to $72\frac{1}{2}^{\circ}$, was the work of Steenstrup. In this is situated the large Umanak Fiord, which branches out into seven or eight ice-fiords. In its neighbourhood the same discoverer has collected a rich treasure in other branches of geology. We must here confine ourselves to giving the measurements he made in three of the fiords.

The Torsukatak glacier is 25,000 feet broad, and the velocity at some distance from the centre is 16-25 feet in 24 hours (according to Helland 29,000 feet broad; velocity in the centre 30-32 feet).

The Karajat glacier has a breadth of 19,000 to 22,000 feet and a velocity of 22-38 feet.

The Itivdliarsuk glacier has a breadth of 17,500 feet, and a velocity of 46 feet in April, 21-28 feet in May.

We have now arrived at the last field of investigation. It extends up to 75° N. lat. (the last camp of our travellers was at $74\frac{1}{2}^{\circ}$). Inhabitants in communication with the Danish emporiums are not found beyond this point, and no communication is known to exist between the natives here and those of Smith Sound. The exploration of this territory was carried out by Ryder, Block, and Ussing, as was mentioned before. The two former spent two summers over this work, wintering in the most northern colony, Upernivik. In the southern part of this district lies a comparatively large area unencumbered by ice, but further north such ground is almost entirely restricted to the larger islands and a few headlands, which shoot out from between the arms of the inland ice. The most remarkable spot is the Bay of Augpadlartok, the central inlet of which forms an extensive ice-fiord. The branch of the inland ice, which there descends into the sea, has the highest rate of velocity ever observed in a glacier, namely, 100 feet in 24 hours, or over 4 feet an hour. A measurement at about the same point gave only 34 feet per day in April. The icebergs in this fiord were of no great height, and even the highest (about 200 feet) did not seem to rise above the terminal wall of the glacier. To judge from the map, about 15 glaciers were observed proceeding from the inland ice in the north of this bay, some of which produce large numbers of icebergs.

We know but little of the behaviour of the inland ice beyond this limit of the territory explored by our expeditions. It is, however, supposed that the coast exhibits the same features as far as Cape York, and that huge icebergs sail out of Melville Bay also. This, however, is doubtful as regards the region north of 76° . The extraordinary difficulties encountered in penetrating into Smith's Sound are, it is well known, due to floes, not icebergs. It is even doubtful, whether the noted Humboldt glacier is exceptionally productive of icebergs, and still further north, as far as I have been able to ascertain, their occurrence entirely ceases. Taking into account what has been already stated with regard to the East Coast, it would seem, that the West Coast between $68\frac{1}{2}^{\circ}$ and 76° N. lat. is most prolific in icebergs, and that the majority of these, that pass over to Newfoundland, and thence wander over the Atlantic Ocean, must originate in this region. The great breadth of the northern half of Greenland renders this intelligible, especially if the tableland, observed by the second German North Pole Expedition and accessible from Franz Joseph's Fiord, marks the watershed, and, as has been supposed, lies a third of the distance from the East to the West Coast.

If the opinion stated in the foregoing pages concerning the inland ice is correct, it is easy to answer the question, whether it really differs from the icy mantle of a mountain in the temperate zone, except in magnitude

or extent. No doubt it may be looked upon as a further development of a system of glaciers, such as flow down the flanks of one of these mountains. These glaciers spread themselves over the low-lying land, but there they have at the same time expanded and united, so as to assume the form of an inundation, though in their under parts they remain divided owing to the influence of their original watersheds, and indicate their condition by amazingly large differences of velocity at the common outer edge. In order to continue the comparison, one must picture to one's-self, on the one hand, a large mountain glacier with the snow field on the mountain summits, which feeds it, and on the other a glacier giving off large icebergs in connection with a part of the interior, which serves it as a river basin. Then it must be remembered that the former glacier fails to satisfy the conditions of this comparison. It may fairly be assumed that an ordinary mountain glacier consists of three parts, of which the first and uppermost is continually forming fresh ice out of snow, the middle part retains its volume unchanged during its progress, and the lowest is constantly diminishing owing to melting, which, at last, places a limit to the further progress of its extremity. Compared with such a glacier, the arm of the inland ice, which gives off icebergs, corresponds only to the foremost end of the middle division, if this be broken off over the verge of an abyss. To compare it with an ordinary glacier in its entirety, the Greenland glacier must be supposed to extend over level ground, and there be dissolved by summer heat, instead of breaking off in the deep water of an ice-fiord and floating away. The primary origin of the inland ice also has been, probably, somewhat different from its present continuous formation. First of all, mountain glaciers have checked the flow of rivers, and these may, by long-continued floods during the winter, have added to the quantity of ice, so that the increased elevation of the whole constantly became more favourable to the congelation of snow.

In conclusion, it may be added incidentally that numerous proofs collected by the expeditions indicate that at an earlier period the inland ice covered also the greater part of the coast land, islands, and peninsulas now bare. The marks it has left behind are erratic blocks and rocky slopes, polished and furrowed up to a certain height, above which mountain peaks rose like islands, just as the *nunataks* do now.

OBITUARY, 1888.

BRAZZA, JACQUES DE.—Jacques de Brazza, a brother of the distinguished Governor-General of the Congo French Territory, died on the 1st of March last at Rome. In 1883 he went out to West Africa as a member of the mission of which his brother was the chief; he distinguished himself by his scientific observations and, above all, by his exploration of the river Likwala, which settled definitely the disputed question regarding the Licona. On returning from his voyage he brought with him an ethnographical collection which is now exhibited in the Paris museum. Shortly before his death, the Italian Geographical Society had