NORSK POLARINSTITUTT
(Tidl. Norges Svalbard- og Ishavs-undersøkelser)

MEDDELELSER

Nr. 71

CONGLOMERATES FORMED IN SITU ON THE GIPSHUK COASTAL PLAIN, VESTSPITSBERGEN

BY
ROLF W. FEYLING-HANSSEN

OSLO
I KOMMISJON HOS JACOB DYBWAD
1952

NORSK POLARINSTITUTT
(Formerly Norges Svalbard- og Ishavs-undersøkelser.)
Observatoriegaten 1, Oslo

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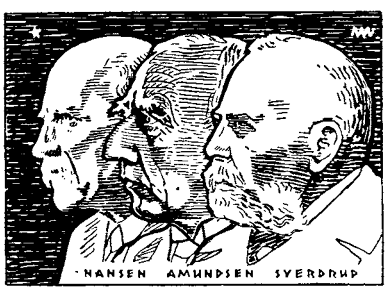

OSLO
I KOMMISJON HOS JACOB DYBWAD
1952

A. W. BRØGGERS BOKTRYKKERI A/S

The Gipshuk coastal plain is located at the inner end of Isfjorden, Vestspitsbergen (abt. 78° 27′ N. lat.). It forms the mainland inside Gåsøyane (Anser Islands) from Gipsvika (Gips Bay) to Anservika. The plain emerges directly from the sea and rises gently inland, reaching in a little more than 1 km a height of about 75 m.

The bedrock consists of diabase, giving the morphological features a character somewhat different from those generally present in the surrounding area, because in this region the occurrence of diabase is strictly limited. Gåsøyane are composed of diabase, and so is the coastal plain dealt with here. A bed of the same rock continues in an anticlinal fold reaching a height of about 200 m above sea-level on the SSW side of the mountain Gipshuken. As far as known, the occurrence of diabase in the Gipshuk locality is limited to the east by a line roughly drawn from the easternmost part of Anservika to the western part of Gipsvika (cf. the geological map by Orvin, 1940). Elsewhere in the area diabase outcrops in the southern parts of the peninsula between Billefjorden and Dicksonfjorden, and on the south coast of Isfjorden, at Diabasodden and the adjacent localities. Thus, diabase is sparingly represented in the area.

The solid rock in the Gipshuk coastal plain is to a great extent exposed on the platform. Loose material, mostly some sand and gravel carrying vegetation, is limited to broader or narrower bands running approximately perpendicular to the coast line and forming depressions in the plain.

The exposed surface of the rock gives evidence of glacial action, the forms are smoothed and glacial striae are met with. Two directions of the striae have been noted: NE—SW and ESE—WNW, of which the latter direction is by far the more common.

The Gipshuk coastal plain is a plain of marine denudation. After its formation glaciers have swept over it, having left glacial striae on

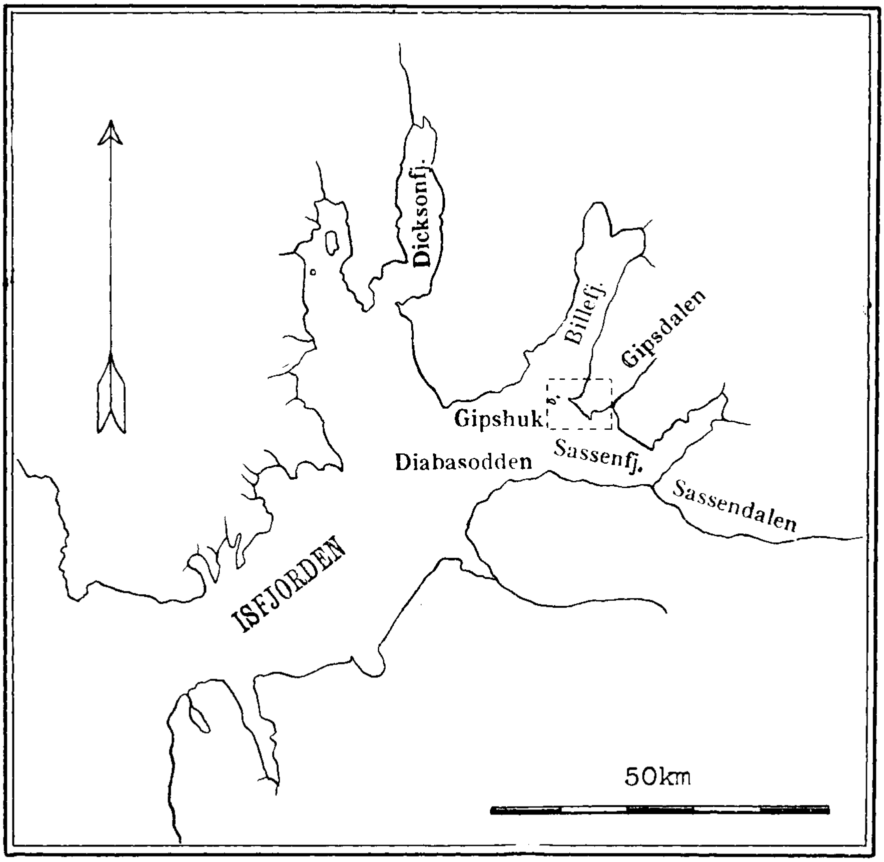

Fig. 1. The location of the coastal plain at Gipshuken.

its surface and some morainic material in its depressions. The position of sea-level at that time is not known, but, clearly, the plain has been submerged after it was released from the glaciers, and subsequently, probably rather recently, a regression of the sea has taken place. This regression has been interrupted by stationary periods. — Thus, we have got a plain with exposed and gently sloping surface, composed of a rock the outcropping of which is strictly limited within the area.

In this locality numerous blocks are seen spread over the plain. Högbom (1910, pp. 41—43, and 1914, pp. 274—280) has discussed in details how these blocks are generated by frost action. Generally

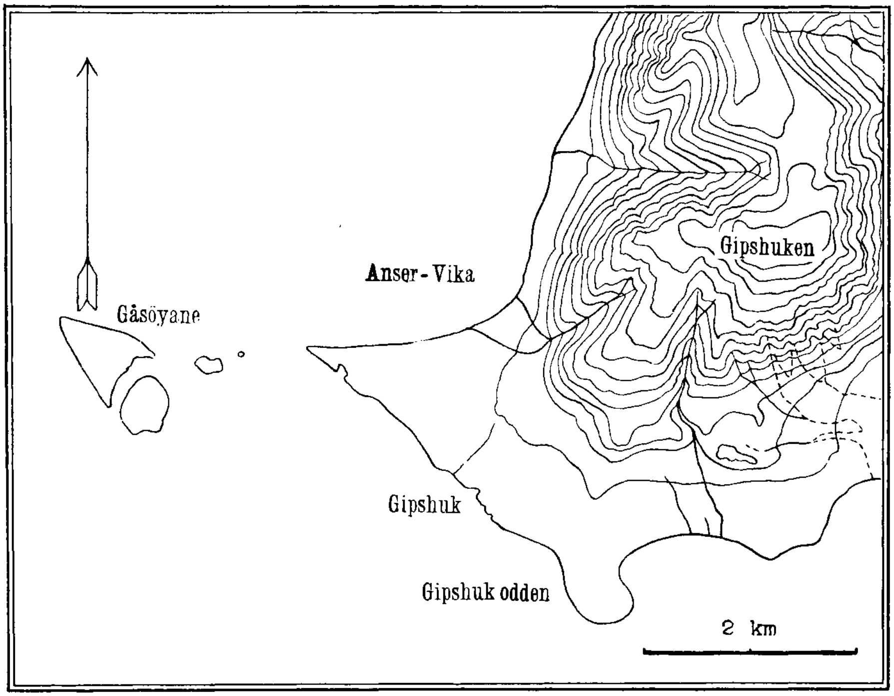

Fig. 2. The coastal plain SW of the mountain Gipshuken.

the bedrock seems to crack up in particles of nearly cubical shape with sides of about 0.5 m. Blocks of other forms and other sizes are also common. When first a block is loosened from the solid rock, the freezing of water in cracks or fractures, little by little, causes an elevation of the block above the main rock surface, an elevation which may amount to 2 m or even more, according to the size of the block. Generally the greater blocks divide into smaller ones during their rise. Masses of blocks which originated in this way, are met with in the locality, and all stages of development can be studied there. These blocks are exclusively of diabase, they are angular, and they are located *in situ*.

In addition to the angular blocks there are large quantities of more or less rounded ones. Some of them have diameters smaller than 256 mm and should therefore be characterised as cobbles, whereas, by far the greater part of them, are larger and should be called boulders (Wentworth's grade names, 1926). Pebbles are sparingly represented. The angular blocks seem to be almost evenly distributed over the rock plain, whereas most of the rounded ones are grouped in horizontal zones running parallel to the coast line at different levels. These boulder zones are raised beach ridges, shore formations, which have been developed during stationary periods in the change of sea-level. Prominent beach ridges are found between 55 m and 45 m above sea-level, between 35 and 25 m above sea-level, at about 20 m, and at about 15 m above sea-level. Less prominent ridges are found at about 10 and at about 5 m above sea-level. These heights are in fairly good accordance with the heights of marine terraces within the same area (cf. Feyling-Hanssen and Jørstad, 1950).

By closer examination of these beach ridges, they appear to comprise both rounded blocks, viz. boulders, and angular ones. The rounding may have taken place to a lesser or greater degree. The highest grade of rounding is met with in those ridges where the blocks, as a whole, are most numerous. However, particles that may be described as well rounded are rare. Angular blocks as well as boulders occur both inside and outside the ridges, but within the ridges the angular blocks generally form a small percentage of the whole assemblage.

These boulders almost exclusively consist of diabase, *i. e.* the same material as that of the angular blocks and of the underlying bedrock. Foreign particles, sandstone, shale, and limestone, are very rare.

Thus, these beach ridges of diabase boulders represent conglomerates which have been formed *in situ*. They result from a close cooperation between the two agencies: frost wedging and wave action. Frost wedging has supplied the shore with diabase blocks, whereas wave action is responsible for having transformed them into boulders.

On account of the severe climatic conditions frost action affects the rocks of Spitsbergen with considerable intensity. Wherever the rock surface is exposed, *i. e.* where it is situated above sea-level and not covered by any considerable amount of loose material, it is subjected to rather rapid destruction by frost. The effects of this activity depend on the constitution of the different rocks. The diabase is very resistant against surface-weathering. For this reason glacial striae are well preserved even on exposed surfaces, and even up to a height of about 200 m above sea-level the ice-smoothed surface of the diabase cliff appears to be almost unaffected by post-glacial weathering. Nevertheless, the diabase is very liable to split up in more or less regular blocks when exposed to fluctuating temperatures and to repeated freezing and melting of water in cracks and fissures. Frost action therefore, is capable of generating diabase blocks at all heights above sea-level, *i. e.* above low-tide level. Beneath this limit frost action is, moreover, eliminated. Thus, frost action has supplied the Gipshuk coastal plain with angular diabase blocks.

The process of rounding of such blocks can be studied along the present shore. The coast of the Gipshuk locality is exposed to frequent heavy seas running in from the Isfjord gap. Wave action, therefore, severely affects this coast. Diabase blocks in all stages of development can be observed along the shore, from actual boulders, to angular blocks recently affected by wave action. — The upper limit to which boulders can be formed is generally marked by the storm ridge.

The diabase boulders on the Gipshuk coastal plain are formed in the overlap zone between wave action and frost action, *i. e.* they are, moreover, formed within the tide-water zone. The lower limit of wave action extends far below low-tide level, but the boulders cannot, generally, be formed below this level because the blocks are not present there. Wave action alone cannot, in general, detach blocks from a smooth, gently sloping, and hard parent rock surface (cf. fig. 3).

The accumulation of blocks within the beach ridges is primarily due to the acceleration of frost action about the tidal zone, where cracks and fissures are richly supplied with water and where frost and thaw are frequently alternating. The objection could be made, that sea-water, when it freezes in fissures of the rock, has a small disintegrating power compared with that of fresh-water, and that the erosive effect on the shore is therefore not so great (cf. Nansen, 1922, p. 30). It should, however, be considered that the surface layer of the sea-water, especially in inner fjord regions, of Spitsbergen is usually very much diluted by fresh-water from rivers and glaciers (cf. Nansen, l. c.). Furthermore, the presence of an ice-foot during winter time strongly supports this "beach erosion by frost" (Nansen, l. c.), by which diabase blocks are continuously loosened from the bedrock, wave action thus being supplied with raw material for the manufacturing of boulders.

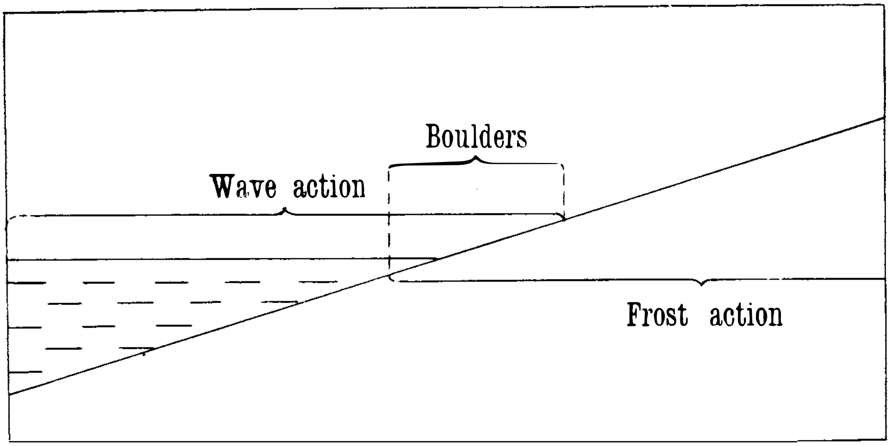

Fig. 3.

The angular diabase blocks, which may be found within the raised beach ridges, have come into existence when the ridge was already elevated above reach of wave action. Some of these blocks originate from the bedrock, whereas others represent boulders split by frost action. — The occasional foreign boulders found, have probably been carried in by drifting ice stranded on the beach. In the upper beach ridges foreign blocks are more frequent. There they are probably derived from morainic material which is present at the upper termination of the coastal plain, especially north and east of Gipshukodden, where it has been redeposited as a terrace at an altitude of 45—56 m (Feyling-Hanssen and Jørstad, 1950, pp. 31—32).

Authors who are dealing with the formation of conglomerates (cf. *i. a.* Wentworth, 1919, pp. 507—521; Hadding, 1927, p. 146; Twenhofel, 1947, pp. 119—128), ordinarily count as general factors in the formation of conglomerates 1) the block-yielding factor, and 2) the block-enriching factor (Hadding, l. c.). The latter is responsible for transportation, sorting, and deposition of blocks. The transporting activity is generally regarded as the most important.

By the formation of the conglomerates on the Gipshuk coastal plain the block-enriching factor is wave action. The transporting activity of this factor is, however, much reduced. Wave action will tend to concentrate boulders along the strand line. There will be a grinding of the particles within reach of the battering waves. By this some of

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1. The termination of the diabase to the east.
2. Diabase subjected to frost action.
3. A beach ridge on the coastal plain at Gipshuken.
4. Beach ridge abruptly cut off towards Anservika at the termination of the diabase outcrop.
5. Conglomerate in formation.
   All photos are from the plain at Gipshuken and photographed by the author.

the smaller and smallest particles may be carried away. But the majority of blocks are only set in rocking motion by the waves, and most probably they remain close to the spot at which they were detached from the bedrock. Neither north of the diabase coast (Anservika) nor south of it (Gipsvika) diabase blocks were noticed on the beach.

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