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FEATURES OF THE TERTIARY VOLCANIC ROCKS OF THE NIAQORNAT AREA, NÛGSSUAQ

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During the summer of 1974 and in previous years the writer mapped parts of the volcanic sequence around Niaqornat on the north coast of Nûgssuaq. The results of the regional mapping by the writer and others have been published in the Agatdal map sheet (The Geological Survey of Greenland, 1974). Certain hitherto undescribed large-scale features of the volcanic rocks are described here.

The Niaqornat cliff section

The fishing village of Niaqornat is situated at the eastern end of a headland approximately 3½ km long and up to 1½ km wide which is composed of Tertiary volcanic rocks rising to a height of 326 m above sea level (fig. 5). South of these volcanic rocks is a long curved depression filled with Quaternary deposits.

On each side of the headland and south of the depression the lowest rocks exposed are black shales and sandstones of Cretaceous–Tertiary age. Landslip and spontaneous combustion have occurred in black shales both to the east and to the west (the well known burnt shale locality of Pujôrtoq lies west of the headland). The sedimentary rocks are overlain by Tertiary volcanic rocks, which make up the upper part of a long coast-parallel ridge, to a height of over 800 m. Immediately south of the headland the boundary between the sediments and the volcanic rocks ranges in height from just below 300 m to over 550 m. In relation to the area to the south the Niaqornat headland with its volcanic rocks is in an anomalous position.

About 3 km east of Niaqornat the boundary between the volcanic rocks and the underlying sediments reaches sea level and the volcanic rocks are visible at the coast for about half a kilometre. East of this again the coast section consists of sediments, with basalts being present farther inland. The boundary is mainly faulted around Niaqorssuaq, but is a normal depositional boundary farther east.

The Tertiary volcanic rocks of the Niaqornat cliff section consist of two types, pillow breccias and subaerial basalt flows. The story which can be read in these cliffs is one of extreme tectonic instability during the early part of the volcanism in this area. Fig. 6 shows the distribution of subaerial lavas and pillow breccias within the headland. As can be seen, the distribution is highly irregular, and indicates a very disturbed volume of rocks.

The sequence as exposed along the cliff section itself becomes younger from the east to west. It will therefore be described from Niaqornat westwards.

Around Niaqornat itself and for the first 2 km westwards the rocks are dark brown pillow

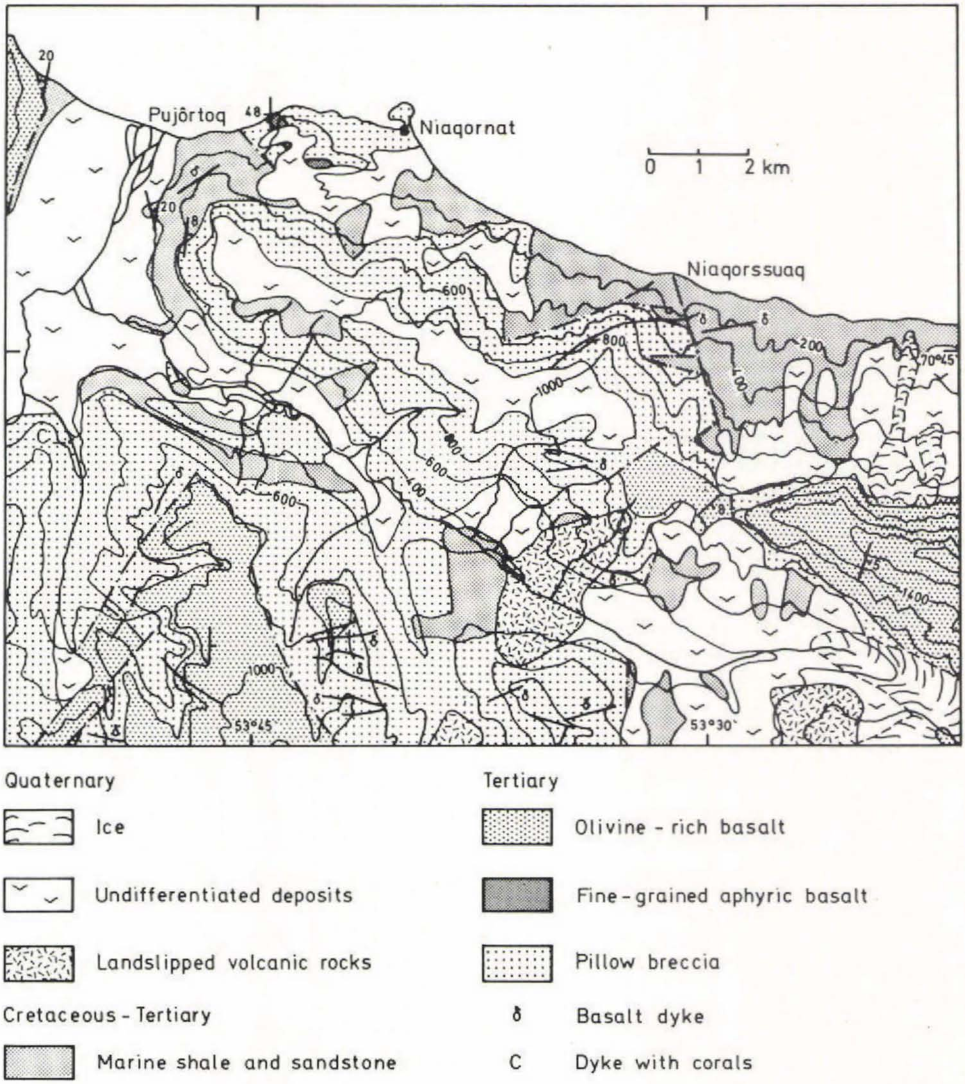

Fig. 5. Generalised geological map of the area round Niaqornat. (Taken from the GGU 1:100 000 map Agatdal.)

breccias. The darkness is due to the amount of volcanic glass in the matrix and on the margins of the pillow fragments. Whole pillows are common in places.

Two kilometres west of Niaqornat these pillow breccias are overlain by a sequence of subaerial flows about 40 m thick which strike NW–SE and dip 70° to the south-west. Details of the boundary relations are shown in fig. 7. The boundary between subaerial flows and subaqueous deposits is discordant to the primary layering in the lower unit and is in fact diachronous, subaerial flows passing laterally (up the cliff) into flow-foot pillow

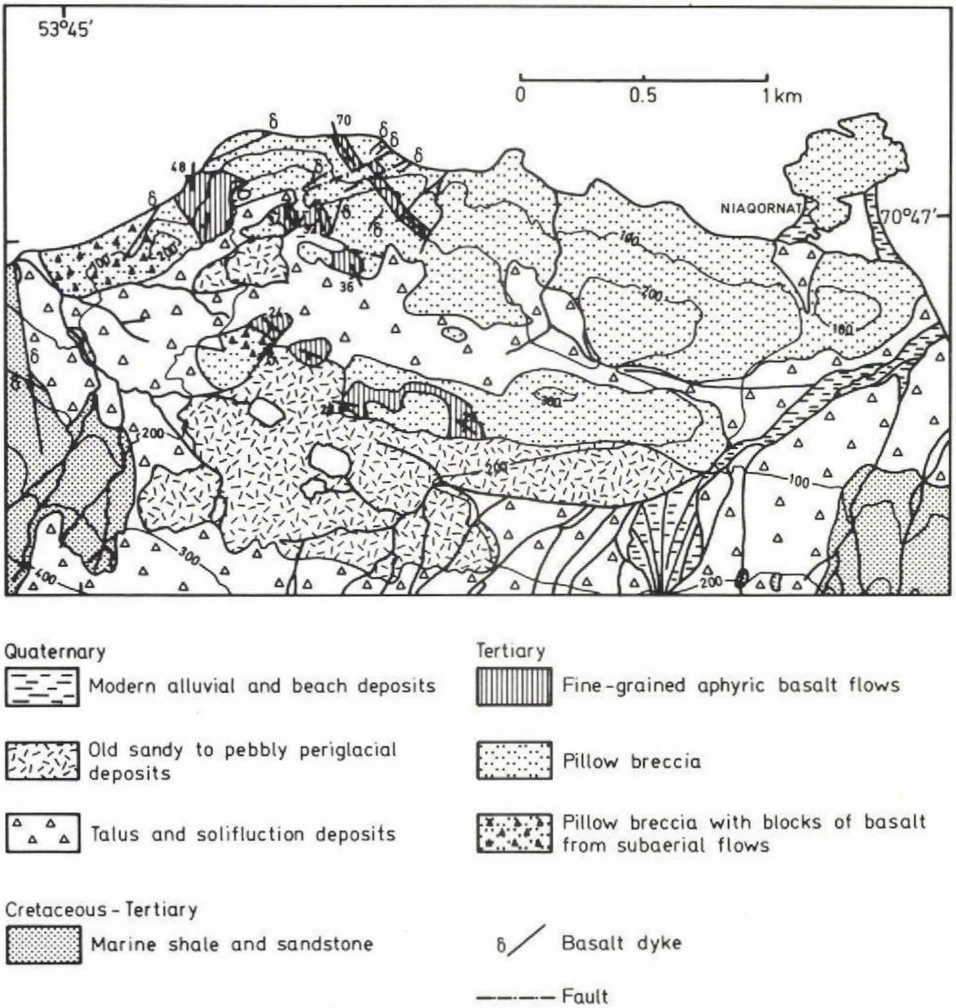

Fig. 6. Map of the Tertiary volcanic rocks of the Niaqornat headland.

lavas. Similar relations were found by Pedersen (1973, p. 25) between subaerial flows and pillow breccias along the north coast of Disko. Just below the flows at this particular locality the pillows are so well preserved in a glassy fragmental matrix that the writer has chosen to call the rock pillow lava rather than breccia. Lower in the sequence the volcanic rocks are pillow breccias. In fact, the obvious close relation between pillow lavas and very shallow water in this and other areas seen by the writer leads to the suggestion that in lavas of approximately the same composition as here, pillow lavas are developed in very shallow water while in deeper water the pillows are disintegrated mechanically by further transport thus giving rise to pillow breccias (pillows have undoubtedly planes of weakness anyway

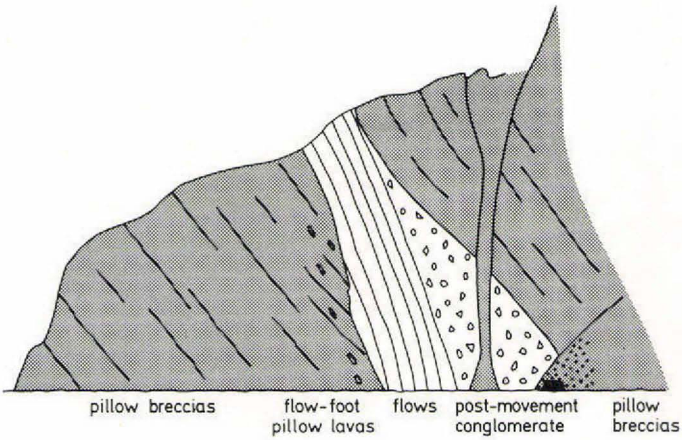

Fig. 7. Sketch showing the easternmost of the two subaerial flow sequences in the Niaqornat cliffs.

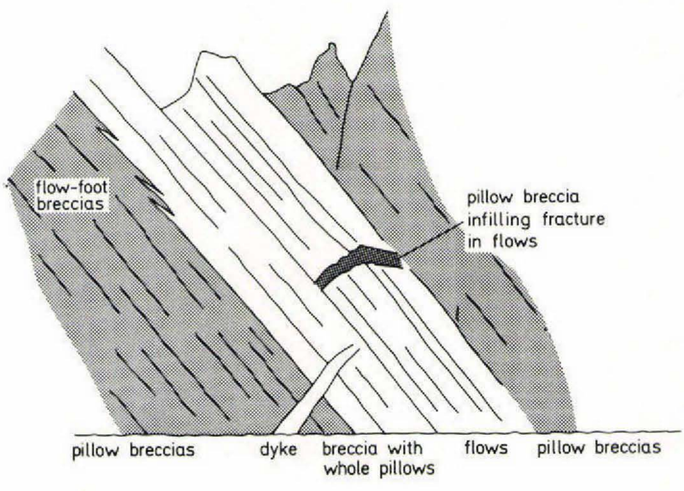

Fig. 8. Sketch showing the westernmost of the two subaerial flow sequences in the Niaqornat cliffs.

owing to the rapid cooling involved). On this particular cliff face as now seen the component of the direction of lava flow has been from the shoreline upwards, i. e. the source of material was originally somewhere to the west of the present position.

Deposition of a sequence of medium brown aphyric basalts above the subaqueous deposits marked the temporary filling-up of the area originally under water. This was short lived; subsidence followed by considerable tilting (possibly about 20° of rotation) brought the area once more under water. The first deposits were basaltic conglomerates containing large blocks of subaerial basalt, presumably derived from continuations of flows originally present as a prolongation of those now seen on the skyline in fig. 7. Thereafter the deposition of dark brown pillow breccias was resumed in a subaqueous environment.

Just over half a kilometre farther west a similar sequence is encountered (fig. 8). A sequence of subaerial basalt flows about 70 m thick overlies the subaqueous deposits. The strike is N–S and the dip 48° west. In this case the layering in the flows is parallel to the layering in the underlying pillow breccias. Immediately below the flows at shoreline level there are whole pillows in the breccias, but the rock is a pillow breccia rather than pillow lava. Further up the cliff there is some lateral transition from flows into flow-foot breccias.

Boundaries of individual flows are not pronounced, but tend to be somewhat emphasized by the arrangement of amygdales; pipe amygdales mark the base, the middle of the flow is free of amygdales, while the top is amygdaloidal.

Here also the component of the direction of the lava flow has been from the present shoreline upwards in the cliff. The source of material was thus to the west of the present position.

This lava sequence also marks the temporary filling-up of an area originally under water. Renewed and this time catastrophic subsidence and rotation (probably nearly 50°) produced some highly spectacular results. Downwarping of the flow sequence has resulted in the opening-up of a fissure in the flows. This has been filled by dark brown pillow breccia (figs 8 and 9). The flows terminate abruptly against pillow breccia just below the skyline (fig. 9) in a manner suggesting a physical break rather than a sudden facies change, but this remains to be confirmed. A small remnant of subaerial basalt caps the hill on the left of the figure. The most spectacular development of all is west of the flows, where giant blocks comprising parts of several flows and innumerable smaller blocks representing parts of single flows have tumbled down into the water ahead of the slope formed by the tilted subaerial flows and became embedded in a matrix of pillow breccia (fig. 10). The hill in the centre of fig. 9 is 225 m high, so this gives some idea of the size of the largest blocks.

The two zones of subaerial basalts have been followed inland. The lower zone is broken by two faults trending at about 65° and terminates against a fault trending at 45°.

The upper zone continues for some distance inland, the strike swinging round from N–S to ESE–WNW, while the dip decreases from 48° to 26–28°. This zone is also broken by

Fig. 9. Panorama showing the western part of the Niaqornat cliff section. The hill in the centre is 225 m high.

Fig. 10. Conglomeratic pillow breccia at the western end of the Niaqornat cliff section. Immediately behind the hammer is a well preserved pillow with glassy margin. Above the hammer is a large exotic mass of subaerial basalt.

faults. One of the faults cutting the lower zone must continue under a linear depression cutting the upper zone and probably extends south-west along the edge of the outcrop of the large area of pillow breccia with blocks.

A further zone of pillow breccia containing blocks of subaerial basalts was found in a hill south-east of the coastal occurrence.

Basalt dykes, some with the same trend as the faults mentioned, intrude the volcanic sequence. Basalt dykes cutting the pillow breccias along the coast have produced zones of alteration of the country rock on each side and a consequent bleaching (fig. 11).

The question is, when did this mass of volcanic rocks reach its present position. There are various explanations to be considered. Masses of basaltic rocks overlying poorly consolidated shale-sandstone sequences are inherently unstable in a dissected topography. On the west side of Agatdalen in central Nûgssuaq there are classical examples of rotational slip, where after the ice filling Agatdalen retreated, large and often coherent masses of basaltic rocks on the west of the valley slipped and rotated so that they now dip in towards the main hill behind. Two factors make relatively young gravity slipping unacceptable for the Niaqornat mass. Firstly, the depression south of the mass is filled with Quaternary deposits, including some bedded sediments (C. Mohr, Univ. of Copenhagen, unpublished report), which have clearly been laid down after the present volcanic mass reached its present position. Secondly, the very characteristic rocks of the headland do not

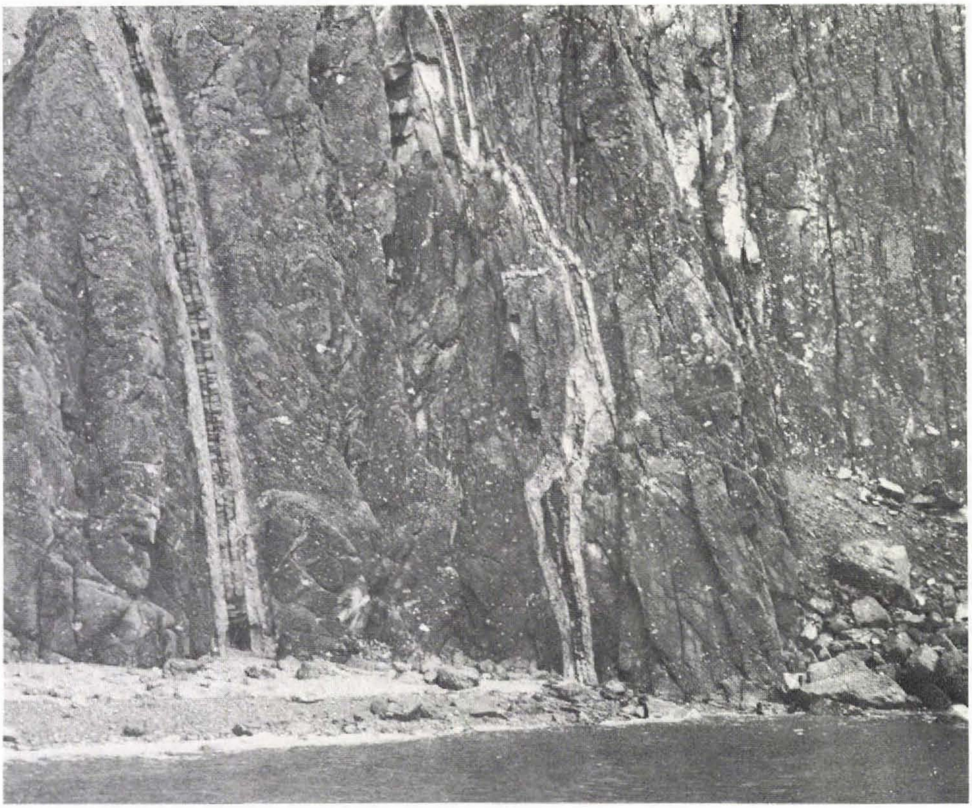

Fig. 11. Basalt dykes intruding pillow breccia, central part of Niaqornat cliff section. Note the zone of alteration and bleaching of the country rock.

have any counterpart in the ridge immediately to the south. Philip (1973) has published an account of green and brown volcanic breccias overlying the sediments to the south. The present writer has seen these rocks, which are not at all like the Niaqornat rocks. This being so, two further explanations are possible. The Niaqornat rocks could represent a level originally above the present top of the volcanic rocks to the south. These are now capped by Quaternary moraine deposits, so this would mean postulating erosion of hundreds of metres of volcanic rocks prior to deposition of the moraine. Much more likely is the conclusion that the Niaqornat rocks never were present to the south, but that they accumulated during the earliest part of the Tertiary volcanism in a tectonic depression formed partly in sediments and partly in volcanic rocks. Renewed subsidence would have caused the features just described, and there need not necessarily have been any substantial movement after the movement that produced the spectacular conglomeratic breccia on the west of the headland. The volcanic mass would thus have reached its present relative position already during the early Tertiary.

Evidence on the east face of the volcanic mass farther east, above Niaqorssuaq, supports such a conclusion. Here, there are both pillow breccias and subaerial flows which were probably laid down very early in the basaltic volcanism and which still are part of a mass that includes younger volcanic rocks. The cliff face referred to also gives a picture of extreme instability during the early phases of the volcanism, and does contain some brown pillow breccias reminiscent of those around Niaqornat.

A brecciated dyke with interstitial coral-bearing sediment, Sôrdlut

The valley of Sôrdlut is located in north-western Nûgssuaq, and the locality described here is just over 9 km in a direct line from Niaqornat (fig. 1). The river flowing down the valley originates from a local ice cap in basalt terrain farther south, and passes Tertiary olivine basalt flows, pillow breccias and the underlying Cretaceous-Tertiary sediments on its way north. The writer's visit was limited to the outer part of the valley, at the level of the sediment–breccia boundary.

There are very few exposures in the valley floor at the entrance to the valley. A small outcrop of shale with sandstone bands of maximum thickness 20 cm shows N–S strike and 45° dips to the east. 400 m further up the valley an outcrop comprising 1.5 m of well bedded green hyaloclastites overlain by 3 m of sandy shales and sandstone probably marks the approximate boundary between the sediments and the volcanic rocks. The dyke in question is 700 m south of the above-mentioned outcrop and is about 30 m higher in altitude,

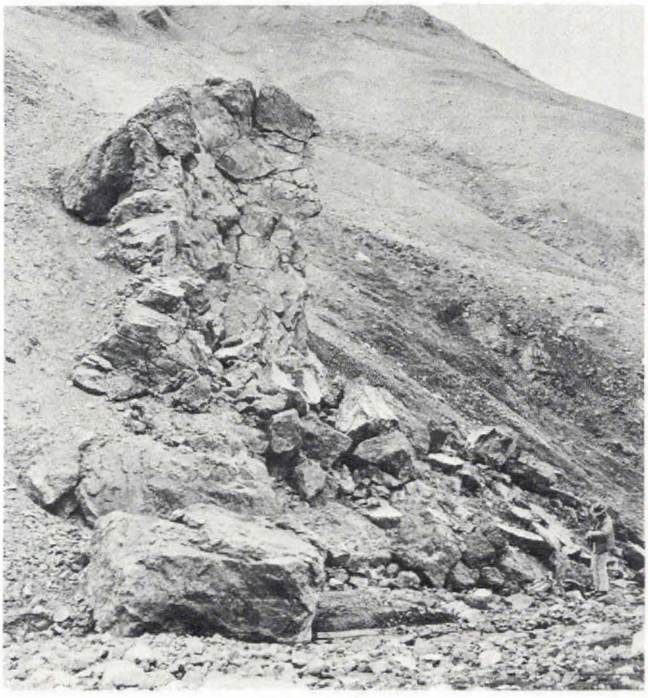

Fig. 12. The brecciated dyke, Sôrdlut.

occurring at 175 m above sea level. The stratigraphic level is above the base of the volcanic rocks, but it is probably not far up into the sequence.

The intrusion is shown in fig. 12. It forms a small ridge with a trend of 80° rising to a height of about 10 m above the river bed and with a width of 4–5 m. The southern border is complete but extensive rock fall has removed the northern border.

The rock when fresh is a very fine-grained to glassy dark grey tholeiite. At stream level it has undergone large-scale brecciation *in situ*. About half-way up there are more homogeneous basalt masses and brecciated patches rich in glass. The absolute top consists of a basalt breccia with fragments of cobble size. As can be seen from fig. 12 the top is domed and this is considered to have marked the sea floor at that time. There is a slight tendency towards pillow formation in the dyke, but pillows are not well formed.

Immediately above the top of the dyke are friable green ultrabasic hyaloclastites. Just upstream there are well bedded green hyaloclastites varying in texture from coarse breccias to fine volcanic sediments. They contain reworked concretions from the shales. They also contain some block and fragments of brown breccia.

The basalt with corals was obtained from very large blocks at the base of the pile of blocks on the right-hand side of fig. 12. Here the basalt is not only brecciated, but the interstices between the breccia fragments are filled with sediment which in places is very rich in corals. Different types of breccia development were observed on the block faces. There are basalt masses where the sudden cooling has resulted in a network of cracks, but where the masses have not disintegrated further. Another variety consists of angular pieces of basalt mainly in the size range from 5 cm down. The pieces comprise fine-grained basalt, fragments of fine-grained basalt with glassy borders, and dark glass, and are in a sedimentary matrix. These breccia fragments indicate a further degree of disintegration of the basalt after chilling with significant movement of the breccia components relative to each other. However, the interpretation in the field was that these fragments had not been transported more than a very short distance from the point of origin.

The petrography and fossil content of samples from this locality are described by Schiener & Floris (this report).

References

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