ON EXTRUSION FORMS IN PLATEAU BASALTS. 2.

THE KLAKKSVÍK FLOW, FAEROE ISLANDS

By

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Abstract

The Klakksvík lava, an olivine tholeiite flow within the plateau basalts of the Faeroe Islands, has been thoroughly mapped over an area of about 150 km^2. At least 1.5 km^3 of lava and basalt slag was erupted from several craters along a fissure more than 20 km long. Much of the flow has been eroded away; what remains crops out in a belt which is from 5 to 8 km wide.

INTRODUCTION

Early in the course of their geological mapping of the Faeroe Islands ARNE NOE-NYGAARD and JOANNES RASMUSSEN recognised the value as a stratigraphic marker horizon of a light grey, olivine-bearing lava, which is well exposed in a small quarry northwest of the township Klakksvík on Borðoy in the northern islands. During the mapping that followed, the Klakksvík lava was found at several other localities farther north on Borðoy and on Kunoy and Kallsoy, although not on Eysturoy. – In the meantime the stratigraphical succession of lavas in the Faeroe Islands was established with the help of other marker horizons (NOE-NYGAARD and RASMUSSEN, 1968). – Now and again, however, the distinctive Klakksvík lava came into the mind of the senior author, who felt that it could perhaps be used to illuminate the problem of extrusion forms of plateau basalts, a problem about which there is still very little data (MACDONALD in HESS and POLDERVAART (Edt. s), 1968, p. 4).

In 1966 NIELS HALD and REGIN WAAGSTEIN traced the Klakksvík flow over the whole of its area of outcrop (fig. 1). The total thickness of the lava, including an upper and a lower slag, and local internal slag horizons, was measured at regular intervals. The lower part of the overlying lava flow is well exposed in many places except where it consists of grey vesicular basalt (fig. 3) and is therefore very useful in the field. The boundary between the massive lava and its upper slag is often very indistinct, and sometimes it was possible to measure the thickness of only the massive lava itself.

On the whole the Klakksvík lava is well exposed, and over long stretches the massive lava forms a marked escarpment. The best exposures are on the steep western side of Kallsoy where the flow, due to later movements of the plateau, reaches the greatest height above sea level. Here however it is difficult to trace the layer continously, because of the numerous ravines. In the hanging cirques on eastern Kallsoy and in parts of the

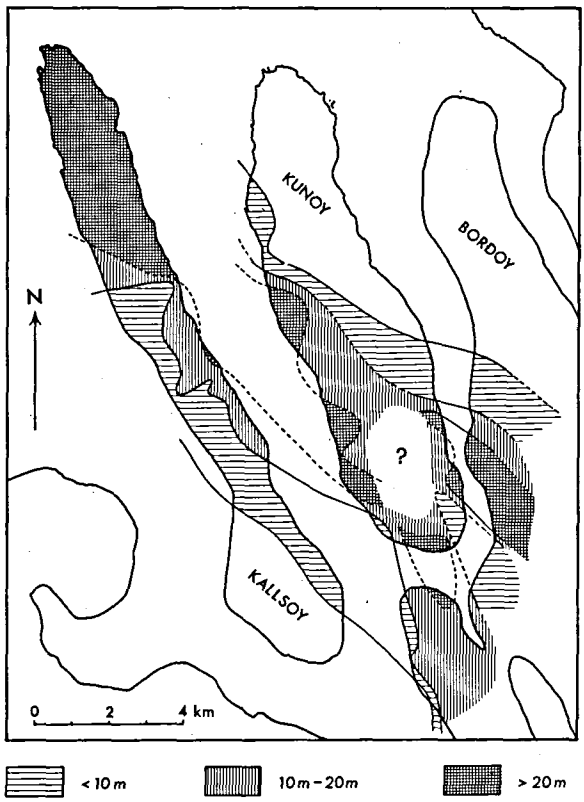

Fig. 1. Map of the outcrop area of the Klakksvík flow. Klakksvík lies at the head of the short narrow fjord in the SE corner of the map.

western side of Kunoy the lava is mostly covered with talus. Between the cirques it is well exposed. On the eastern side of Kunoy and on Borðoy the lava lies below the level of the floors of the hanging valleys, and on the more gently inclined slopes below the valleys it is often covered by screes. Where the massive part of the flow is relatively thick it forms a "trap" in the landscape. The lower and especially the upper, slaggy parts are often hidden, and the redcoloured upper slag layer can be seen, only in rivulets with a steep gradient.

THE UNDERLYING LAVAS

The Klakksvík lava rests almost everywhere on a sequence of thin flows of vesicular basalts of pahoehoe type, from which it can easily be distinguished in the field. Like the Klakksvík lava the underlying lavas have a greyish

colour, but they are fine-grained rather than aphanitic and are always highly vesicular along their upper and lower boundaries, the thinnest flows being vesicular throughout. The vesicles are now filled with zeolites. There is no tuff between the individual flows; their upper surfaces are often reddened and may in good exposures show the characteristics of ropy lava.

Because of their vesicular nature and probably also because of their coarser grain size, these basalts weather considerably easier than the Klakksvík lava. They therefore form an even slope below it and can be studied only in stream beds. In a section in a small river at Ánir on the west side of Borðoy a sequence of 35 metres consists of 14–16 separate flows or flow units, the thickest of which is 7½ metres. The vesicular basalts contain scattered lath-shaped phenocrysts of plagioclase ½ to 1 cm. long.

THE KLAKKSVÍK LAVA

This lava is a typical aa-lava with an upper slag layer at the top, constituting on an average 25% of the total thickness of the flow, and a very much thinner bottom slag. The lava is aphanitic and only locally fine grained. It carries scattered phenocrysts of olivine, most of which are about 1 mm across, although some are 4 mm or even more. The rock is light grey in colour, sometimes with a light bluish tinge. It is very compact, except where the massive part of the lava is thin. Only a few vesicles are found in the massive lava, generally within a narrow zone near the bottom and a somewhat broader belt at the top. At one locality on western Kunoy a narrow, red, vesicular zone in the middle of the compact lava marks a boundary between two flow units that lacks a separating slag layer. All the vesicles are filled with zeolites.

Along the upper and lower boundaries there is a narrow, intensely red-coloured zone which locally may attain a thickness of one meter, for instance in the quarry at Klakksvík. The lava is cut by curved cooling cracks which may be traced into the bottom slag; these can be seen in the same quarry.

Small, subrounded fragments of vesicular basalt generally less than 10 cm. across occur here and there especially in the upper part of the flow.

Where typically developed, the slags are tile red and consist of fragments of basalt embedded in a fine-grained, red matrix. The amount of matrix varies considerably, even within short distances, but usually the basalt fragments touch each other. The fragments are usually only a few centimetres in diameter, but may vary a good deal in size; they are generally somewhat rounded. The smaller fragments consist almost exclusively of a reddish basalt full of tiny round vesicles, whereas the larger fragments consist of a dense, grey basalt with a red crust. On freshly broken surfaces it may be difficult to distinguish between fragments and matrix; on a weathered surface, however, the fragments stand out. The matrix contains irregular bodies of zeolites.

The top slag is by far the thicker of the two: commonly it is between one and five metres thick, but can be 10 m thick over long distances, and

locally it is 25 metres thick or more. In places where it is absent the upper part of the massive basalt is highly vesicular and reddened, fig. 2 b.

As a general rule the top slag is thickest where the massive basalt is thickest. It thins out towards the margin of the flow and has never been found beyond it. The top slag is especially thick on the southwestern side of Kunoy, at Klakkur northwest of Klakksvík and on both sides of Haraldssund, the sound between Kallsoy and Kunoy, northeast of the village Strond.

The nature of the boundary between the top slag and the massive lava varies. When the top slag is less than about two metres thick, the transition is normally simple; the slag rests on a somewhat uneven basalt surface and the aphanitic, grey basalt passes through a reddened, porous and partly brecciated top layer into an agglomerate-like slag within a few decimetres. In thicker slag layers relations are often more complicated and thin lamellae of massive basalt may form stringers in the slag (fig. 2 c).

The thin bottom slag is generally only a quarter to half a meter thick, and may be missing altogether. Locally it can be as much as four metres thick. Its upper boundary is usually sharp; apophyses of massive lava may intrude it from above. Like the top slag the bottom slag is thickest in the centre of the area in which the Klakksvík lava crops out.

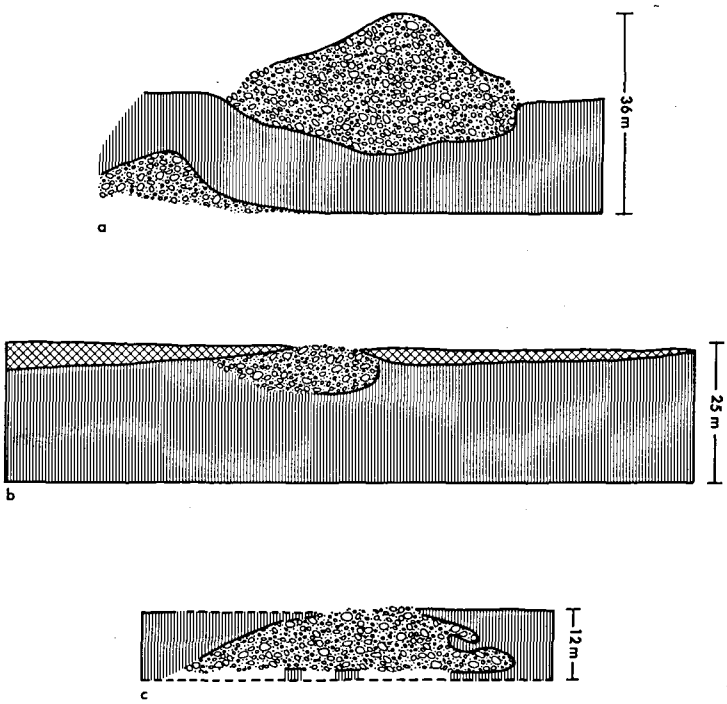

Fig. 2. Three sections through the Klakksvík flow with different signatures for slag and massive lava. In fig. b also the covering lava is indicated.

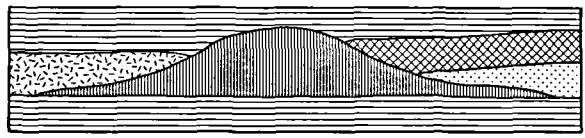

Fig. 3. Schematical cross section of the Klakksvík flow – vertically ruled. The vertical scale of the figure has been considerably exaggerated.

The bottom slag is absent at some localities near the margins of the lava flow where the top slag is still present; the opposite situation has never been observed. There is every reason to believe that the bottom slag consists of material which fell down the front of the advancing lava.

The chemical composition of the lava from the quarry at Klakksvík differs somewhat from the main mass of olivine tholeiitic lavas which dominate the sequence above the C-horizon (NOE-NYGAARD and RASMUSSEN, 1968). The contents of both alkalies and MgO are greater than the average. None the less the lava is considered akin to the olivine tholeiitic lavas of the upper lava series because of its normative ol and hy (YODER and TILLEY, 1962). A chemical analysis was carried out by ME MOURITZEN (NOE-NYGAARD and RASMUSSEN, 1957, p. 403).

TUFFS

Thin layers of red tuff are found in places both below the bottom slag and above the top slag. It is uncertain whether or not these tuffs have anything to do with the formation of the Klakksvík lava. Their present extension suggests that they may be redeposited.

THE OVERLYING BASALTS

After the Klakksvík lava had been extruded a production of porphyritic basalts began. On the northeast side of the oblong Klakksvík lava mound these were followed by dark, aphyric basalts. The total thickness of these was sufficient to cover only the lower parts of the Klakksvík lava. The central part of the Klakksvík eruption zone was finally buried by thin flows of grey vesicular basalt (fig. 3) of the same type as occurs beneath the Klakksvík lava.

THE MODE OF ERUPTION

The isopach map (fig. 1) shows the trend of the eruption zone: NW-SE, that is, subparallel to the direction of the present fjords.

It is inferred from the changing number of individual flows from one place to another, that the eruption of the Klakksvík lava took place from a number of smaller craters.

Several of the eruption sites must have been within the area of the present Kallsoy Fjord, because the lavas and slags are thickest on either side of this fjord; most likely they have been localized on a fissure subparallel to the fjord. Other areas where the Klakksvík flow is very thick are the southern part of Haraldssund and just north of Klakksvík. In these areas the lava may be more than 25 metres thick.

No doubt most of the upper slag layer was formed by degassing of the advancing cooling lava. Possibly some of the bigger slag accumulations in the central parts of the flow were formed by explosive outbursts directly from the craters.

This type of fissure eruption is well known from post-glacial eruptions in Iceland, i. e. Lakagígar (HELLAND, 1886; THORARINSSON, 1968) and Þrengslaborgir (RITTMANN, 1939).

The lava crops out over an area 5 to 8 km wide and 21 kilometres long from the northernmost end of Kallsoy, over Kunoy to Borðoyarvík and to Arnafjördur on Borðoy, where the lava disappears below sea level. The lava is about 15 metres thick, where it ends in the air on the northern Kallsoy, in Borðoyarvík, where it goes below sea level, it is still 9 metres thick. There is, therefore, every reason to believe that the fissure was even longer than 21 kilometres, perhaps it has an echelon course.

The Klakksvík lava covers at least 125–150 km^2. Within this area the average thickness is estimated to be 10–12 metres, which means that the total volume of the layer is at least 1.5 km^3.

Stratigraphically the Klakksvík lava belongs in the uppermost part of the middle lava series of the Faeroe Islands. Petrographically it must be considered as a forerunner of the olivine tholeiitic basalts which characterize the upper lava series (NOE-NYGAARD and RASMUSSEN, 1968).

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