CHAPTER VII

The Faskrudsfjordur Composite Lavas.

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(i) Introduction

One of the outstanding features of the upper part of the Reydarfjordur Acid Volcanic Succession is the group of four composite lavas. The flows are not synchronous as one was erupted during the Fourth Phase and three during the Sixth. The clarify the description of these lavas the best exposed and most complete example - one of the Sixth Phase lavas - is described first.

(ii) The Upper Gilsardalur Composite Flow

The best-exposed and most compact and complete section through a composite lava is found on the north side of Gilsardalur, north of Faskrudsfjordur. This flow, the Upper Gilsardalur Composite Lava, has been erupted from a composite dyke which is uncovered by erosion for a depth of 1,500 ft. below the base of the extrusion. The flow rests upon the massive Sixth Phase rhyolitic andesite lava which forms such a conspicuous feature in the Gilsardalur area.

Exposures on the north side of Gilsardalur.

On both sides of Gilsardalur the composite dyke is seen to cut the massive rhyolitic andesite flow mentioned above, expanding upwards as it does so from 40 ft. on the shore of Faskrudsfjordur to over 100 ft. in width, and on the north side passing directly into a composite lava. The basaltic eastern margin of the dyke here continues eastwards as a layer one to two feet thick at the base of the composite lava, and the rhyolite interior of the dyke is continuous with the rhyolite which forms the remaining upper part of the flow.

Exposures of the base of the flow are incomplete west of the dyke feeder, but are sufficient to establish

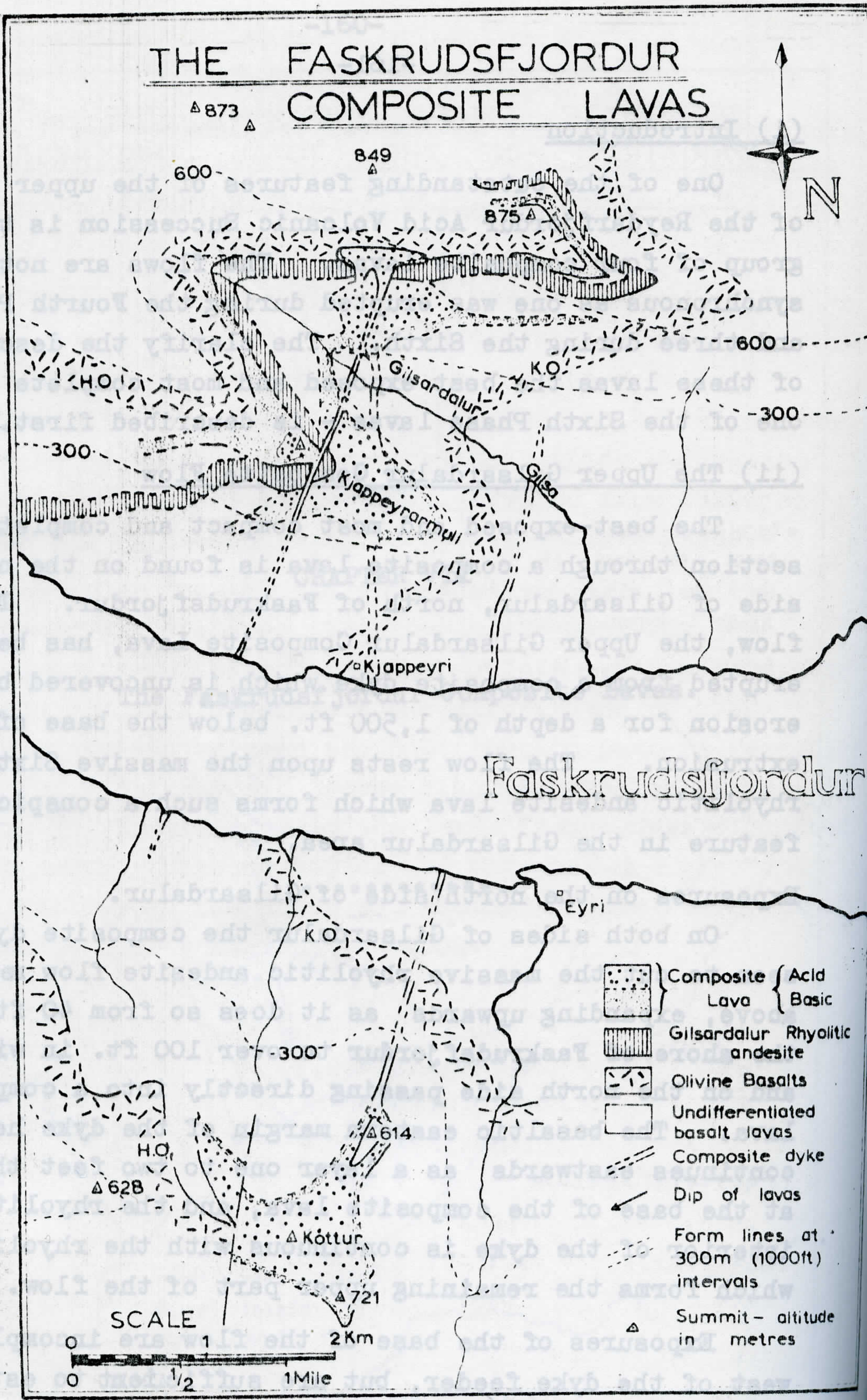
THE FASKRUDSFJORDUR
COMPOSITE LAVAS
N
873
849
875
600
600
300
300
300
H.O.
K.O.
Gilsardalur
Gilsa
Kjappeyrarmuli
Kjappeyri
Faskrudsfjordur
Eyri
K.O.
H.O.
614
628
Kottur
721
SCALE
0
1
2 Km
0
1/2
1 Mile
Composite Lava
Acid
Basic
Gilsardalur Rhyolitic andesite
Olivine Basalts
Undifferentiated basalt lavas
Composite dyke
Dip of lavas
Form lines at 300m (1000ft) intervals
Summit - altitude in metres

Fig. 35

that the basal basalt layer is also discontinuous; in places here the acid component rests directly upon a thin tuff bed separating the composite lava from the rhyolitic andesite flow beneath.

The composite flow has a maximum thickness of about 200 ft. The two components, the lower of basalt and the upper of rhyolite, are separated by a sharp and welded, but unchilled, contact, without intervening slag. The rhyolite is non-porphyritic and highly spherulitic and cavernous through most of its mass, making the flow structure difficult to trace, although it appears to be steep or vertical in the pitchstone top of the flow. Xenoliths, which are similar in composition to the basalt of the basal layer, are found throughout the rhyolite; they are particularly abundant near to the base where they make up to 10 to 20 per cent of the rock, but decrease to around 7 per cent in the interior of the flow. The basaltic layer itself constitutes only 1 to 2 percent of the bulk of the flow, but the abundant basalt xenoliths in the rhyolite bring the total percentag of basic material to about 10.

At the eastern termination of the flow this basalt selvage curves over the termination and for a short distance overlies the rhyolite. The steeply-inclined basalt layer is here rather fractured and locally discontinuous. Where the basalt is missing the rhyolite is chilled marginally to a pitchstone, and a pitchstone layer occurs everywhere along the top of the rhyolite where, again, basalt is missing.

East of the dyke feeder the underlying tuff and the slaggy top of the rhyolitic andesite flow are missing, and the composite lava rests directly on massive rhyolitic that the basal basalt layer is also discontinuous; in places here the acid component rests directly upon a thin tuff bed separating the composite lava from the rhyolitic andesite flow beneath.

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East of the dyke feeder the underlying tuff and the slaggy top of the rhyolitic andesite flow are missing, and the composite lava rests directly on massive rhyolitic andesite. The eastern termination of the composite flow is in contact with, and the toe underlies, a mass of brecciated andesite slag, at least 50 ft. thick; it is believed that this breccia represents the slaggy top of the andesite flow, stripped off and bulldozed by the advancing front of the composite flow.

From the section (see fig. 36) it will be noted that the underlying rhyolitic andesite flow has a very much reduced thickness immediately west of the dyke feeder, and the composite flow in part rests in a depression in this flow. A possible explanation is provided by the presence of the domed top of the Lower Gilsardalur Composite Lava (the earlier Fourth Phase composite flow) which projects up into the rhyolitic andesite, immediately below the depression. It is believed that this resulted in a depression in the top, or a gap in the continuity, of the rhyolitic andesite.

The flow structure in the rhyolite of the western portion of the composite lava above the depression in the rhyolitic andesite flow, appears to be cut across by that of the eastern part, without chilling at the contact. This suggests that the former may be slightly earlier and perhaps erupted from a different point along the dyke feeder. The bulldozing of the floor of the composite flow east of the dyke feeder may be due to the restraining influence of this slightly earlier western portion.

The Kjappeyrarmuli exposures

The second exposure of the Upper Gilsardalur Composite flow is seen on Kjappeyrarmuli (fig. 35) where it rests upon the rhyolitic andesite flow referred to above. South west of the summit the latter flow is overlain by the basaltic portion of the composite lava,

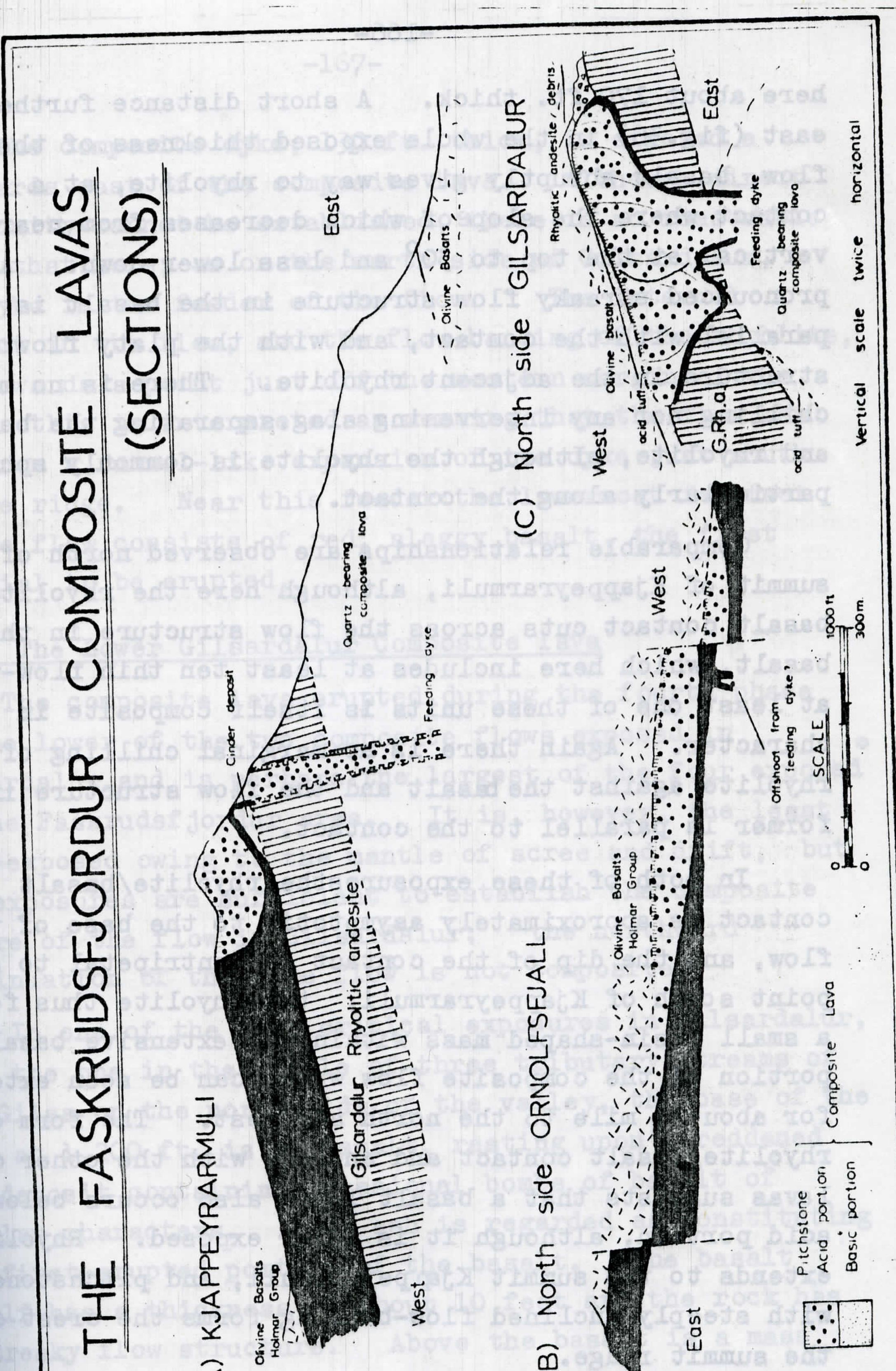
THE FASKRUDSFJORDUR COMPOSITE LAVAS
(SECTIONS)
(A) KJAPPEYRARMULI
Olivine Basalts
Holmar Group
Gilsardalur Rhyolitic andesite
Cinder deposit
Feeding dyke
Quartz bearing composite lava
Olivine Basalts
West
East
(B) North side ORNOLFSFJALL
Olivine Basalts
Holmar Group
Offshoot from feeding dyke?
East
West
(C) North side GILSARDALUR
Rhyolitic andesite / debris
Olivine basalt
acid tuff
G.Rh.a.
acid tuff
Feeding dyke
Quartz bearing composite lava
West
East
Pitchstone
Acid portion
Basic portion
Composite Lava
SCALE
1000 ft
300 m
0
0
Vertical scale twice horizontal

Fig. 36

here about 170 ft. thick. A short distance further east (fig.36) in the whole exposed thickness of the flow, basalt abruptly gives way to rhyolite, at a contact where the slopeof which decreased from nearly vertical at the top to 30° and less lower down. A pronounced streaky flow structure in the basalt is parallel with the contact, and with the platy flow structure in the adjacent rhyolite. There is no marginal chilling nor any intervening slag.separating the basalt and rhyolite, although the rhyolite is commonly spherulitic particularly along the contact.

Comparable relationships are observed north of the summit of Kjappeyrarmuli, although here the rhyolite/basalt contact cuts across the flow structure in the basalt, which here includes at least ten thin flow-units; at least one of these units is itself composite in character. Again there is no marginal chilling of the rhyolite against the basalt and the flow structure in the former is parallel to the contact.

In both of these exposuresthe rhyolite/basalt contact is approximately asymptotic to the base of the flow, and the dip of the contact is centripetal to a point south of Kjappeyrarmuli; the rhyolite thus forms a small basin-shaped mass within the extensive basaltic portion of the composite flow which can be seen extending for about a mile to the north and west. The form of the rhyolite/basalt contact and anology with the other composite lavas suggests that a basalt layer also occurs below the acid portion, although it is never exposed. Rhyolite extends to the summit Kjappeyrarmuli, and pitchstone with steeply-inclined flow-banding forms the crest of the summit ridge.

The composite dyke, 130 ft. thick, is exposed a few yards east of the composite lava. Although direct continuity cannot be established, there is no reasonable doubt that here, as on the north side of Gilsardalur, the dyke is the feeder of the flow. The internal contact in the flow, and the flow-banding of the rhyolite, dip towards a point just off the western margin of the dyke; this is interpreted as meaning that the flow was fed from a funnel-like expansion of the dyke just south of the ridge. Near this feeder the lowermost few feet of the flow consists of red, slaggy basalt, the first material to be erupted.

(iii) The Lower Gilsardalur Composite lava

The composite lava erupted during the fourth phase is the lower of the two composite flows exposed in Gilsardalur and is perhaps the largest of the four exposed in the Faskrudsfjordur area. It is, however, the least well-exposed owing to the mantle of scree and drift, but the exposures are sufficient to establish the composite nature of the flow in Gilsardalur; the northward continuation of the same flow is not composite.

In one of the most critical exposures in Gilsardalur, i.e. the one in the middle of three tributary streams of the Gilsa on the north side of the valley, the base of the flow at 1,200 ft. is of basalt, resting upon a reddened ash deposit containing occasional bombs of basalt of similar characters. The ash is regarded as constituting the first-erupted portion of the basalt. The basalt itself has a thickness of about 10 feet and the rock has a streaky flow structure. Above the basalt is a mass of rhyolite some 300 ft. thick, with pitchstone top. The contact between the basalt and rhyolite is sharp and unchilled. The rhyolite veins the basalt in a zone some 2 ft. wide and the veins, which are of very vesicular rhyolite, cut across the flow structure of the basalt. Basalt xenoliths in the rhyolite are apparently identical with the basalt basal layer. The rhyolite is unusual for an Icelandic rhyolite in containing quartz phenocrysts, while the basalt contains sparse quartz xenocrysts.

The rhyolite part of the flow does not extend far laterally from the feeding fissure, and is dome-like in cross section with the later basalt lavas banked up against it. Locally it is overlain by the thick rhyolitic andesite flow upon which the upper composite flow was erupted. At the western termination of the rhyolite of the lower flow, a thick pyroclastic or talus deposit is seen which contains basalt fragments identical in shape, size and other characters with basalt xenoliths in the rhyolite. The rhyolite appears locally to have over-ridden these rocks, although exposures are too incomplete to be certain of this. The quartz-bearing basaltic lower portion of the flow can be traced for about one mile further west than the rhyolite in the Gilsa.

Two further exposures of what must be a continuation of the same flow are seen on either side of the valley north of Ornolfsfjall, but in neither is the flow composite. The southern is of almost completely non-xenolithic rhyolite and has an arch-like form, with later basalt lavas banked up against it. The northern is of slightly xenolithic rhyolite and is associated with a plug-like intrusion of identical character which is clearly its feeder. This intrusion, which has caused some updoming of the adjacent basalts, is in line with the composite dyke which feeds the Lower Gilsardalur flow.

(iv) The Kottur Composite flow

The only composite lava on the south side of Faskrudsfjordur was extruded during the Sixth Phase. It is a predominently rhyolitic, dome-shaped flow, which constitutes the upper portions of the mountains Kottur and Grafell. The existence of the mass was recorded by Hawkes (Hawkes & Harwood 1932) while the composition of the pitchstone and its phenocrysts has recently been determined by Carmichael (1962B and 1963A) The basaltic basal portion of the flow is often obscured by scree from the very much thicker overlying rhyolite, and is best exposed on Eyrartindur, where it is 20 to 30 ft. thick.

On the N.W. slopes of Eyrartindur the composite flow is seen joined to its dyke-feeder and this composite dyke is exposed at intervals down to the shore of Faskrudsfjordur, where it is 40 ft. thick. The rhyolite of the dyke is everywhere rich in basaltic xenoliths.

The rhyolitic portion of the flow has a chilled pitchstone top, well seen on the slopes west of Kottur, but pitchstone is also seen at intervals within the rhyolite. Relationships are confused but the rhyolite appears to be made of two or three components or flow units, and the pitchstone seems to represent local internal chilled contacts. The rhyolite is unusual for Iceland and contains anorthoclase phenocrysts. It is xenolithic only near its base. Spherulites are common throughout the rhyolite.

Where thin on Eyrartindur, the extrusive nature of the body is clear. South of Eyrartindur the flow rapidly increases in thickness to form the rhyolite dome of Kottur itself. This dome has a pitchstone carapace, and the basalt lavas which cap Eyrartindur are very obviously banked up against the side of the dome

(v) The Ornolfsfjall Composite Flow

The third Sixth Phase composite lava is well exposed at about 2,100 ft. near the base of the precipitous northern face or Ornolfsfjall(fig.35) The thickness varies from 100 ft. to a maximum of 160 ft. Where it is thickest, the flow is composite in character, and a thin basal component of basalt is overlain by a layer of conspicuously xenolithic non-porphyritic rhyolite. Traced in either direction from the thickest point, the basaltic layer is seen to thicken at the expense of the rhyolite until the flow is made up entirely of basalt. The rhyolite component is completely missing in exposures of the flow on the southern side of the Ornolfsfjall ridge.

The rhyolite is highly vesicular and spherulitic through much of its mass and has a pitchstone top with steeply-inclined flow structure typical of rhyolite extrusions. The composite body is nowhere transgressive and is clearly a surface extrusion; it rests on a thick basaltic andesite flow and a tuff bed everywhere separates it from the succeeding basalts. Where the flow is not composite and consists of basalt throughout its thickness the basalt has a slaggy and vesicular top.

From a distance the contact between the rhyolite and basalt components of this flow is a smooth and gently curving surface, but in detail rhyolite is seen to vein the basalt over a thickness of several inches - or even several feet. In places the basalt is chilled against the rhyolite. At one point where the flow is composite and near where the basal basalt layer is thinnest, the basalt descends abruptly some distance below the normal line of the base of the flow, and exposures of acid rock are also seen associated with this basalt. Scree conceals many of the exposures at this point, but it is possible that the feeder of the flow is loated here.

(vi) Discussion

All the field evidence proves that the basic and acid magmas of these composite lavas were liquid at the same time and emerged from the composite dyke-feeder essentially simultaneously. The form and spatial distribution of the two components - the wrapping-around of the toe of the Upper Gilsardalur flow by the basalt margin, for instance, and the gradual thickening of one component at the expense of the other in the Ornolfsfjall flow - perhaps constitutes the most cogent evidence for the contemporaneity of the two magmas. The finer details confirm this conclusion. Thus rhyolite veins basalt in the Ornolfsfjall flow, but the basalt is itself chilled to a pitchstone only where the basalt veneer is missing; elsewhere the 1 to 2 ft. layer of basalt, which was hot at the same time that the rhyolite was hot and plastic, has protected the rhyolite from chilling. It is likely, however, that sometimes basalt commenced to erupt before

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The proportion of basalt in a composite flow varies over wide limits, from 10% or less to perhaps over 80%. Not only does it vary from one flow to another, but it also varies in different exposures of the same flow. Thus the upper Gilsardalur flow is predominantly of basalt in the Kjappeyrarmuli exposure, but mainly of rhyolite north of Gilsardalur. The lower composite flow seen in Gilsardalur contains comparable volumes of basalt and rhyolite and has been erupted from a composite dyke. The northward continuation of the same flow, where seen north-west of Ornolfsfjall, is not composite and is wholly of rhyolite; in the northernmost outcrop the rhyolite has clearly been erupted from a plug-like conduit in line with the composite dyke in Gilsardalur.

Surface conditions were evidently not favourable for the mixing of the two magmas and they retained their individuality in the composite flows to a remarkable degree. This may be due partly to differences in the viscosity of the two magmas, and partly due to the formation of a skin of chilled basalt between the two magmas which inhibited their mixing.

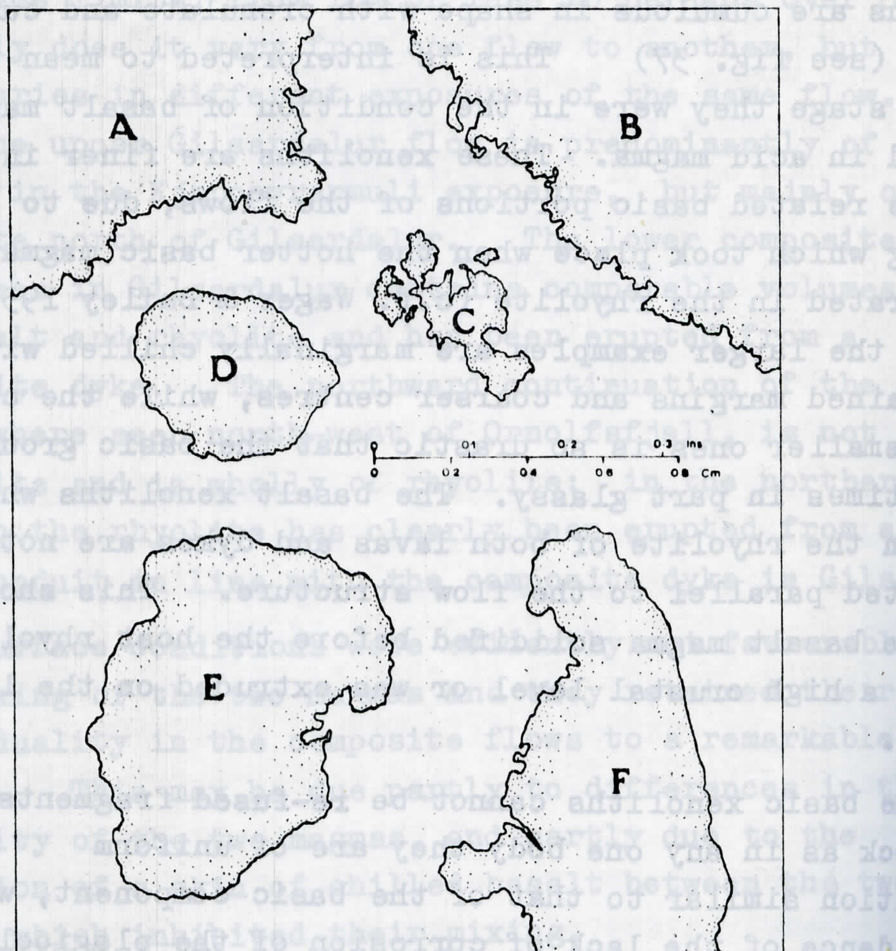
Xenoliths are widespread in the rhyolite of most of the composite flows studied and they are almost invariably of basalt similar to the basaltic component of the flow. They are generally more abundant in the rhyolite adjacent to the basaltic portion of flow. Thus near the base of the Upper Gilsardalur flow they constitute about 15% of the rock, falling off to 7% in the centre of the same rhyolite mass. Normally the xenoliths are small, most being 3 ins. or less in diameter, but larger examples are found, especially adjacent to the basaltic portion of the lavas, and exceptionally they attain a diameter of 2 ft.

It is highly significant that the majority of the xenoliths are cumulous in shape with crenulate and curious margins (see fig. 37) This is interpreted to mean that at some stage they were in the condition of basalt magma enclosed in acid magma. These xenoliths are finer in grain than the related basic portions of the flows, due to chilling which took place when the hotter basic magma was incorporated in the rhyolite (c.f. Wager & Bailey 1953) Some of the larger examples are marginally chilled with fine grained margins and coarser centres, while the chilling in the smaller ones is so drastic that the basic groundmass is sometimes in part glassy. The basalt xenoliths which occur in the rhyolite of both lavas and dykes are not attenuated parallel to the flow structure. This shows that the basalt magma solidified before the host rhyolite reached a high crustal level or was extruded on the land surface.

The basic xenoliths cannot be re-fused fragments of wall rock as in any one body they are of uniform composition similar to that of the basic component, while the evidence of the lack of corrosion of the plagioclase phenocrysts shows that the acid magma was not super-heated prior to the inclusion of the basic material. Thus the widespread melting of wall rocks is unlikely. The xenoliths were clearly derived from the same primary magma source as the basic component of the composite body.

Where the rhyolite is porphyritic the basalt contains a small proportion of phenocrysts identical with the phenocrysts in the rhyolite. In the lower Gilsardalur flow these are of quartz and sodic plagioclase. Many

XENOLITHS IN THE FASKRUDSFJORDUR COMPOSITE LAVAS AND RELATED DYKES



Xenoliths from :-

A Dyke feeder for U. Gilsardalur Composite Lava

B & C Dyke feeder for Kottur Composite Lava

D, E & F Ornolsfjall Composite Lava

Fig. 37

composite dykes described in the literature are similar in this respect (Bailey & McCallien, 1956) and it is generally taken to show that the basalt absorbed some acid magma, probably at an early stage, before extrusion. The xenocrysts are relics of this absorbed material.

At present the only other known example of a rhyolite/basalt composite lava also occurs in Eastern Iceland. It is one of the constituent lavas of the Breiddalur Central Volcano (Walker, 1963) The structure of this lava is simple in that nearly everywhere it is composite in character with a basal basalt layer, 5 to 10 ft. thick, and an upper rhyolite component between 100 and 150 ft. thick. In contrast to the lavas described above, there is a narrow zone of mixed rocks between the two components.

The Gardiner River rhyolite basalt complex (Fenner 1938 and 1944, Wilcox 1944) shows many of the features of the Icelandic composite lavas. Hawkes (1945) realised the similarity between this complex and the British Tertiary composite bodies and the present author also considers that the Gardiner River complex may be a composite lava. It is similar to the examples described here and may be the extrusive product of a composite dyke, the rhyolite and basalt emerging essentially simultaneously from the same fissure.

The Icelandic composite lavas warrant comparison with some gabbro-granophyre intrusions where basic and acid rocks are intimately associated. Often these intrusions show veining of the gabbro by the granophyre along their mutual contact, and in places the gabbro may be chilled against the granophyre. Wager & Bailey (1953) found evidence on St.Kilda that basic magma could be chilled against cooler acid magma without widespread mixing - an hypothesis fully supported by the present author. Since then further examples showing similar features have been described from Slieve Gullion (Bailey & McCallien 1956; Elwell 1958), Guernsey (Elwell et al 1960) and S.E.Iceland (D.Blake, pers. comm.)

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