HISTORICAL AND GEOLOGICAL NOTES ON BOUVETØYA

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ABSTRACT. It is suggested that "Thompson Island", reported on two occasions north-east of Bouvetøya at the southern end of the Mid-Atlantic Ridge, may have disappeared as a result of a volcanic eruption during the nineteenth century.

The lavas of Bouvetøya belong to the alkali-basalt–trachyte–rhyolite series and are characterized by a high iron content and relatively low total alkalis.

A new platform which appeared on the west coast of the island during the period 1955–57 is thought to have originated during a minor volcanic eruption involving the emplacement of a trachyte dome. Chemical analyses of the new trachyte are presented together with spectrographic analyses for trace elements. The clinopyroxene separated from the trachyte has a ferro-augite composition.

BOUVETØYA, situated in the South Atlantic Ocean 2,600 km. from South Africa and 1,700 km. from the Antarctic continent, is the southernmost island on the Mid-Atlantic Ridge (Fig. 1).

Fig. 1. General location map, showing the position of Bouvetøya at the southern end of the Mid-Atlantic Ridge.

For nearly two centuries after its discovery in 1739 there was considerable doubt as to its exact position and there were conflicting reports of the number of islands in this region. That it was inaccurately located for so long is understandable in view of its isolation and the prevailing climatic conditions. What is less easily explained is the fact that at least two observers reported a second island, "Thompson Island", to the north-east of Bouvetøya. The following account reviews the history of the discovery of Bouvetøya and the evidence for the existence of "Thompson Island", and it is followed by an outline of the geology of Bouvetøya incorporating the results of a survey of part of the west coast during 31 March to 2 April 1964.

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History of the Discovery of Bouvetøya and the Evidence for "Thompson Island"

An interesting review of reports relating to islands in the vicinity of Bouvetøya was given in an editorial article in the *Geographical Journal* (Anonymous, 1928), the main facts of which are summarized in Table I.

Table I. The reported position of Bouvetøya according to various navigators

Date	*Captain*	*Vessel*	*Land reported*	*Position* lat.	long.
1739	J.-F.-C. Bouvet de Lozier	*Aigle* *Marie*	"Cap de la Circoncision"	54°S.	11°E.
1808	James Lindsay Thomas Hopper	*Swan* *Otter*	An island (later referred to as "Lindsay Island")	54°22′S.	4°15′E.
1822	Benjamin Morrell	*Wasp*	"Bouvettes Island"	54°15′S.	6°11′E.
1825	George Norris	*Sprightly*	"Liverpool Island" (landed)	54°15′S.	5°E.
			"Thompson Island"	53°56′S.	5°30′E.
1893	Joseph Fuller	*Francis Allyn*	"Circumcision or Bouvet Island"	52°55′S.	4°10′E.
			"Thompson Island"	North-east of "Bouvet"	
1898	Krech	*Valdivia*	"Bouvet"	54°26′S.	3°24′E.
1927	Harald Horntvedt	*Norvegia*	Bouvetøya (landed)	54°26′S.	3°24′E.

A number of ships have visited this area since 1927 but none has reported having seen more than the one island, which is now recognized as Norwegian territory with the name Bouvetøya. It is virtually certain that Norris's "Liverpool Island" was in fact Bouvetøya but the question of "Thompson Island" has never been resolved. Because of the numerous unsuccessful searches that have been made for "Thompson Island" and the fact that in recent years ships equipped with radar have navigated in this region, it is reasonable to accept that the island does not exist. This leaves two possible explanations for the conflicting reports of the nineteenth century: either the observations of Norris and Fuller were at fault or "Thompson Island" did exist at that time but it has since disappeared.

The evidence for the existence of "Thompson Island" supplied by Norris is convincing. As reproduced in the *Geographical Journal* (Anonymous, 1928, p. 541), the log of the *Sprightly* gives details of the positions of rocks around "Liverpool Island" and includes the statement that an island which they named "Thompson's Island" bears north-north-east 15 leagues (72 km.) from "Liverpool Island". The sketches of "Liverpool Island" and "Thompson Island" made by Norris are also included in the same account (Anonymous, 1928, p. 588). The sketch of "Liverpool Island" is readily recognizable as a view of Bouvetøya which at least establishes the veracity of Norris's observations insofar as the one island is concerned. There, is no reason to suppose that his sketch of "Thompson Island" is any the less reliable; it is quite unlike any view of Bouvetøya, and therefore the possibility that he made two different sketches of the same island can be ruled out. In addition, the sketch of "Thompson Island" displays sufficient detail to make it extremely improbable that Norris was actually representing low

cloud or a mirage as land. Finally, the topographic features are plausible: most of the island is shown as having a gently domed form and a single sharp peak rises above the general level in the distance; in the foreground there is a strip of low ground at the foot of the main cliffs and at one end of this is a single small hill which looks very much like a volcanic cone. It seems unlikely that Norris would have imagined a view such as this.

The evidence for "Thompson Island" provided by Capt. Fuller is much less substantial and amounts to the following statement by Balch (1904, p. 82–83): "He saw Thompson Island bearing about northeast from Bouvet Island, but he could not land on either, on account of ice, wind and fog." This report of Fuller's observations in itself scarcely provides adequate grounds for believing in the existence of an island which has never been seen since but a very strong case indeed can be made from Norris's evidence. It would not seem unreasonable to adopt the view that "Thompson Island" existed in 1825, although it definitely does not exist today. As the Deutsche Tiefsee-Expedition of 1898 was the first to establish the correct position of Bouvetøya and in addition made a prolonged search for "Thompson Island", it is unlikely that the island was in existence at that time. If Fuller's report is also accepted, then it must be assumed that "Thompson Island" disappeared between the years 1893 and 1898.

If this view is accepted, there remains the question of the manner in which "Thompson Island" disappeared. From Norris's sketch map it appears to have been a very small island measuring no more than about 2 km. by 1 km. It is inconceivable, however, that it could simply have been eroded away during the time interval that is suggested. Submergence as a result of down-faulting, perhaps associated with a rift structure on the Mid-Atlantic Ridge, is one possibility but a volcanic eruption would probably provide the most likely explanation. Although there is evidence of recent volcanic activity in the area and specifically on Bouvetøya (Baker and Tomblin, 1964), there is no record of an earlier eruption which might have been responsible for the removal of "Thompson Island". However, considering its extremely isolated location, it is quite possible that an eruption of considerable magnitude could have passed undetected in the nineteenth century.

If "Thompson Island" was destroyed as a result of either an explosive eruption or caldera subsidence, then a shoal or seamount should exist today at the former site of the island. The South African Navy has recently carried out soundings in the area 45 miles (72 km.) north-east of Bouvetøya but a shoal has not been located, the depth of water being about 900 fathoms (1,645 m.) (personal communication from Lt Cdr A. B. Crawford). On the basis of this information it would seem virtually impossible that "Thompson Island" existed in the position assigned to it by Norris. Whether he merely failed to locate it precisely or whether he was mistaken as to its existence at all is the question that now remains. Perhaps final judgement should be reserved until the bathymetry around and particularly to the north of Bouvetøya has been thoroughly charted.

Previous Geological Work on Bouvetøya

The Deutsche Tiefsee-Expedition of 1898 was unable to land on Bouvetøya but rock specimens (mostly basalts) were dredged from the sea floor about 3 miles (4·8 km.) east of the island and they were subsequently described and analysed by Reinisch (1907). In the course of the two Norwegian Antarctic Expeditions (1927–29) landings were made at various localities in the south-western part of the island. Holtedahl (1929, p. 89–94) has given an account of the geology and physiography of Bouvetøya based on the observations of both the Deutsche Tiefsee-Expedition and the Norwegian Antarctic Expeditions. He adopted the view that the island is part of a single large volcano which had its main crater in the vicinity of the present summit and suggested that there may have been subsidiary centres especially in the area inland from Norvegiaodden on the west coast. Broch (1946) published a detailed account of the petrography of the specimens collected during the Norwegian Antarctic Expeditions together with a table of all the existing chemical analyses. He emphasized the "pantelleritic" character of the lavas and considered the occurrence of alkali-rhyolite as a particularly notable feature. The principal rock types and their localities as described by Broch are summarized in Table II.

TABLE II. ROCK TYPES FROM BOUVETØYA AND LOCALITIES DESCRIBED BY BROCH (1946)

Locality	*Rock types*
Larsøya	Basalts, rhyolite, obsidian, pumice and scoria
Sjøelefantstranda	Basalts and obsidian
Norvegiaodden	Basalts (many of them altered)

RECENT GEOLOGICAL INVESTIGATIONS

H.M.S. *Protector* visited Bouvetøya during the period 31 March to 2 April 1964 to make a brief survey in collaboration with the British Antarctic Survey. Only very limited investigations were possible on account of the unfavourable weather conditions and the short time available. The geological work involved observations on the general form of the island and the nature of the cliffs from helicopter flights around the island. In addition, helicopter landings were made on a low-lying area at the foot of the main cliffs on the west coast; a reconnaissance survey of this platform was carried out and 18 rock specimens were collected. It was established that a recent volcanic eruption had occurred in this area and a preliminary report of the findings has already been published (Baker and Tomblin, 1964).

More recently, a substantial scientific programme has apparently been carried out by a South African expedition which visited Bouvetøya in February–March 1966.

GENERAL PHYSIOGRAPHY AND GEOLOGY OF BOUVETØYA

Bouvetøya, which is about 9·5 km. from east to west and 7 km. from north to south, reaches a height of 935 m. a.s.l. (Fig. 2). The summit region, which is known as Wilhelm II Platå, is displaced slightly to the west of the geographical centre of the island. It was not observed by the writer but on existing charts it is portrayed as a relatively flat area about 2 km. across, more or less encircled by a number of higher peaks. In all probability, the main crater or caldera responsible for forming the bulk of the main Bouvetøya volcano lies within this area.

Eastwards from the summit the slopes are fairly regular and relatively gentle, but in other directions the gradient is much steeper and there are numerous topographic irregularities. Some of the hills, such as Rustadkollen in the south-west, are probably parasitic eruptive centres. The cliffs around the western half of the island are appreciably higher than those to the east, a feature which is undoubtedly a reflection of the prevailing westerly winds and currents. The entire upper part of the island appears to be covered by ice and snow and in several places glaciers reach down to the sea; rock exposures are restricted to the cliffs and to the occasional beaches and low-lying promontories.

Rock outcrops are rather limited around the eastern and southern coasts where glaciers predominate, but in several places a succession of thin lava flows was observed. Kapp Valdivia and Kapp Circoncision are lava promontories on the north coast; the former is a particularly conspicuous columnar-jointed bluff. The remainder of the north coast is composed of thin lava flows interbedded with scoria and in places overlain by yellow tuff. Although there are numerous lava flows and dykes exposed along the west coast, the proportion of pyroclastic material seems to be much greater than elsewhere; red, yellow and greenish tuffs are well exposed at several localities.

STRUCTURE AND INTERPRETATION OF THE NEW PLATFORM ON THE WEST COAST OF BOUVETØYA

Discovery of the new platform

Information kindly supplied by Lt Cdr A. B. Crawford indicates conclusively that a new

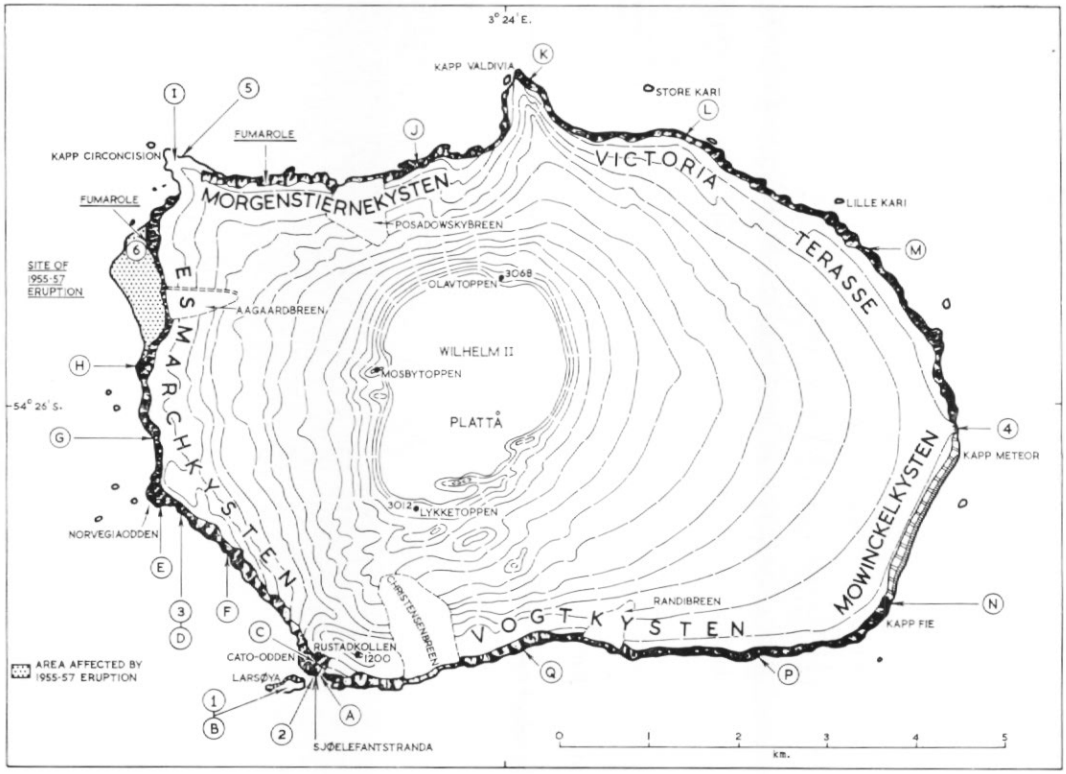

Fig. 2. Map of Bouvetøya showing the localities where landings have been made and summarizing the previous and present geological observations. The topography is based on the South African Hydrographic Office chart (S.A.1, 1956) and the spot heights are in feet.

Landings:

1. Norwegian Antarctic Expeditions, 1927–29.
2. Probable landing place of Morrell in 1822, and Norris in 1825. Also Norwegian Antarctic Expeditions, 1927–29.
3. Norwegian Antarctic Expeditions, 1927–29.
4. S.A.S. *Transvaal* expedition, 1955.
5. S.A.S. *Transvaal* expedition, 1955.
6. Helicopter landings from H.M.S. *Protector* and *R.S.A.*, 1964.

Previous geological observations (Holtedahl, 1929; Broch, 1946):

A. Basalt and obsidian.
B. Rhyolitic lava, obsidian and pumice overlain by tuff containing basalt and other fragments.
C. Interbedded lavas and tuffs.
D. Altered basalts.
E. Lavas overlying agglomerate.

Present geological observations (from helicopter flight):

F. Red and yellow tuffs and thin lava flows.
G. Brown and red tuffs and lava flows.
H. Greenish tuffs and thin lava flows cut by dykes.
I. Lava cut by dykes.
J. Yellow tuff overlying lava.
K. High cliff of columnar-jointed lava.
L. Many thin lava flows with interbedded scoria.
M. Many thin lava flows with scoriaceous partings.
N. Lava exposed at base of cliff.
P. Many thin flows with rubbly partings.
Q. Thin flows with rubbly partings.

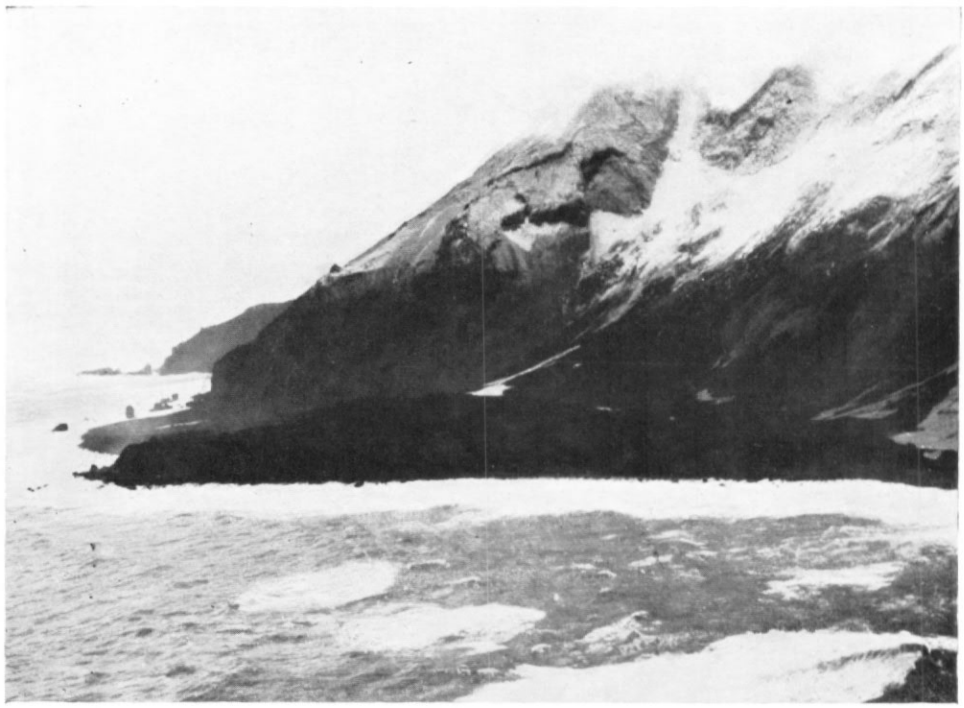

Fig. 3. The new platform on the west coast of Bouvetøya viewed from the south-west (see Fig. 2).

low-lying platform (Fig. 3) appeared on the west coast of Bouvetøya, south of Kapp Circoncision, some time during the period 1 February 1955 to 1 January 1958. The relevant evidence is as follows:

i. The South African frigate *Transvaal* visited Bouvetøya during the period 30 January to 1 February 1955. The platform in question did not exist at this time, as established by the observations of Lt Cdr Crawford, photographs of the west coast and the print of the radar scan.

ii. On 1 January 1958 photographs of the west coast of Bouvetøya were obtained from a helicopter of U.S.C.G.C. *Westwind*. One of these photographs shows a substantial low-lying platform at the foot of the cliffs south of Kapp Circoncision.

iii. Lt Cdr Crawford visited Bouvetøya aboard M.V. *Polarbjørn* on 10 December 1959 and, although it was not possible to land, he observed and photographed the new platform from the ship. He was able to confirm from his own observations that the platform definitely did not exist on 1 February 1955.

Description of the new platform

The platform measures about 650 m. from north to south and 350 m. from east to west. It has an exceedingly irregular surface with an average height of about 25 m. a.s.l. and a maximum height of about 40 m. Along its seaward edge, the platform terminates in cliffs which are in general about 5 m. high but somewhat higher in the centre and lower towards the northern and southern edges; there is a narrow boulder beach at the foot of this cliff for most of its length. To landward the platform ends against the talus slopes reaching down from the main cliffs of the island.

Geologically, the new area may be divided into four zones which are repeated to the north and south of the central higher part of the platform, giving the impression of crude bilateral

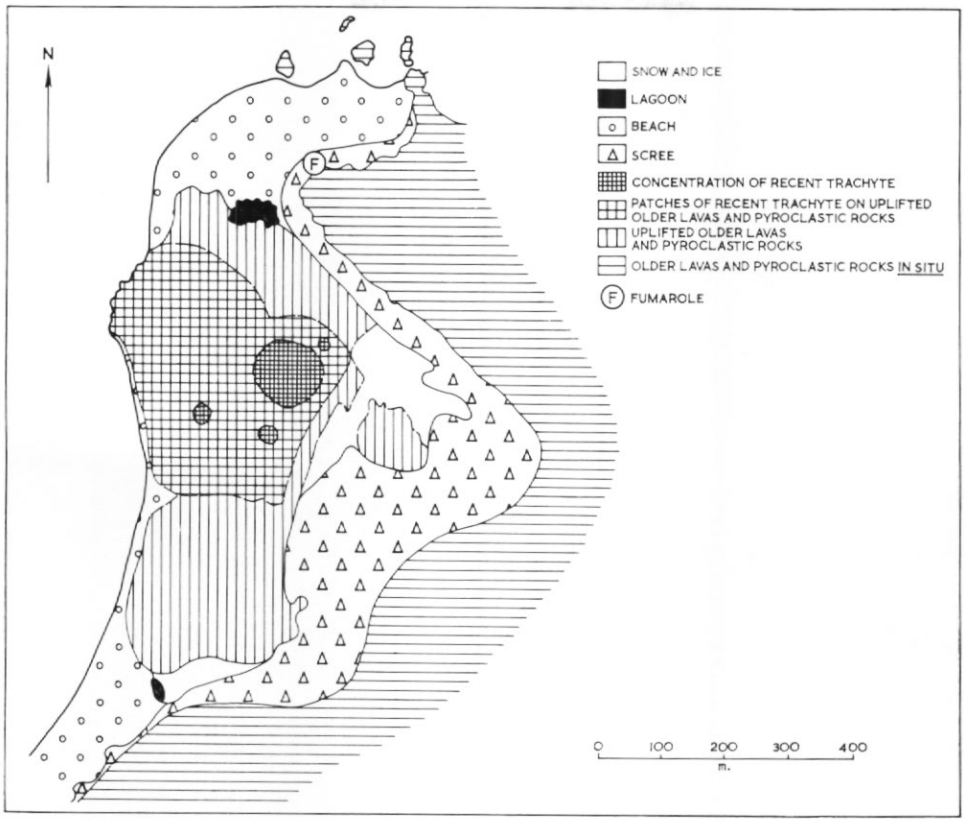

Fig. 4. Geological sketch map of the area affected by the 1955–57 eruption on the west coast of Bouvetøya. The position of this area is indicated on Fig. 2.

symmetry (Fig. 4). It should be emphasized, however, that this is only a very rudimentary zonation and that well-defined geological boundaries do not exist. The four zones that have been recognized are as follows:

i. Broad beaches are situated to the north and south of the higher rocky area. Most of the sand-size material is dark in colour, much of it being magnetite or ilmenite. In addition, there are boulders of lava (probably derived from the cliffs behind) and also boulders of pumice which are believed to have drifted some 2,000 km. from the South Sandwich Islands, where a submarine eruption occurred in 1962 (Gass, Harris and Holdgate, 1963).

ii. Moving in towards the rocky platform, the land rises slightly to a zone composed of conical mounds of greenish ash, similar in appearance to some of the tuffs and ash found in the main cliffs behind. There are also patches and hillocks of fragmented lava (Fig. 5).

iii. Nearer the centre, the land is higher and its surface is composed of large lava blocks. Most of this area consists of heaps of a highly altered lava of basaltic appearance but there are some patches of a blocky lava which has a reddish surface.

iv. The red-surfaced blocky lava is more concentrated in a few places on the highest part of the platform. It appears as short tongues and occasionally forms small dome-like protuberances. One of these small domes stands about 5 m. high and is about 10 m. across at the base; it is composed of the same block or slab lava and

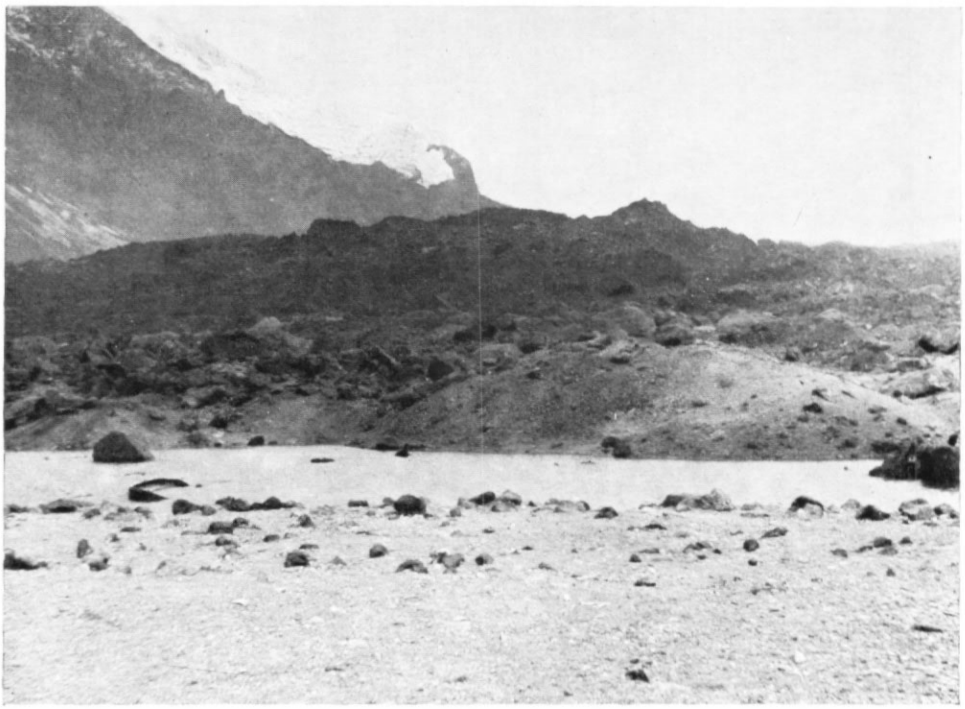

Fig. 5. The new platform on the west coast of Bouvetøya viewed from the north (see Fig. 4). The lagoon is in the foreground; behind it is the zone composed of mounds of greenish ash, and beyond is the central highest part of the platform.

has a distinctly concentric jointing, rather like a large upstanding lava pillow. Although on a smaller scale, it possesses the characteristic structure of a volcanic dome and appears to have solidified in its present position.

Two other features of the new area should be mentioned. First, many blocks of a vesicular black glassy lava can be found lying on the surface of the platform. Secondly, in April 1964 a small fumarole was active at the base of the scree below the main cliff behind the northern beach. The gas being emitted seemed to be mostly, if not entirely, water vapour and no sublimates were observed around the point of emission.

Interpretation of the new platform

There appear to be three possible explanations of the new platform and these are discussed in turn below.

i. That the platform is the result of a landslip, all of the material having been derived from the cliffs behind. The chaotic and fragmentary nature of the whole area and the presence of a slight recession in the cliffs behind it are consistent with such an origin. On the other hand, a landslip would be unlikely to produce the rudimentary outcrop pattern found on the platform nor can it account for the dome-like structures which appear to have solidified *in situ*. Also, the platform has the appearance of a separate physiographic unit rather than an extension of the scree slope from the cliffs behind.

ii. That the platform was uplifted to its present position without the extrusion of a new lava. This could account for most of the features apart from the small domes. Any such localized and rapid uplift would almost certainly be associated with some form of near-surface igneous activity.

iii. That the platform resulted from localized uplift associated with a volcanic eruption. Such an explanation could account adequately for all of the observed features. The lava forming the small domes and the vesicular glassy blocks found on the surface of the platform has a trachytic composition (Table V). A body of viscous trachyte magma may therefore have been intruded at the foot of the main cliffs, carrying with it a carapace of older lavas and pyroclastic rocks fragmented during its ascent. For the most part the new lava was concealed beneath the debris but on the central highest part of the up-domed area, where stresses presumably were at a maximum, new lava was just able to break through to the surface as small dome-like protrusions and short blocky flows. Possibly, the vesicular blocks were emitted in a preliminary explosive phase. The emplacement of this trachyte dome and its debris-strewn capping may well have been accompanied by localized earth tremors which could have resulted in minor landslips from the cliffs behind. The fact that a small fumarole located in this area was active in 1964 (Baker and Tomblin, 1964) but had apparently expired by 1966 (personal communication from W. J. Verwoerd) is also suggestive of a declining phase of activity following recent volcanicity.

Petrography

Broch (1946) has described a number of alkali-basalts and rhyolites from Larsøya and the west coast of Bouvetøya. Several of the specimens collected in 1964 from the new platform and from the cliffs behind are described briefly below.

Lavas from the main cliffs behind the new platform

All of the specimens collected from this area appear to be of basaltic or intermediate composition but most of them are considerably altered.

The lava forming the headland at the northern end of the beach north of the new platform is less altered than most. It consists of plagioclase phenocrysts, zoned largely within the andesine range, and occasional phenocrysts of ilmenite in a matrix of oligoclase, ore, chlorite and calcite; in addition there are amygdales and veins consisting mostly of calcite and quartz.

All of the specimens contain appreciable amounts of calcite and the ferromagnesian constituents have invariably been replaced by chlorite. Occasionally there are veins of pyrite.

Trachyte from the new platform

The analysed trachyte lava BV1 (Table V) was collected from the higher central part of the new platform and it is believed to represent a new lava which reached the surface sometime during the period 1955–57. The lava has a blocky character and the surfaces of individual blocks are reddish in colour, whereas freshly cut surfaces are slightly greenish; flow banding is quite common. The surface colour and banding are not to be mistaken for weathering phenomena; they are features commonly found in new lavas, particularly in those with an intermediate or acid composition. Amygdales and veins, which are conspicuous features of all the older lavas from this part of Bouvetøya, do not occur in the trachyte.

The freshness of the trachyte in thin section, in sharp contrast with the altered character of the other specimens, is taken as further evidence of its recent origin. It is a porphyritic rock with phenocrysts of plagioclase, clinopyroxene and ilmenite in an intergranular groundmass of plagioclase laths, alkali-feldspar (probably anorthoclase), clinopyroxene and ore; there is also a certain amount of interstitial calcite which is believed to be of deuteric origin.

The plagioclase phenocrysts, most of which show signs of resorption, are zoned in the andesine-oligoclase range with cores of about An_{40}; the groundmass plagioclase has a composition of about An_{20}. The clinopyroxene phenocrysts and microphenocrysts have a slightly greenish grey body colour and a ferro-augite composition ($Ca_{41}Mg_{28}Fe_{31}$) as shown in Table III. Like the augites of Gough Island (Le Maitre, 1962, p. 1318–19), the clinopyroxene from the Bouvetøya trachyte has a relatively high Al_2O_3 content and it is moderately enriched in

TABLE III. CHEMICAL COMPOSITION AND OPTICAL PROPERTIES OF CLINOPYROXENE FROM TRACHYTE BV1

		Cations on the basis of 6 oxygens
SiO_2	48·02	Si 1·851
Al_2O_3	5·14	Al 0·234
Fe_2O_3	1·89	Fe^{+3} 0·056
FeO	15·07	Fe^{+2} 0·486
MnO	0·65	Mn 0·021
MgO	8·59	Mg 0·493
CaO	17·53	Ca 0·725
Na_2O	0·87	Na 0·065
K_2O	0·33	K 0·016
TiO_2	1·67	Ti 0·049
	99·76	3·996
Mg	27·7	$\beta = 1{\cdot}723 \pm 0{\cdot}002$
Fe	31·6	$2V(+) = 52°$
Ca	40·7	

TiO_2. The crystallization trend of the clinopyroxenes in the Gough Island lavas is one initially of iron enrichment, followed by enrichment in both iron and sodium as they move towards the composition of aegirine. As shown in Fig. 6, the Bouvetøya pyroxene appears to lie on an extension of the trend initiated by the Gough Island augites. Unlike any of the Gough Island pyroxenes, however, it has a relatively high iron content whilst retaining a low sodium content.

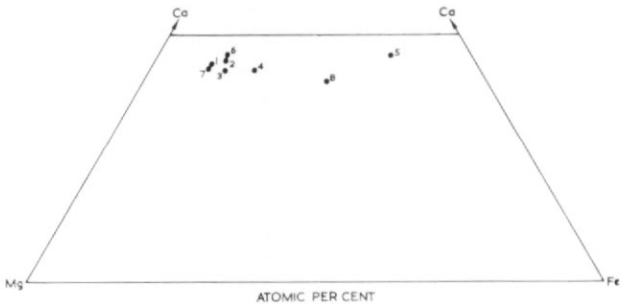

Fig. 6. Ca–Fe–Mg plot of analysed clinopyroxenes from some of the islands on the Mid-Atlantic Ridge.
1–5. Clinopyroxenes from Gough Island (Le Maitre, 1962, p. 1318). Analysis No. 5 contains 2·21 per cent Na_2O.
6. "Basaltic augite" from Tristan da Cunha (Dunne, 1946, p. 44).
7. "Basaltic augite" from San Miguel, Azores (Esenwein, 1929, p. 120).
8. Ferro-augite from trachyte (BV1), Bouvetøya (Table III).

Glassy trachyte

The analysed specimen BV15 is one of a number of highly vesicular glassy blocks found loose on the surface of the new platform. The texture is vitrophyric and the phenocrysts are

the same as in the crystalline trachyte, i.e. plagioclase (largely of andesine composition), clinopyroxene and ilmenite. The matrix is a pale brown glass with microlites. Phenocrysts are slightly more abundant than in the crystalline trachyte but their relative proportions are approximately the same. The modes of the two analysed trachytes are compared in Table IV.

TABLE IV. MODES OF ANALYSED SPECIMENS

	Specimen number BV1	BV15
Phenocrysts		
Plagioclase	17·9	19·1
Clinopyroxene	3·0	3·9
Ilmenite	1·0	1·8
Groundmass	77·9	75·2

GEOCHEMISTRY

Previous chemical analyses of rocks from Bouvetøya (Broch, 1946, p. 24) are of alkali-basalts or rhyolites; the trachytes from the new platform are therefore of interest in that they are the only lavas of an intermediate composition so far reported from the island. All the available complete analyses of lavas from Bouvetøya are given in Table V.

The most notable feature of the chemistry of the Bouvetøya lavas is the high concentration of iron in the intermediate and acid members of the series. The total iron content is not exceptionally high in the basalts, but it remains at almost the same percentage in the trachytes (Fig. 7). Magnesia, on the other hand, diminishes sharply from the basalts to the trachytes and in the latter it is present in very low concentrations as in the trachytes of Gough Island (Le Maitre, 1962) and the Tristan da Cunha group (Baker and others, 1964). Both the total alkali content and the potash : soda ratio are lower than in suites from other Mid-Atlantic Ridge islands.

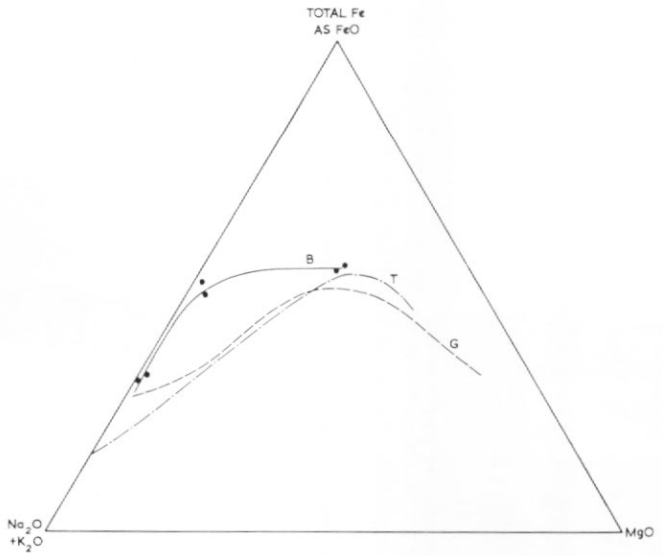

Fig. 7. FeO–MgO–(Na_2O+K_2O) triangular variation diagram for Bouvetøya lavas (solid circles). The approximate compositional trend of series from Gough Island (G) and Tristan da Cunha (T) are shown for comparison with the apparent trend of the Bouvetøya lavas (B). Data for Gough Island are from Le Maitre (1962, table 10) and for Tristan da Cunha from Baker and others (1964, table 6).

TABLE V. CHEMICAL ANALYSES OF LAVAS FROM BOUVETØYA

	1	2	3	4	5	6	7
SiO_2	48·63	49·68	60·52	62·07	68·27	69·47	70·47
Al_2O_3	17·00	18·38	14·88	14·32	14·82	12·84	12·28
Fe_2O_3	5·87	2·70	5·43	1·53	1·31	1·41	2·96
FeO	4·71	6·69	3·67	7·06	3·43	3·70	1·99
MgO	4·46	3·97	0·25	0·55	0·08	0·17	0·18
CaO	9·74	10·62	3·76	3·51	0·67	0·71	0·44
Na_2O	3·13	3·09	5·17	5·15	5·55	5·66	4·91
K_2O	0·84	0·86	2·84	3·35	4·74	4·83	4·85
H_2O+	0·87	0·52	1·33	0·49	0·32	0·35	0·42
H_2O-	1·33	0·32	0·83	0·14	0·02	0·04	0·50
TiO_2	2·73	2·28	1·11	1·18	0·35	0·29	0·29
P_2O_5	0·45	0·35	0·10	0·17	tr	0·03	0·04
MnO	0·18	0·14	0·18	0·22	0·11	0·13	0·06
ZrO_2							0·24
BaO		0·13			0·10	0·11	0·03
CO_2		0·06			0·04	0·12	0·11
S	0·02	0·02			0·01	0·01	0·01
Cl		0·09			0·33	0·28	0·07
		99·90			100·15	100·15	99·85
Less O for C		0·03			0·08	0·07	0·02
TOTAL	99·96	99·87	100·07	99·74	100·07	100·08	99·83
				NORMS			
Q	4·3	1·8	9·7	5·5	15·9	17·9	23·2
or	5·0	5·1	17·2	20·1	28·0	28·6	28·7
ab	26·5	25·5	48·0	47·1	44·5	39·2	36·2
an	29·9	34·2	9·6	6·2	2·9	—	—
ac	—	—	—	—	—	4·1	4·3
di	12·1	13·2	2·7	8·6	0·4	2·5	1·1
hy	5·5	9·9	—	8·9	4·8	5·7	1·9
mt	7·9	3·9	5·9	1·6	1·9	—	2·2
il	5·2	4·3	1·6	1·7	0·7	0·5	0·6
ap	1·1	0·8	0·1	0·3	—	0·1	0·1
wo	—	—	2·4	—	—	—	—
Others	2·6	1·2	—	—	1·0	1·2	1·3
TOTAL	100·1	99·9	100·0	100·0	100·1	99·8	99·6

The trace elements were determined spectrographically on the two trachytes from the new platform and the results are given in Table VI. The average concentration of these elements in

TABLE VI. MINOR ELEMENTS (p.p.m.) IN BOUVETØYA TRACHYTES, COMPARED WITH AVERAGE CONCENTRATION IN TRACHYTES FROM GOUGH ISLAND AND THE TRISTAN DA CUNHA GROUP

	1	2	3	4
Ga	26	20	19	30
Cr	18	7	2	3
V	14	13	4	34
Li	16	17	22	15
Ni	2	3	5	—
Cu	5	7	n.d.	n.d.
Co	7	—	6	—
Sc	28	28	n.d.	n.d.
Zr	670	695	640	490
La	70	70	110	150
Sr	290	315	240	330
Ba	610	740	510	380
Rb	65	70	320	310

n.d. Not determined.

1. BV1. Trachyte; 1955–57 platform, Bouvetøya.
2. BV15. Glassy trachyte block; loose on 1955–57 platform, Bouvetøya.
3. Average of ten trachytes from Gough Island (Le Maitre, 1962, table 11, Nos. G.24, 11, 114, 16, 159, 107, 19D, 3, 18, 149).
4. Average of five trachytes from the Tristan da Cunha group (Baker and others, 1964, table 7, Nos. 560, 30, 31, 420, 439).

trachytes from Gough Island and the Tristan da Cunha group are shown for comparison. In general, there is little difference between the values for the Bouvetøya trachytes and those for the lavas from the other islands. Chromium and barium appear to be slightly higher in the Bouvetøya trachytes and lanthanum slightly lower. The greatest difference, however, is in the concentration of rubidium which is distinctly lower in the Bouvetøya samples.

Chemically and petrographically, the Bouvetøya lavas appear to have more in common with those of Ascension Island (Daly, 1925) than with those of any other island on the Mid-Atlantic Ridge. Extremely basic lavas such as picrite-basalts, ankaramites or even olivine-basalts, which are quite common on Tristan da Cunha, Gough Island and the Azores, have not been reported from Bouvetøya or Ascension Island. The lavas from these two islands are in general more siliceous than those from the other islands, have lower total alkali contents and include rhyolitic obsidian as the most acid member of their series.

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1. Basalt; Larsøya (Broch, 1946, p. 24; anal. E. Klüver).
2. Basalt; Sjøelefantstranda (Broch, 1946, p. 24; anal. E. Klüver).
3. Trachyte; 1955–57 platform (BV1) (anal. P. E. Baker).
4. Glassy trachyte block; loose on 1955–57 platform (BV15) (anal. P. E. Baker).
5. Obsidian; Sjøelefantstranda (Broch, 1946, p. 24; anal. E. Klüver).
6. Obsidian; Larsøya (Broch, 1946, p. 24; anal. E. Klüver).
7. Alkali-rhyolite; Larsøya (Broch, 1946, p. 24; anal. E. Klüver).

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