KOMITET GEOLOGICZNY POLSKIEJ AKADEMII NAUK

PAŃSTWOWE WYDAWNICTWO NAUKOWE • WARSZAWA

acta geologica polonica

Vol. 22, No. 1 Warszawa 1972

KRZYSZTOF BIRKENMAJER

Geotectonic aspects of the Beerenberg Volcano eruption 1970, Jan Mayen island

ABSTRACT: The course of the Beerenberg Volcano eruption 1970 on Jan Mayen island is described. The eruption probably started with the opening of relatively short parallel (stepped) fissures, apparently tension gashes, in the NE part of the island, on the slope of the main stratovolcano. The opening of the fissures was probably due to lateral translation of a part of the island along a NNE-SSW directed tectonic line, the apparent surface projection of a deep-seated dextral strike-slip fault parallel to the Mid-Atlantic Ridge. The southern prolongation of this fault seems to have been the site of minor eruptions in 1732 and 1818, and of slight volcanic activity in 1971 subsequent to the major event in 1970. The opening of the gashes preceded the formation of parasitic craters which were active in producing basaltic lava and ash for a couple of weeks in 1970.

INTRODUCTION

Jan Mayen is a small island (380 sq kms) situated in the northern part of the Atlantic Ocean (71°N and 8—9°W), about 550 km NE from Iceland and 430 km from the east coast of Greenland, on the northeastern extremity of the Icelandic Plateau. The island is elongated SW-NE, parallel to the Mid-Atlantic Ridge and is built almost entirely of volcanic rocks. The island itself lies to the east of the Mid-Atlantic Ridge, on the so-called Jan Mayen Ridge (Fig. 1) which stretches N-S and is truncated on the north by a major fracture, the Jan Mayen Fracture Zone (Johnson & Heezen 1967, Johnson 1968, Johnson & al. 1970).

The south-western part of Jan Mayen, called Sör-Jan, is lower (up to about 800 m a.s.l.) than the northern part, Nord-Jan, which is a large stratovolcano Beerenberg, about 15 km in diameter and up to 2277 m a.s.l., rising from the ocean floor up to about 5300 m (Fig. 2). The Beerenberg

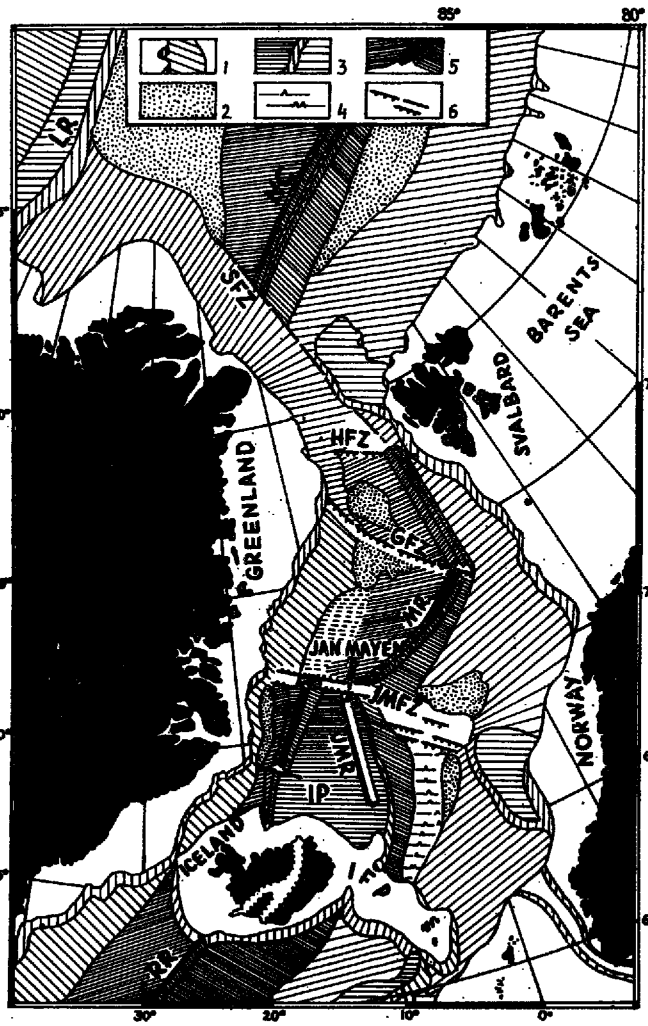


Fig. 1

Position of Jan Mayen in the North Atlantic Basin (morphologic features of the sea bottom after Johnson & Heezen, 1967)

1 continental shelf and continental rise, *2* abyssal plains, *3* submarine platforms, *4* abyssal hills (seamounts), *5* Mid-Atlantic Ridge, *6* fracture zones

GFZ Greenland Fracture Zone, *HFZ* Hovgaard Fracture Zone, *IP* Icelandic Plateau, *IFP* Iceland-Faeroe Plateau, *JMFZ* Jan Mayen Fracture Zone, *JMR* Jan Mayen Ridge, *LR* Lomonosov Ridge, *MR* Mohns Ridge, *NC* Nansen Cordillera, *RR* Reykjanes Ridge, *SFZ* Spitsbergen Fracture Zone

Volcano is covered by firn-fields and by about 20 steep glaciers which radiate from its central, now extinct, crater (Sentralkrateret).

Since the discovery of the island by a Dutch whaler Jan Jacobszon May in 1614 [1], the Beerenberg Volcano was regarded as extinct or nearly extinct, as only twice slight volcanic activity had been reported there. On May 17, 1732, a Dutch sailor Jan Jocobsen Laab observed from his ship which lay at anchor close to Beerenberg a small eruption of flames and black ashes from the south-eastern slope of the volcanic cone, which lasted for about 28 hrs. The site of the eruption was probably that of

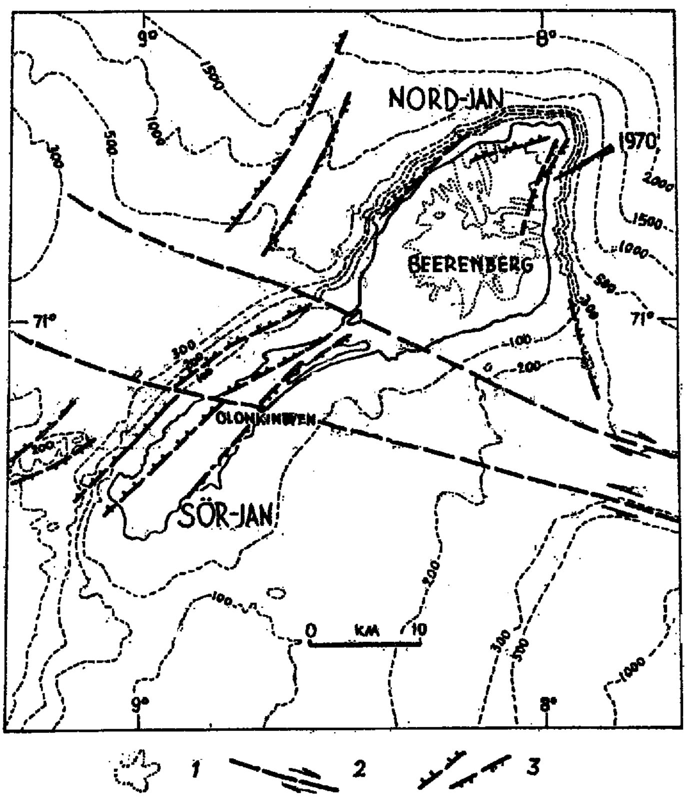


Fig. 2

Supposed major fault systems of Jan Mayen

1 limit of the present glaciation, 2 transcurrent faults parallel to the Jan Mayen Fracture Zone, 3 step-faults parallel to the Mid-Atlantic Ridge

Submarine topography based on *Topografisk kart over Jan Mayen* 1 : 50,000 (Norsk Polarinstitutt, Oslo, 1959)

[1] The exact discovery date is uncertain. Both British and Dutch claim its discovery at the beginning of 17*th* century. It is quite likely that the existence of Jan Mayen was known to the *12th* century Vikings from Iceland or even to Irish sailors from the 6*th* century (*cf.* Orvin 1960, Hahn 1971).

Eskkrateret (*cf.* Fig. 4). Another eruption of smoke rising every 3—4 min. to a height of about 4000 feet was reported from approximately the same place by the famous British sailor William Scoresby Jr. on April 29, 1818. The above reports have been subject to doubt (*cf.* Orvin 1960, Gjelsvik 1970), since neither of these eruptions had produced lava. Since then there were no reports of volcanic activity from Jan Mayen except for exhalations of steam still escaping from small cracks near the Eggöya crater (close to Eskkrateret — see Fig. 4).

The geological history of the Beerenberg Volcano has recently been established mainly by the work of the British geological expeditions (Fitch 1964, Fitch & al. 1965a, b, Roberts & Hawkins 1965) and is here summarized in Tab. 1. The volcanic activity probably started already during the Tertiary, and continued during the Early and Middle Pleistocene (submarine basement of Jan Mayen), the Late Pleistocene and most part of the Holocene. The volcanic products are separated by the Kapp

Table 1

Geological history of the Beerenberg Volcano (after Fitch & al. 1965a, simplified; age in years B.P.)

<table>
<tr><td rowspan="3">Nordkapp Group</td><td>Smithbreen Formation</td><td colspan="2">Small parasitic eruptions up to historical times</td></tr>
<tr><td>Koksletta Formation</td><td colspan="2">2,500—3,500</td></tr>
<tr><td>Tromsöryggen Formation</td><td colspan="2">4,000—5,000</td></tr>
<tr><td>Beerenberg high cone</td><td>Sentralkrateret Formation</td><td rowspan="3">Atlantic</td><td>6,000—7,000</td></tr>
<tr><td rowspan="5">Kapp Muyen Group</td><td>Nordvestkapp Formation</td><td rowspan="2">7,000—8,000</td></tr>
<tr><td>Havhestberget Formation</td></tr>
<tr><td>Storfjellet Formation</td><td colspan="2">Boreal *c.* 9,000</td></tr>
<tr><td>Kapp Fishburn Tillite</td><td rowspan="4" colspan="2">greater than 10,000</td></tr>
<tr><td>Krossbukta Formation</td></tr>
<tr><td>Hidden volcanic formations</td></tr>
<tr><td>Submarine foundation of Jan Mayen</td><td>Submerged volcanic formations</td></tr>
</table>

Fishburn Tillite (Late Pleistocene). Below the tillite there occurs a complex of ankaramitic basalt lavas interbedded with fossil scree material (Krossbukta Formation). The oldest rocks (pre-tillite sequence) seen above sea-level in Sör-Jan (Sörbukta and Ullringbukta) and Nord--Jan (Krossbukta) have been dated by the K-Ar method. Their ages fall within the range 500,000 to less than 30,000 years, *i.e.* are Middle to Late Pleistocene.

Above the tillite appear successively: ankaramitic basalt lavas and cinder accumulations (Storfjellet Formation); basaltic pumice tuff, subordinate lava flows and fissure ridges (Havhestberget Formation); fluent, centrally erupted basalt flows building the main lava dome of Beerenberg, with ankaramitic basalts predominating (Nordvestkapp Formation). The Sentralkrateret Formation is a distinctive glomeroporphyric plagioclase--basalt rock-type. The three youngest formations consist of: 1) ankaramitic basalt lavas and pyroclastics which build great fissure-line ridges, cones and lava fields (Tromsöryggen Formation); 2) volcanic rocks of the latest major eruption cycle (ankaramitic and glomeroporphyric plagioclase-basalts) which build topographically fresh fissure/cone systems, fissure-fed lava fields and coastal lava platforms (Koksslettta Formation); 3) the Recent explosive volcanic accumulations (*e.g.* Dagnyhaugen), moraines of the present ice-field, outwash and torrent gravels, beach and lagoon deposits, present-day scree and avalanche fans (Smithbreen Formation).

Figs 3A, B and 4 show the main fissures, dykes and fault-controlled cliffs in Nord-Jan, the majority of which strike NE-SW. The oldest volcanic rocks on Jan Mayen appear to have been erupted from a fissure swarm aligned close to N 50°E. This early phase of emergence was followed, in Sör-Jan, by a period during which an extensive plateau of trachybasaltic and less basic lavas was erupted from an intersecting network of fissure swarms, the older N 50°E set and the younger N 40°E set. Nord-Jan and the proto-Beerenberg began to grow where the younger and powerful fissure-swarm was intersected by a major cross-fault. This volcanism was probably restricted to the Pleistocene. The principal focus of actvity moved thence northeastwards to Beerenberg and the high summit cone was completed at least 5 to 6 thousand years ago (Fitch & al. 1965b).

COURSE OF THE ERUPTION

The major source of information on the Beerenberg Volcano eruption in 1970 is so far the Norwegian press where eyewitness' reports of both laymen and professionals were released (*cf.* Anonym 1970a—e, 1971a—d; Hjerpseth & Myhre 1970; Oftedahl 1970b). More professional information may be found in short guides to vulcanological excursions to Jan Mayen organized by Bennett's Travel Office and Aftenposten on October 2, 4, 9 and 11, 1970, and led by Ch. Oftedahl (1970a) and J. Naterstad (1970), in the official report by the Norwegian Polar Institute (Smithsonian 1970), and in short descriptions by T. Gjelsvik (1970) and J. Hahn (1971). The author of the present paper had an opportunity to visit Jan Mayen on October 9, 1970, and has published his impressions

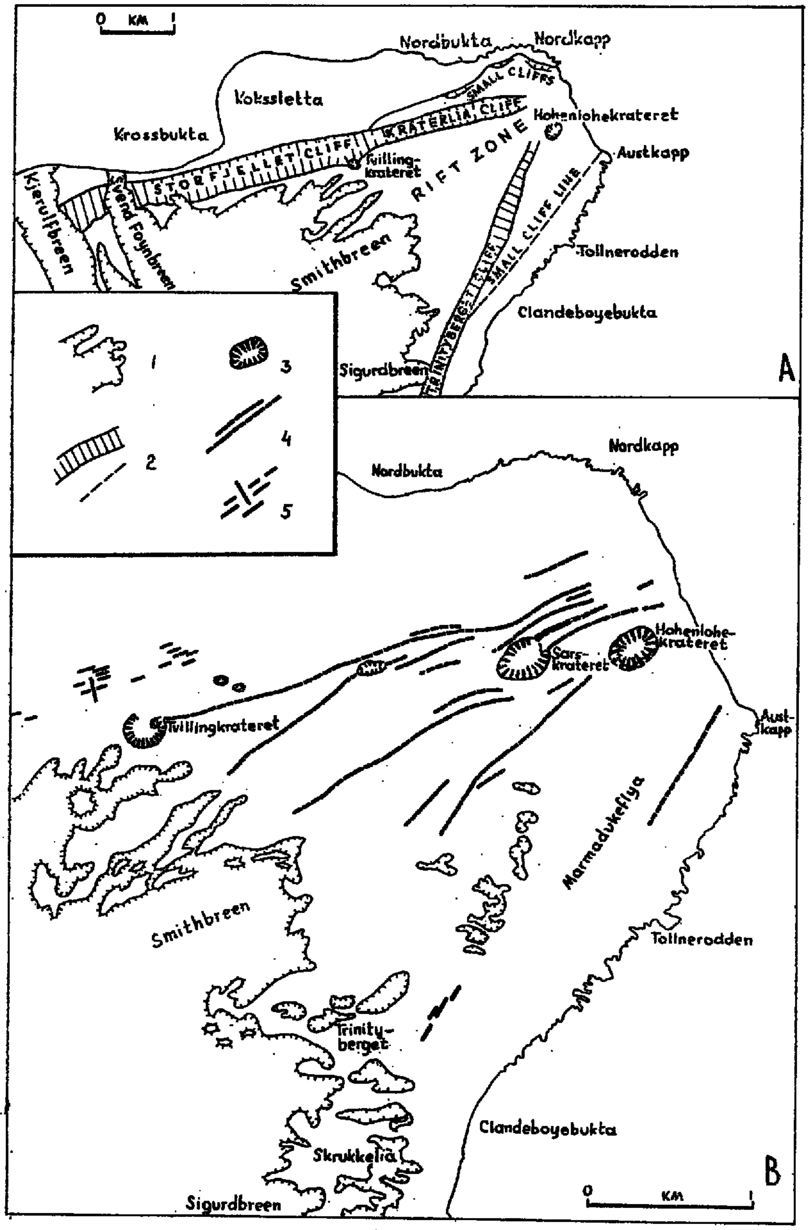


Fig. 3

NE part of Jan Mayen: main morphologic features (*A*) and main structural elements (*B*)

1 glacier margin, *2* fault-controlled cliffs, *3* extinct volcanic craters, *4* major fissures, *5* dykes (adapted from Roberts & Hawkins 1965) and offered some preliminary explanations of the structural problems connected with the eruption (Birkenmajer 1970, 1971).

According to the opinion of the British Meteorological Office based on a careful study of ESSA 8 satellite images showing the extent and height of the volcanic dust and vapours, the Beerenberg Volcano eruption had begun by *9h* GMT on the morning of 18 September, 1970. The main event may have been at the time of the strongest earthquake, reported about five hours earlier that day by the U.S. Coast and Geodetic Survey in the vicinity of Jan Mayen. The quake had a magnitude of 5.1 on the Richter scale. "It seems possible, owing to the spread of the dust cloud by the *21st*, that there were further explosions which put out material into the stratosphere between that time (the *18th*) and the morning of *20th*". Volcanic dust sunset colours and prolonged twilight were noticed in southern England on some of these days (Smithsonian cards 1078—79, 4 January 1971 — see Hahn 1971, p. 17).

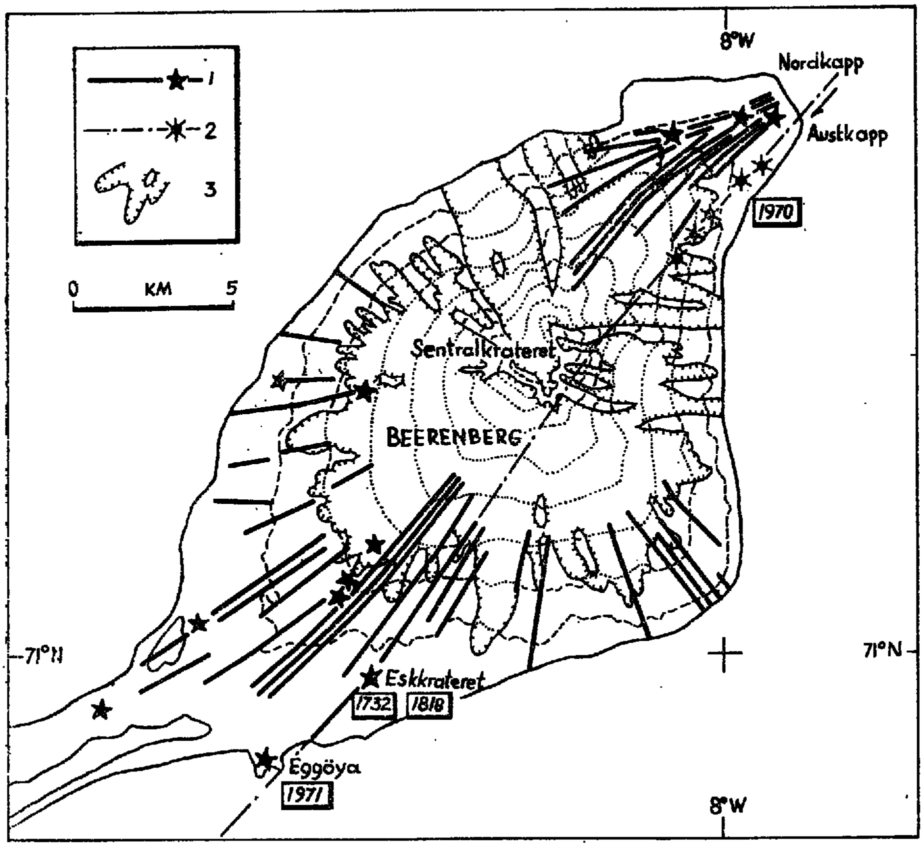


Fig. 4

Beerenberg Volcano, Jan Mayen, the site of the 1970 eruption. Sites of slight volcanic activity marked for Eskkrateret (1732, 1818) and Eggöya (1971)

1 older fissures and volcanic veins with main extinct parasitic craters (asterisked), *2* parasitic craters active in 1970 (asterisked) and the line of supposed deep-seated dextral fault, *3* glacier margin

Contour lines every 250 m (partly after Naterstad, 1970)

On September 19, by *2h* GMT, another earthquake was registered on Jan Mayen by the Norwegian Meteorological Station Olonkinbyen and by the crew of a Braathens S.A.F.E. aircraft, staying overnight on the island. The same day, by *9h* GMT, a peculiar mushroom-shaped cloud was spotted above the Beerenberg Volcano by the same pilots taking off towards Norway who, however, did not realize that this was the eruption cloud. It was not until September 20, at *c*. 3 a.m., that a Japanese airliner flying over Jan Mayen spotted this same cloud which by that time had risen to the considerable height of some 7,000—10,000 m, and reported this to Tromsö as the evidence of a volcanic eruption on Jan Mayen. Shortly afterwards this observation was also confirmed by West German and Italian airliners flying the same route. The Norwegian authorities hastened to evacuate from Jan Mayen the Station's crew, who had been unaware of the situation. It should be added that the eruption took place in the NE corner of the island, some 30 km away from the Station, and that the poor weather conditions (fog and snowfall) rendered it impossible to spot the cloud from Olonkinbyen. A car patrol sent from the Station (on the night Sept. 19/20) to recognize the effects of the earthquake reached the north-west slope of the volcano, but failed to observe anything unusual.

On September 21, the volcanic cloud at Jan Mayen was spotted by J. Friedman, the operator of an amateur receiving station in Scotland when examining NIMBUS coverage taken from 1100 km above the earth.

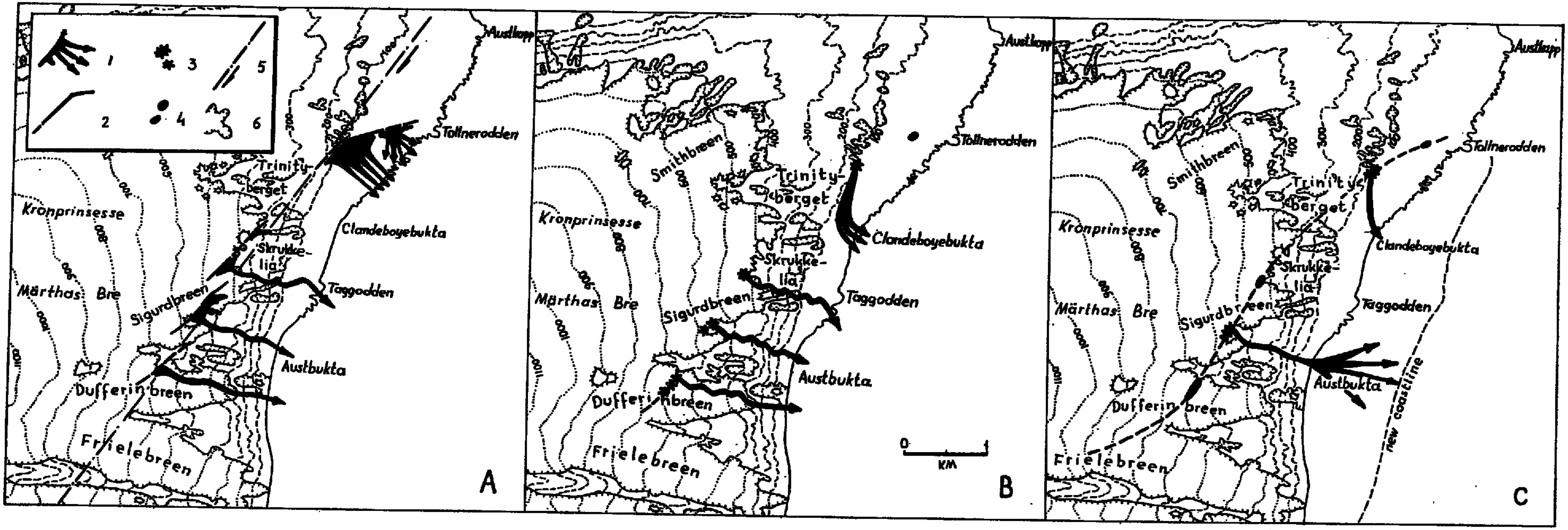
As early as September 21 four Norwegian geologists arrived on Jan Mayen: T. Gjelsvik, B. Flood, T. Siggerud (all from the Norwegian Polar Institute, Oslo) and Ch. Oftedahl (from the Technical University, Trondheim). They were soon joined by the returning crew of the Meteorological Station who resumed their routine survey, as well as by an Icelandic vulcanologist G. E. Sigvaldason. Two Norwegian ships KMN "Heimdal" and M/S "Polarbjörn" were assigned to aid operations in the close vicinity of Jan Mayen, and the Royal Norwegian Air Force (RNAF) continued the aerial survey of the island begun already on September *20th* by Capt. P. Thalberg.

The major features of the Beerenberg Volcano eruption may be summarized as follows.

1. The eruption started on September 18, possibly by about *4h* GMT with an earthquake (magnitude 5.1 on Richter scale). As appeared from the first aerial photographs (taken on Sept. 20—21) four fissures [2] opened along the north-eastern slope of Beerenberg above Clandeboyebukta and Austbukta at an altitude from about 40 m to more than 500 m a.s.l. (*cf*. Birkenmajer 1970, 1971). From these fissures the basaltic lava poured out or erupted in lava fountains up to about 200 m high, while the bombs were ejected into the air still higher (presumably up to about 1000 m or so), and the volcanic ash spread over the effusion area.

2. The lava poured out on the glaciers causing their rapid melting and flood (Jökullhlaup phenomenon), and flowed down the slopes and erosional gullies to reach the sea, where it produced a thick vapour. The

[2] There is an apparent disagreement over the presence of four fissures during the first few days of the eruption. They were reported by Norsk Polarinstitutt in a letter to the Smithsonian Institution on Sept. 29, 1970, but denied in the report from Oct. 23, 1970 (see Smithsonian 1970). The problem will be discussed in the next section of this paper.



Three stages of the Beerenberg Volcano eruption in 1970

A — On Sept. 20—21 *B* — On Sept. 23 (after Oftedahl 1970a) *C* — At the beginning of October

1 lava streams, *2* main eruption fissures, *3* active craters, *4* extinct craters, *5* probable course of deep-seated dextral fault, *6* glacier margin resulting cloud of vapour and dust smelling of hydrosulphur had already risen to 7,000—10,000 m on September 20, but decreased to about 5,000 m on September 21, and to about 2,500—2,800 m on October 9 and 11. Conspicuous belts of brown pumice were observed in the sea outside the island.

The temperature of the lava close to the eruption sites was 1030°C, falling down to 975°C as the lava streams reached the sea. Its velocity measured by Ch. Oftedahl (*op. cit.*) on the mountain slope was about 4 m/sec. The lava heated the sea surface temperature which is usually about 1°C. Already on September 20 (as measured by the RNAF telemetric devices), the temperature of 13°C was reported some seven miles offshore, and on September 21 it had risen to 19°C. About 500 m outside the lava front at Clandeboyebukta and Austbukta some days later, the surface temperatures of 30 to 39°C were obtained by direct measurements. Large numbers of seabirds were seen swimming in hot water, but no dead fish were observed.

3. It is supposed that until September 21 the lava poured out along most of the fissures' lengths. Due to the topographic situation the flow concentrated in separate lava streams, one for each of the three southern fissures, and more numerous for the northernmost, longest fissure (Fig. 5*A*).

4. From September 23 on, five major craters began to form along the pre-existing fissures. Originally some of them had 2—3 vents (Fig. 5*B*) but later, towards the end of September, they apparently enlarged to form single vent craters (Fig. 5*C*), the Tollnerodden-, Trinityberget-, Skrukkelia-, Sigurdbreen- and Dufferinbreen craters. Simultaneously, the four initial fissures disappeared, probably due to filling up with products of eruption, and new, secondary fissures appeared along a line c. 6 km long, interconnecting the craters. This line extended southwards as far as Frielebreen, up to about 1000 m a.s.l.

5. As the result of aggradation by lava the coastline at Clandeboyebukta and Austbukta shifted eastwards by about 1 km, thus increasing the land by about 4 sq kms. The echo-sounding performed from M/S "Polarbjörn" revealed that in Austbukta the sea bottom has risen by about 100 m at the previous 650-m isobath, c. 2.5 km east of the previous shoreline.

6. The volcanic activity was strongest during the first four days (18—21 September) and decreased gradually towards the end of September. The periods of activity of the craters are listed below.

Tollnerodden crater (*c.* 40 m a.s.l.): activity ceased probably on September 21;
Trinityberget crater (50—100 m a.s.l.): still active on October 8;
Skrukkelia crater (*c.* 450 m a.s.l.): activity ceased on September 28;
Sigurdbreen crater (*c.* 500 m a.s.l.): still active on October 8;
Dufferinbreen crater (*c.* 600 m a.s.l.): activity ceased on September 26.

On October 9 and 11 only two craters (Trinityberget and Sigurdbreen) were still active. By late December 1970 the weather was so bad that it was unknown whether eruptions continued, and at the beginning of 1971 it seemed that the remaining two craters had ceased to produce lava.

7. On March 16, 1971, the crew of the Meteorological Station at Jan Mayen again observed smoke and vapour over the NE part of the island. This renewed activity had also been preceded by an earthquake. On March 23 another, strong earthquake was felt at the Station. This was registered by the Seismological Institute in Uppsala at 10.26,19*h* GMT (magnitude of 5.7 on Richter scale), and by the Seismological Station in Bergen at 10.29,11*h* GMT. The same day (March 23) black and yellow patches appeared on the snow at Eggöya (SE corner of Nord-Jan, *cf.* Fig. 4), apparently caused by volcanic dust and sulphuric exhalations from opening fissures.

GEOTECTONIC ASPECTS OF THE ERUPTION

The data already available allow us to discuss some structural problems connected with the recent eruption of the Beerenberg Volcano. Part of these should be verified by field investigations in the forthcoming years.

1. The most important fact, from the geotectonic point of view, was the formation of relatively short separate fissures — lines of lava effusion, preceding the formation of parasitic craters (Birkenmajer 1970, 1971). These fissures were recognized on aerial photographs taken on September 20—21, and were reported in the first letter (September 29, 1970) sent by the Norwegian Polar Institute to the Smithsonian Institution, Center for Short-Lived Phenomena (Smithsonian 1970). In the next report (October 23, 1970) which was based on geological field investigations carried out between September 23 and October 8, 1970, it was stated that "the four fissures ... are misinterpretations of lava streams" (*op. cit.*). It seems, however, that the original fissures were already on September 23 buried under volcanic products when the rapidly decreasing volcanic activity entered its late phase of gradually extinguishing lava-producing craters.

The fissures marked a tectonically active zone (possibly the epicenter of strong earthquakes) extending NNE-SSW (azimuth 30°), parallel to the major dykes, fissures and elevated cliff lines, as recognized *i.a.* by Roberts & Hawkins (1965) — see Figs 3*A, B*. This is also the direction of the Mid-Atlantic Ridge (between Iceland and the Jan Mayen Fracture Zone), its rifts and longitudinal faults, but not the Jan Mayen Ridge (*cf.* Figs 1—2). Prolonging this line towards the SSW we match Eskkrateret, the supposed site of minor eruptions of 1732 and 1818, and Eggöya, where slight volcanic activity was observed in March 1971 (Fig. 4). Towards the NNE, the same line coincides with young extinct craters at Austkapp (Fig. 3*B*). Other parallel, NNE-SSW-oriented tectonic lines both on Nord-Jan (Figs 3*A*, *B* and 4) and Sör-Jan also show the presence of linearly arranged extinct parasitic craters.

2. The direction of individual fissures preceding the formation of parasitic craters differed slightly or markedly from the above NNE-SSW line. The three southern ones, each about 1 km long, were extending NE-SW parallel to each other (azimuth 50°), while the fourth, northernmost and longest, rapidly changed its nearly E-W course (azimuth 80°) towards SW-NE (azimuth 30°). These short fissures were interpreted (Birkenmajer 1970, 1971) as stepped tension gashes opened due to lateral displacement of two blocks along the NNE-SSW-directed tectonic line, the apparent surface projection of a deep-seated dextral strike-slip fault (Figs 4, 5*A*).

3. The opening of the tension gashes could be the result of the translation of the eastern block towards the SSW, of the order of some score metres. This could eventually be detected by detailed geodetic measurements. It is also probable that the 100-m rise of the sea bottom at Austbukta recognized by echo sounding from M/S "Polarbjörn" would eventually reflect rotation of the eastern block along the fault plane rather than the thick accumulation of volcanic products. This problem could be solved by core-sampling from the sea bottom.

4. The suggestions of (2) and (3) are supported by the following:

a) The distribution of craters which developed in the middle parts of the pre-existing fissures, where the opening of the tension gashes would be the greatest;

b) The distances between the craters (Fig. 5*A*) which repeat the same module of about 1 km (0.9 and 0.8 km respectively) between the three southern craters, a double module (2.0 km) between the Skrukkelia and Trinityberget craters, and a 1/2 module (0.5 km) between the latter and the Tollnerodden crater.

There is a great analogy in the arrangement of stepped tension gashes in rocks subject to tectonic stress (Fig. 6*A*), of fissures formed in some artificial products subject to lateral translation due to mass movements (Fig. 6*B*), and of fractures produced by some earthquakes (Fig. 6*C*) to that suggested for the first stage of the Beerenberg Volcano eruption of 1970 (Fig. 5*A*).

5. The appearance of secondary fissures along a line connecting all the craters and extending southwards (Fig. 5*C*), after the disappearance of the tension gashes, could be the net effect of several agents. The most important seems to be the lateral shift and rotation of the eastern block along the plane of a deep-seated fracture. Other factors contributing to

the final effect may be the unfreezing of the permafrost zone due to the increased geothermal grade, the overloading of the slope foot by products of eruption, and the unloading of the slope above the fissures due to

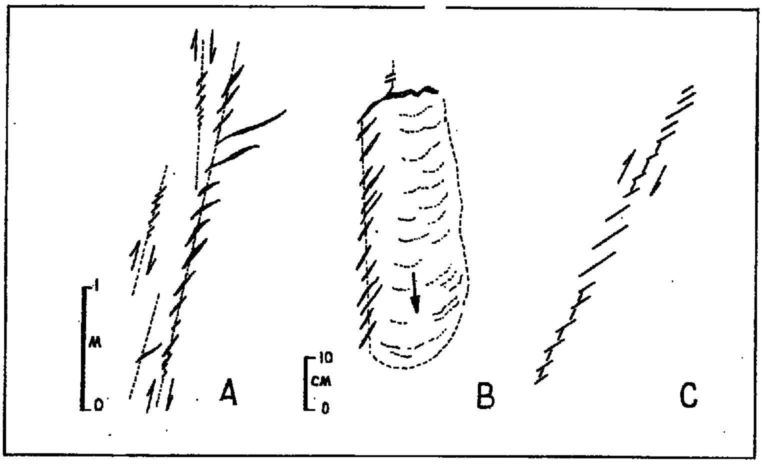


Fig. 6

A — Quartz-filled tension gashes in a Precambrian quartzite (Hornsund, Spitsbergen); *B* — Open gashes formed due to mass movement in asphalt (Majorstua, Oslo); *C* — Earthquake fracture at Hólar, Iceland, formed in 1912 (after Einarsson 1967; scale not given)
Arrows indicate direction of translation

rapid melting of the glaciers. These secondary fissures, for the most part, had no direct connection with the feeder as is evident from the lack of subsequent linear-type lava eruption.

FINAL REMARKS

The presented analysis points to the importance of deep-seated NNE-SSW-trending faults responsible for renewed volcanic activity on Jan Mayen in 1970—1971. These faults are parallel to the Mid-Atlantic Ridge (*cf.* Figs 1—2) and possibly reflect the tectonic regime of the present Atlantic Ocean-floor spreading. The elongation of Jan Mayen island also reflects the same pattern.

The location of the Beerenberg stratovolcano is close to the seismically active Jan Mayen Fracture Zone (*cf.* Johnson & al. 1970) and is at the intersection of two systems of geofractures: WNW-ESE (roughly parallel to the Jan Mayen Fracture Zone which stretches NW-SE) and

NNE-SSW (parallel to the Mid-Atlantic Ridge situated farther west). Johnson (1968) interprets the morphological and earthquake data in favour of a displacement of the Mid-Atlantic Ridge 200 km eastwards along the Jan Mayen Fracture Zone. The displaced ridge to the north of the fracture zone is commonly known as the Mohns Ridge.

The lines of the present volcanic and seismic activity on Jan Mayen differ markedly from the direction of the generally seismically inactive Jan Mayen Ridge which is N-S. This ridge, according to Johnson and Heezen (1967) is a continental fragment split off the Greenland shelf during the recent relocation of the oceanic axis. The partially buried chain of seamounts in the Norwegian Basin (*cf.* Fig. 1) delineate the extinct rift axis (Johnson & Heezen 1967, Johnson & al. 1970). The volcanic Jan Mayen which was probably constructed in Mid-Tertiary to Early Pleistocene times may then have represented an emerged portion of Mid to Upper Tertiary Iceland (Johnson 1968). The flat-topped Jan Mayen Ridge would be the highest remnant of a northern extension of Iceland which has foundered with time (Johnson & al. 1970).

Acknowledgements. The author wishes to express his sincere gratitude to the Royal Norwegian Council for Scientific and Industrial Research, Oslo, whose post--doctorate fellowship enabled him to elaborate the data while at the Norwegian Polar Institute (Norsk Polarinstitutt) in Oslo. Dr. T. Gjelsvik, the Director, kindly made the facilities of the Institute readily available to him, for which he is most grateful.

Geological Laboratory
of the Polish Academy of Sciences
Kraków, ul. Senacka 3
(Oslo, May 1971)

REFERENCES

ANONYM 1970a. Lava laget badetemperatur i ishavet rundt Jan Mayen. — Dagbladet 21 sept. 1970, p. 20. Oslo.

— 1970b. Utbruddet på Jan Mayen avtar. — Aftenposten 21 sept. 1970 (aftenutgave), pp. 1 & 2. Oslo.

— 1970c. Jan Mayen-vulkanen kan få ny kraft. 18 mann fløyet ut til ishavsöya igår. — Aftenposten 22 sept. 1970 (morgenutgave), pp. 1 & 14. Oslo.

— 1970d. Uvisst med start og drift av Jan Mayen-stasjonene. — Aftenposten 22 sept. 1970 (aftenutgave), p. 6. Oslo.

— 1970e. Lava gjör Norge större. Hoppet i sjöen med 25 kg lava. Aktiviteten på Jan Mayen avtar trolig. Stort utbrudd lördag — men nu trolig på retur. — Aftenposten 5 okt. 1970 (morgenutgave), pp. 1 & 46. Oslo.

— 1971a. Hot spots in the frigid ocean. — Scandinavian Times, No. 6 (Jan. 1971), p. 18. Copenhagen.

— 1971b. Norsk Polarinstitutt vil undersöke Beerenberg. — Aftenposten 17 feb. 1971 (morgenutgave), p. 15. Oslo.
— 1971c. Beerenberg på Jan Mayen er aktiv igjen. Vulkanlandet skal kartlegges i detalj. — Aftenposten 22 mars 1971 (morgenutgave), pp. 1 & 14. Oslo.
— 1971d. Svovelgasser fra Beerenberg igår. — Aftenposten 24 mars 1971 (morgenutgave), p. 19. Oslo.

BIRKENMAJER K. 1970. New Polar record [*in Polish*]. — Problemy, no. 12, pp 745—748. Warszawa.
— 1971. Beerenberg Volcano eruption on Jan Mayen island [*in Polish*]. — Wszechświat, no. 2 (2088), pp. 32—37. Kraków.

EINARSSON T. 1967. The Icelandic fracture system and the inferred causal stress field. *In:* Iceland and Mid-Oceanic Ridges (S. Björnsson ed.). — Vísindafélag Íslendinga (Soc. Sci. Islandica), vol. 38, pp. 128—141. Reykjavik.

FITCH F. J. 1964. The development of the Beerenberg Volcano, Jan Mayen. — Proc. Geol. Ass., vol. 75, pp. 133—165. Colchester.
— , NAIRN A. E. M. & TALBOT CH. J. 1965a. Palaeomagnetic studies on rocks from North Jan Mayen. — Norsk Polarinst. Årbok 1963, pp. 49—60. Oslo.
— , GRASTY R. L. & MILLER J. A. 1965b. Potassium-Argon ages of rocks from Jan Mayen and an outline of its volcanic history. — Nature, vol. 207 (No. 5004), pp. 1349—1351.

GJELSVIK T. 1970. Volcano on Jan Mayen alive again. — *Ibidem*, vol. 228 (no. 5269), p. 352.

HAHN J. 1971. Of volcanoes — satellites — whales — jealousy and cold feet (The eruption of a long dormant volcano on the Arctic island Jan Mayen provides some historical reflections). — Oceanus (The Woods Hole Oceanogr. Inst.), vol. 16, no. 1, pp. 15—21. Woods Hole.

HJERPSETH T. & MYHRE J. 1970. Vulkanutbrudd om babord. — Aftenposten 3 okt. 1970 (morgenutgave), pp. 1 & 16. Oslo.

JOHNSON G. L. 1968. Marine geology in the environs of Jan Mayen. — Norsk Polarinst. Årbok 1966, pp. 105—111. Oslo.
— , FREYTAG J. S. & PEW J. A. 1970. Structure of the Norwegian Basin. — *Ibidem*, Årbok 1969, pp. 7—16. Oslo.
— & HEEZEN B. C. 1967. The morphology and evolution of the Norwegian-Greenland Sea. — Deep Sea Res., vol. 14, pp. 755—771.

NATERSTAD J. 1970. Tilleggs-guide til Aftenposten/Bennetts tur til Jan Mayen 9.10 og 11.10.1970. Oslo.

OFTEDAHL Ch. 1970a. Guide for Bennetts tur til Jan Mayen 2.10 og 4.10.1970. Oslo.
— 1970b. Landet som glödet. — A-Magasinet nr 44 (uketillegg til Aftenposten 31 okt. 1970), pp. 12—14. Oslo.

ORVIN A. K. 1960. The place-names of Jan Mayen. — Norsk Polarinst., Skrifter nr 120. Oslo.

ROBERTS B. & HAWKINS T. R. W. 1965. The geology of the area around Nordkapp, Jan Mayen. — Norsk Polarinst. Årbok 1963, pp. 25—48. Oslo.

SMITHSONIAN 1970. Smithsonian Institution, Center for Short-Lived Phenomena: event 89—70 (23 Oct. 1970, Cards Nos. 1035 & 1036), Beerenberg volcanic eruption.

K. BIRKENMAJER

ASPEKTY GEOTEKTONICZNE ERUPCJI WULKANU BEERENBERG NA WYSPIE JAN MAYEN W 1970 R.

(Streszczenie)

Autor relacjonuje przebieg wybuchu wulkanu Beerenberg na wyspie Jan Mayen w 1970 r. Erupcja nastąpiła w północno-wschodniej części wyspy, na zboczu głównego stratowulkanu uważanego dotychczas za wygasły. W pierwszym stadium erupcji utworzyły się stosunkowo krótkie równoległe szczeliny o typie tensjonalnych. Otwarcie się tych szczelin, jako dróg erupcji, zostało prawdopodobnie spowodowane przemieszczeniem się wschodniej części wyspy wzdłuż linii o kierunku NNE-SSW, odpowiadającej wgłębnemu uskokowi równoległemu do przebiegu wału śródatlantyckiego. Na południowym przedłużeniu tego uskoku słaba działalność wulkaniczna była notowana w 1732 i 1818 oraz 1971 r. (już po zakończeniu działalności wulkanicznej w pn.-wschodniej części wyspy). Dalszym stadium było utworzenie się kraterów pasożytniczych (usytuowanych głównie w środkowej części szczelin), które produkowały popiół i lawę bazaltową w ciągu kilku tygodni jesienią 1970 r.

Pracownia Geologii Młodych Struktur
Zakładu Nauk Geologicznych PAN
Kraków, ul. Senacka 3
(Oslo, w maju 1971 r.)