

J-G

TR-139

UNIVERSITY OF RHODE ISLAND  
Graduate School of Oceanography

KINGSTON, R. I.  
Narragansett Bay Campus

J-G

CRUISE REPORT  
TR-139 (Kolbeinsey and Mohns)  
17 July - 8 August 1973  
R/V TRIDENT

SCHEDULE

A 23-day cruise was undertaken north of Iceland, primarily along the Kolbeinsey Ridge Crest from 66°30'N to 71°40'N, and the Mohns Ridge from 71°30'N, 4°36'W to 73°N, 5°32'E. Extensive rock dredge sampling was carried out, and each dredge site was accompanied by magnetic and seismic reconnaissance profiling.

SCIENTIFIC PARTY

Dr. Jean-Guy Schilling	URI	Chief Scientist	Switzerland
Thomas Johnston	URI	Geologist	USA
Dr. David Gottfried	USGS	Geochemist	USA
William White	URI	Geologist	USA
Mark Zajac	URI	Geologist	USA
Susan Anderson	WHOI	Marine Affairs	USA
Jeremy Boak	Harvard	Geologist	USA
Dave Mayerson	Wesleyan	Geologist	USA
Peter Meyer	Dartmouth	Geologist	USA
Kathleen Dorn	-	Technician	USA
Philip Hendershot	URI	Marine Technician	USA
Mark Weishan	URI	Marine Technician	USA

SHIP'S COMPANY

Terry Hansen, Master	John Symonds, Chief Engineer
Glenn Jones, Chief Mate	Theodore Surette, First Engineer
Jeffrey Seeley, Second Mate	Frank Richard, Second Engineer
John Stohlberg, Jr., Bos'n	Paul Sullivan, Radio Officer
Omer Palardy, AB Seaman	Manuel Faria, Steward
Frederick Russell, AB Seaman	Kenneth Erban, Second Cook
Richard Demers, AB Seaman	James Merritt, Oiler
Ian Chase, Ordinary Seaman	Jean Cormier, Oiler
David Fisk, Ordinary Seaman	William Cowsill, Oiler

OPERATIONS

The objective of this cruise was to study geochemical variations of basalt erupted along the northern Mid-Atlantic Ridge away from Iceland in order to delineate the extent of mantle flow from the Iceland plume, northward beneath the Kolbeinsey Ridge. Particular attention was given to the Tjörnes Fracture Zone, South of Kolbeinsey Islet, where the position of the present axis of rifting over the submerged northern Iceland Shelf is uncertain and complex. Exploratory rock sampling of the Mohns Ridge was planned, time permitting, and was carried out.

TR-139

Five days were spent south of Kolbeinsey Islet in Tjörnes Fracture Zone (12 stations), four days on the Kolbeinsey Ridge Axis between Kolbeinsey Islet and the Spar Fracture Zone, 69°N, (9 stations), and five days on the Kolbeinsey Ridge Crest between the Spar and the Jan Mayen Fracture Zone, 71°30'N, (6 stations). Considerable time was lost in this latter segment of the Mid-Atlantic Ridge due to temporary stagnation of fog and ice derived from the Greenland Coast, resulting in a rather limited number of successful dredge stations. Three days were spent on the Mohns Ridge (6 stations).

Time allocation was as follows:

Seismic and magnetic profiling (24 profiles)	122 hrs
Dredging (33 stations)	85 hrs
Transit, including magnetic and depth profiling	319 hrs

### PRELIMINARY RESULTS

Each dredge site was chosen on the basis of seismic and magnetic profiling across the ridge axis. The preliminary results of these profiles and dredging stations are summarized below.

#### 1. Tjörnes Fracture Zone -

\* South of Kolbeinsey Islet in direct continuation of the Kolbeinsey Ridge, a small graben appears to have developed rather recently. Considerable block faulting, sediment disturbance, and localized volcanism are evident. Dredge sampling in the northern section of the graben, near Kolbeinsey Islet, confirms that very recent volcanism has intruded the sediment within the graben. Further south, within the graben, irregular shallow basement is clearly evident, but volcanism has not been sufficiently intense to intrude the sediment blanket, which is only locally disturbed.

\* The Grimsey Shoal north to Kolbeinsey Islet appears to be a relatively older subaerial ridge, now covered in part by sediments. Dredge sampling of a large tablemount just SE of Kolbeinsey Islet suggests that the feature was built up by subaerial volcanism, then subsided and was eroded by wave action at two distinct levels (or terraces) - one at a 50-60 meter level and the other at a 80-100 meter level. The Hornbanki Shoal appears also to have been built by subaerial volcanism. Presence of oxidized scoriaceous volcanic material suggests that the dredge site is near a vent.

\*The origin of the Tjörnes-Manareyjar Ridge remains uncertain. Only tuff was dredged north of Lagey Islet. No evidence of submarine volcanic activity was encountered along the major north trend of this ridge, which very likely has been built only by subaerial volcanism. However, near its NW end (66°30.4'N, 17°20.4'W), a small isolated seamount was dredged and provided very vesicular, small pillow lava (fist size) with glassy palagonitized crust. The seamount definitely represents a submarine eruption at very shallow depth. It perhaps represents the 1868 volcanic activity reported in Icelandic history.

Further north, west of this latter seamount, or NE of Grimsey, another small isolated seamount (66°38.5'N, 17°47'W) was encountered while we were testing a possible en echelon connection of the North Neovolcanic Zone of Iceland with the Kolbeinsey Ridge and its southern graben. This feature represents a small and recent submarine vent (9D). Time did not allow us to determine if this vent is part of a larger submarine chain of vents along a N-S fissure, as would be anticipated from the en echelon model. However, one can affirm that recent submarine volcanic activity has occurred in the Tjörnes Fracture Zone, between the Northern Neovolcanic Zone of Iceland and the Kolbeinsey Ridge or its southern extension as a graben.

\* Kolbeinsey Islet was visited and sampled on a day of calm sea with an eastward swell. The islet was approached in a rowboat from the SE where landing appeared easiest. A party of three men directed by Schilling, spent one hour on the islet. The islet is made of fresh subaerial vesicular lava with local bands of highly oxidized lava (reddish). The upper surface is, of course, quite weathered and covered with guano.

Lagey and Hayey Islets, as well as Grimsey, were also visited and sampled. Hayey Islet is made of palagonitized tuff only, containing rather sparse volcanic bombs, vesicular and scoriaceous in nature. The base of Lagey is a grey basalt flow overlaid by tuff (and perhaps sedimentary deposit).

## 2. Kolbeinsey Ridge up to the Spar Fracture Zone -

Just north of Kolbeinsey Islet, the ridge starts to develop. The crest is narrow and asymmetrical, and exposed volcanic peaks are irregularly distributed. Progressing north, the crest widens and becomes more symmetrical. It has an inverted-V shape, and exposed peaks reflecting recent volcanic activity are located near the top of the crest. There appears to be no rift along the entire length of this segment of Kolbeinsey Ridge. Fresh, glassy pillow basalts were dredged on the crest along the entire length (7 stations). A few dredge hauls on the flanks of the crest show aging features such as palagonitization and a thin coating of manganese on the more weathered pillows. This suggests that the rocks, indeed, increase in age away from the axis of the ridge, as postulated by the seafloor spreading theory. The Meteor bathymetric and magnetic survey map proved to be very useful in locating the crest of the ridge, and was quite accurate (Meyer, Voppel, Fleisher, Closs, and Gerke, *Sonderdruckt Deutsch. Hydrogr. Zeitschrift* 25, 193-201, 1972).

## 3. Kolbeinsey Ridge between the Spar and Jan Mayen Fracture Zones -

Because of ice and fog, only a few seismic profiles could be made across this segment of the ridge. As indicated by Johnson and Vogt (*J. Geophys. Res.*, 77, 5688-5696, 1972), the ridge north of the Spar Fracture Zone widens considerably, and a small irregular rift appears to be present. The zone of recent volcanism was found to be more irregularly distributed over the crest and more difficult to locate than that south of the Spar Fracture Zone.

Recent volcanism appears to be displaced toward the east or west of the axis of symmetry of the ridge (determined from topographic cross-section profiles).

Just south of the Jan Mayen Fracture Zone, the ridge is featured by a small asymmetrical graben with pronounced step-block faulting on the east side (profile 26). Recent pillow basalt volcanism intrudes the center of the graben (27D).

#### 4. Mohns Ridge -

Five seismic and magnetic profiles were made across the Mohns Ridge, and four successful dredge hauls obtained. The topographic and magnetic maps published by Johnson and Heezen (Deep Sea Res., 14, 755-771, 1967) were found to be very accurate. Rock sampling of the Mohns Ridge was carried out for exploratory purposes, because, to our knowledge, no samples within the rift had yet been obtained. Dredging of the westernmost recognizable part of the ridge, 140 kilometers NE of Jan Mayen, was unsuccessful in recovering hard rocks. Dredging of both the north and south wall of the rift up to 200-300 meters above the bottom of the rift indicates that both walls are covered with a thin blanket of mud. This in turn suggests that this most western segment of the Mohns Ridge has remained volcanically inactive for sometime. West of this profile, the Mohns Ridge axis remains unknown, as does its relation with the Jan Mayen Fracture Zone and Island.

Further east, pillow basalts were consistently recovered within the rift of the Mohns Ridge to the limit of our sampling at 73°N, 5°32'E. Consistently, these pillows show signs of aging, such as weathered surfaces, palagonitized glass, and thin coatings of manganese, yet they were obtained right at the bottom of the rift below the magnetic high. An unusual amount of mud was also encountered there. This suggests to us that the Mohns Ridge has remained volcanically relatively inactive for the last 100,000 years or so.

#### ACKNOWLEDGMENTS

Drs. K. Hinz and O. Meyer generously provided photographs of unpublished seismic records of the Kolbeinsey Ridge. G. L. Johnson and P. R. Vogt kindly provided large-scale maps and bathymetric data of the Kolbeinsey and Mohns Ridge. Unpublished seismic records from R/V VEMA 23, 27, 28, and 29 cruises were generously made available for inspection by M. Talwani and O. Eldholm. Visual inspection of samples previously dredged from R/V LYNCH on the Kolbeinsey Ridge were kindly made possible by S. P. Jakobsson. Useful comments were provided by K. Saemundsson concerning the geological nature of the Tjörnes Fracture Zone. I wish to thank the kind and generous assistance of all these persons.

The TR 139 cruise endeavor would not have been possible without the enthusiastic assistance and safe guidance of Captain Hansen and his crew, as well as the devotion of the scientific party. The assistance of the

Chief Engineer, John Symonds, and his men in maintaining the deep-sea winch operational during the entire cruise is particularly acknowledged.

Cruise TR 139 and its preparation were generously financed by the National Science Foundation.

TR 139 DREDGING STATIONS

Station	Latitude & Longitude	Date 1973	Depth Range	Operator	# Gunny Sacks	Results
✓ 1D	66°30.5'N 17°20.5'W	7/19	65-80 m	Schilling	3	Seamount top - glassy pillow fragments; sponges
✓ 2D	66°25.5'N 17°10'W	7/19	16-25 m	Schilling	1 canvas	Mjornes Ridge - tuff fragment
	66°25'N 17°11'W					2nd attempt - small tuff debris and rock fragments
✓ 3D	66°48.5'N 18°09'W	7/20	180-205 m	Johnston	9	Grimsey Ridge, elongated shoal Hornbanki - rounded and jointed cobbles; altered vesicular basalt of subaerial nature; some oxidized as if near vent; sponges
4D	66°49.5'N 18°08'W	7/20	55-80 m	Johnston	-	Grimsey Ridge, Northern point of Hornbanki - no recovery
5D	66°50'N 18°09'W	7/20	85-100 m	Johnston	-	Grimsey Ridge, Northern point of Hornbanki - lost dredge
✓ 6D	67°00.5'N 18°42.5'W	7/21	270-310 m	Johnston	10	South Kolbeinsey Graben - fresh glassy pillow basalts and necks
✓ 7D	66°54.5'N 18°46.5'W	7/21	400-410 m	Johnston	1	South Kolbeinsey Graben - fresh glassy pillow basalt with palagonite crust
✓ 8D	66°44.5'N 18°00.5'W	7/22	340-350 m	Johnston	1 plastic bag 1 box mud	Grimsey Ridge - tuff fragments, 3 small pebbles of massive basalt, and small indurated balls of mud with glass shards (one surrounded with a small film of lava)

TP 139 DREDGING STATIONS (cont'd)

Station	Latitude & Longitude	Date 1973	Depth Range	Operator	# Gunny Sacks	Results
9D	66°38.5'N 17°47'W	7/22	180-210 m	Johnston	6 1 box mud	Isolated seamount NE of Grimsey - small fresh highly vesicular pillows (potato size) with palagonite crust; 4 rounded cobbles
10D	67°02.5'N 18°28.5'W	7/23	68-80 m	Schilling	1	Large flat seamount SE of Kolbeinsey Islet, 55-meter terrace - 1 foot diameter vesicular basalt rounded by wave action, probably subaerial
11D	67°01.5'N 18°26'W	7/23	90-100 m	Schilling	7	Large flat seamount SE of Kolbeinsey Islet, 90-meter terrace - scoriaceous and wave rounded basalt; banded tuff, near vent sampling; few erratics
12D	67°02.5'N 18°22'W	7/23	90-100 m	Schilling	3	Large flat seamount SE of Kolbeinsey Islet, small peak on 90-meter terrace - cobbles and pebbles of basalt; 1 limestone fragment; appears to be eroded terrace (or beach!)
13D	67°18.5'N 18°39.5'W	7/23	240-260 m	Johnston	3	Kolbeinsey Ridge - a fresh pillow basalt with black glass and crusts
14D	67°28.5'N 18°38'W	7/23	300-480 m	Johnston	4	Kolbeinsey Ridge Crest - one fresh pillow basalt with glass; other pillow fragments, some with greenish alteration; few erratics
15D	67°42.5'N 18°32.5'W	7/24	380-425 m	Schilling	6	Kolbeinsey Ridge Crest - fresh glassy basalt pillow fragments with some brown palagonite

TR 139 DREDGING STATIONS (Cont'd)

Station	Latitude & Longitude	Date	Depth Range	Operator	# Gunny Sacks	Results
✓ 16D	67°54'N 18°24.5'W	7/24	550-580 m	Johnston	3	Kolbeinsey Ridge Crest - one glassy basalt neck, several medium fresh pillow fragments; toad fish
✓ 17D	68°10.5'N 18°26'W	7/25	700-800 m	Zajac	2	Kolbeinsey Ridge Crest - mostly ice-rafted erratics; some volcanics may be present
✓ 18D	68°10'N 18°08'W	7/25	650-700 m	Schilling	5	Kolbeinsey Ridge Crest, E of 17D - fresh glassy pillow fragments and dark brown palagonite crusts
✓ 19D	68°24.5'N 18°03.5'W	7/25	880-890 m	Johnston	5	Kolbeinsey Ridge Crest - older pillows, fragments with rounded palagonite surfaces; thin manganese coating; mud and few erratics
✓ 20D	68°22'N 17°59.5'W	7/26	600-700 m	White	5	Kolbeinsey Ridge Crest, E of 19D - relatively fresh vesicular pillow basalt with good glassy rim; older blocky, greenish weathered, vesicular basalt with pipe vesicles. Two ages represented
✓ 21D	68°38'N 17°41'W	7/26	900-915 m	Schilling	3	Kolbeinsey Ridge (E side) - pillow basalts and fragments, palagonitized with thin manganese coating
✓ 22D	69°42'N 15°36'W	7/27	930-960 m	Johnston	2 boxes mud 1 canvass	Kolbeinsey Ridge (E flank - magnetic anomaly max.) - ice-rafted erratics and mud



TR 139 DREDGING STATIONS (cont'd)

Station	Latitude & Longitude	Date	Depth Range	Operator	# Gunny sacks	Results
23D	69°43.5'N 15°35.5'W	7/27	885-950 m	White	5	Kolbeinsey Ridge (E of rift, NW of 22D) - older pillow basalt with palagonitized glass well preserved; ice-rafted erratics and mud
24D	69°44'N 15°44.5'W	7/27	1012-1065 m	Schilling	2 canvass 1 box mud	Kolbeinsey Ridge, perhaps W of rift, NW of 23D - few glassy with palagonite crust fragments; few ice-rafted pebbles and rounded mud cakes
25D	69°09'N 16°13'W	7/29	1130-1160 m	Schilling	15	Kolbeinsey Ridge, N of Spar FZ, rift - fresh feldspar rich porphyritic pillow basalts and fragments; few fragments of fresh massive aphyritic lava, 1 large slab and fragments of "tectonite" with glass shards and large grooves apparent; 1 small volcanic conglomerate
26D	69°23'N 15°55'W	7/29	880-1045 m	Johnston	-	Kolbeinsey Ridge, E flank - mud and 1 small granitic rounded pebble
27D	71°19.5'N 12°38.5'W	7/31	1150-1260 m	Johnston	6	Kolbeinsey Ridge Graben, S Jan Mayen FZ - fresh glassy, brown palagonite pillow basalts and fragments; few mud balls and one erratic
28D	71°29.5'N 04°14.5'W	8/1-2	2690-2820 m	Schilling	-	Mohs Ridge, rift bottom, S wall - no recovery, covered with mud
29D	71°28.5'N 04°16'W	8/2	2535-2865 m	Schilling	-	Mohs Ridge, rift bottom, N wall - no recovery, covered with mud

TR 139 DREDGING STATIONS (cont'd)

Station	Latitude & Longitude	Date 1973	Depth Range	Operator	# Gunny Sacks	Results
30D	71°49'N 02°04.5'W	8/2	2500-2600 m	Johnston	4	Mohns Ridge, central rift - pillow basalt with greenish cast, with some palagonitized glass remains
31D	72°10.5'N 00°14'E	8/3	2824-2100 m	Johnston	19	Mohns Ridge central rift - pillow basalt with greenish cast and with some palagonitized glass remains; also fracture zone products - breccias, heavily chloritized mylonites, serpentized rocks
32D	72°36.5'N 03°22.5'E	8/4	2990-3050 m	Schilling	7	Mohns Ridge, central rift - pillow basalt fragments with glass preserved on several but also coated with manganese; some samples have contorted features similar to aa or complex flow features; greenish weathered surfaces; one gneiss erratic boulder and one pebble of chert
33D	73°00.5'N 05°11'E	8/4	2700-3100 m	White	3 1 box mud	Mohns Ridge, NW bottom-rift wall - 400 lbs massive pillow basalt with fresh black glass; some pillows appear somewhat older with glass partly palagonitized; some blocky fragments; a few pebbles; dark grey mud



