UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GLORIA INVESTIGATION OF THE EXCLUSIVE ECONOMIC ZONE IN THE DEEP BERING SEA

MV FARNELLA CRUISE F2-86-BS
5 July to 4 August 1986

by

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This report is preliminary and has not been reviewed for conformity with Geological Survey editorial standards and stratigraphic nomencluature. Any use of trade names is for descriptive purposes only and does not imply endorsement by the USGS.

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THE ALASKA EEZ-SCAN PROGRAM

EEZ-SCAN is a cooperative research program between the United States Geological Survey (USGS) and the British Institute of Oceanographic Sciences (IOS). The major aim of the EEZ-SCAN 86 program was a reconnaissance of the deep Bering Sea (Fig. 1) using the long-range side-scan sonar, GLORIA (Somers et al., 1978; Swinbanks, 1986). The area covered by the survey extends seaward of the Bering Sea shelf between the Aleutian Island ridge and the US-USSR 1867 convention line. In addition to GLORIA data, 160-cu in two-channel airgun and 3.5-kHz seismic-reflection, 10-kHz bathmetric, gravity, and magnetic (gradiometer) data were collected during the survey. The cruises were conducted aboard the M/V FARNELLA by USGS and IOS scientists and technicians (Table 1). Navigation was obtained using LORAN C and GPS satellites.

EEZ-SCAN 86 was extremely successful. A complete mosaic was produced of overlapping sonographs of 75% of the deep Bering Sea south of the convention line. During the summer of 1986 from July 5 to September 30, the three Bering Sea legs insonified about 700,000 sq km of the deep Bering Sea (Fig. 1) and approximately 16,000 km of geophysical trackline data were collected during the 83 days at sea.

Leg 2 (F2-86-BS) departed from Dutch Harbor, Alaska on July 5, 1986 and returned to port on August 4, 1986. During 30 days at sea, 9620 km of track line data were obtained (Fig. 2).

OBJECTIVES

1. The chief objective of Leg F2-86-BS was to obtain overlapping side-scan sonar (GLORIA) coverage of the slope, rise, and abyssal plain between the US-USSR convention line and Zhemchug Canyon and between the shelf edge and Bowers Ridge (Fig. 1).

2. A second goal was to collect seismic-reflection, bathymetric, and geopotential data along the same grid of relatively closely spaced (15-30 km) track lines (Fig. 2).

EQUIPMENT PROBLEMS

1. The GLORIA vehicle had beam-steering problems throughout the leg, which caused over correction of the yawing experienced during rough weather.

2. The Litton airgun produced a high frequency noise that caused some striping on the GLORIA images.

3. Deteriorating brushes on the 110 volt generator created power problems near the end of the cruise. When we switched to ship's power, the main generators produced irregular electrical power, causing occasional problems with the recorders, the navigation computers, and the gravity meter.

4. The biggest problem encountered on leg F2-86-BS was the failure of the Mass-Comp system. As a result, we could collect only analog airgun records on leg F2-86-BS.

ENVIRONMENTAL PROBLEMS

We also experienced sonic difficulties in the water column due to a shallow, sharp thermocline that fluctuated at depths of 25 to 45 meters. Several XBTs also showed a slight warming trend at a depth in the water column of greater than 150 m. These water column characteristics created problems with the GLORIA signal. The complex reflections and refractions of the GLORIA sound signal off the colder water zone produced some peculiar sonograph images. Instead of bottom returns being imaged, we received swirly irregular patterns that looked much like wood grain. We concluded on the cruise that we were seeing internal wave patterns from the water column. Further study by the IOS engineers, however, suggests that the unusual patterns were caused by a Lloyds mirror effect (Urick, 1983). More investigations are now being conducted on these anomalous patterns and we hope these interference patterns can be removed.

The weather on leg F2-86-BS was good throughout most of the cruise. We only had to alter course twice during the entire 30 days because of high wind and rough seas.

PRELIMINARY RESULTS

About 225,000 km^2 of the deep Bering Sea were insonified during the 30 days at sea. The 9620 km (5200 n.mi) of trackline (Fig. 2) were traversed during 617 hours of profiling at an average speed of over 8 knots.

Areas insonified on cruise F2-86-BS included: (1) The Beringian margin (below 200 m) between the US-USSR 1867 convention line and Zhemchug Canyon (about 21,000 km^2); (2) the northwestern 17,000 km^2 of Bower Ridge; and (3) 185,000 km^2 of the Aleutian Basin abyssal plain (Figs. 1 and 2).

The mosaic created from the GLORIA images displays prominent geomorphic features of the Beringian continental slope and rise including the massive submarine canyons, the north-facing Aleutian Island slope, the abyssal floor of the Aleutian Basin, and the northern part of Bowers Ridge (Bering Sea EEZ SCAN 86 group, 1987).

Visible on the GLORIA imagery are sedimentary patterns and features such as large sand waves (600 m wave length and 2-15 m relief) in the heads of Navarinsky and Pervenets Canyons (Fig. 3). Although these sand waves had been observed before (Karl and Carlson, 1982) and attributed to the amplification of internal-wave currents in the canyon heads (Karl and others, 1986), the GLORIA side-scan imagery allows us to confirm the true orientation and to determine the continuity of these large-scale bed forms, which cover areas in the canyon heads of approximately 1400 km^2 in Navarinsky and approximately 800 km^2 in Pervenets Canyons. These sand waves, some of which are relict, buried features, attain a maximum stratigraphic thickness of 120 m and consist of several cross-bedded sets (Fig. 3).

Large slide and slump features, some measuring kilometers in dimension, dominate much of the Beringian margin within the large canyons and also on the slope and rise between canyons (Fig. 4). A wide variety of slides and flows have been recognized on the margin from seismic-reflection profiles (Carlson and Karl, 1984/85), but we did not appreciate the pervasive nature of these mass movement features until we obtained the GLORIA imagery.

Many rills and gullies dissect the slopes of the Beringian margin as well as the sides of Bowers Ridge. Along the Beringian slope and on both sides of Bowers Ridge, sediment-flow patterns extend basinward from the numerous canyons and gullies incised in the slopes. The sediment-flow patterns probably resulted from sheet flow rather than channelized flow. There is a surprising lack of channeling on the northern Aleutian abyssal plain; however, very pronounced channel patterns associated with Bering, Umnak, and Amchitka Canyons dominate the GLORIA mosaic of the southern Aleutian abyssal plain (Gardner et al., 1986; Cooper et al., 1986).

The 160-cu-in airgun provided enough power to delineate acoustic basement throughout most of the abyssal plain surveyed on leg F2-86-BS. Four buried basement ridges such as Farnella Ridge (Fig. 5) were discovered (Marlow et al., 1987), making a total of six buried basement ridges (Fig. 2).

Much of the Aleutian abyssal plain sedimentary section which varies in thickness from two to seven km, contains acoustic anomalies that suggest the presence of gas-charged sediment. Of the 280 zones of subsurface psuedo-structures mapped by Rearic et al. (1986), 88% are identified as velocity amplitude anomalies (VAMPS) (Fig. 6). Our survey expanded the areas in which VAMPS were first recognized by Scholl and Cooper (1978), and identified additional VAMPS.

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Table 1. Scientific and support personnel that participated on cruise F2-86-BS

SCIENTIFIC PERSONNEL

U.S. Geological Survey

Paul R. Carlson	Co-Chief Scientist
Michael S. Marlow	Co-Chief Scientist
Shawn Dadisman	Geologist
Douglas Rearic	Geologist
Ed Maple	Watch stander

Institute of Oceanographic Sciences

Michael Somers	Chief GLORIA Engineer
Lindsay Parson	Co-Chief Scientist
Jon Campbell	GLORIA Engineer
Andy Harris	GLORIA Engineer
Steve Williams	Photographer
Gareth Knight	Navigator
Linton Wedlock	Navigator
Robin Bonner	Air Gun Technician
Mick Gooden	Air Gun Technician

FIGURE CAPTIONS

Figure 1. Areas of Bering Sea insonified by GLORIA side-scan sonar during July - September 1986.

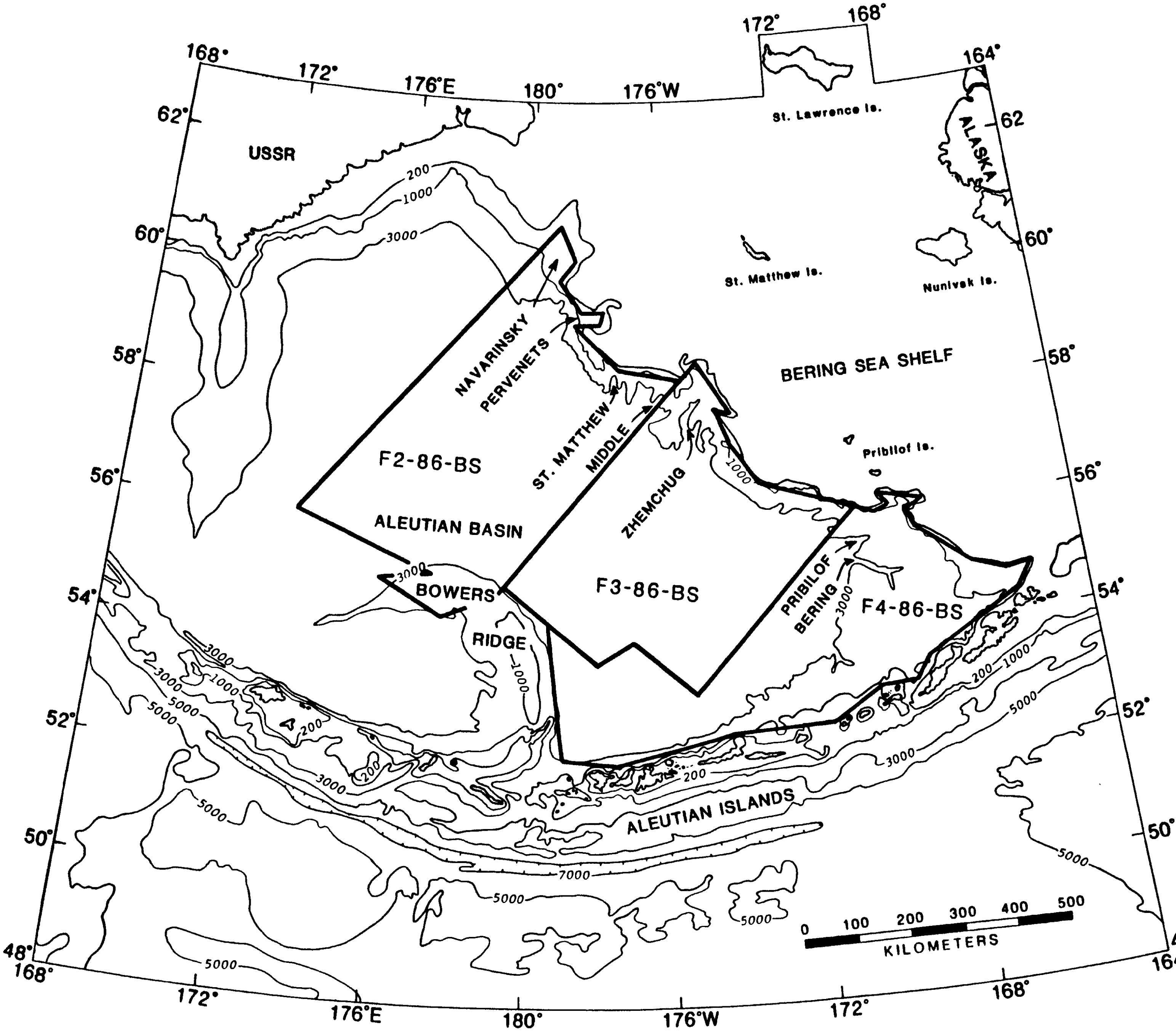
Figure 2. EEZ-SCAN 86 track lines occupied on leg F2-86-BS in Bering Sea. Numbers refer to basement ridges: 1 - Ridge A, 2 - Sounder Ridge, 3 - Farnella Ridge, 4 - Ridge B, 5- Barlett Ridge, and 6 - Pear Ridge (after Marlow et al., 1987).

Figure 3. (Top) Minisparker profile and (bottom) GLORIA shipboard uncorrected imagery across Navarinsky sand-wave field.

Figure 4. GLORIA image and interpretative sketch of upper slope between Navarinsky and Pervenets Canyons showing 4 km long, 2 km wide block (B) pulling away from long irregular slump scarps (S). One scarp can be traced along 26 km of slope. Cracks (C) are developing at several locations along the scarp. A large block has slumped down in left third of the image from evacuated area (X).

Figure 5. Newly discovered Farnella Ridge as seen on 6 second, 160 in^3 air gun, 6 sec. sweep) across Aleutian basin abyssal plain.

Figure 6. Seismic-reflection profile (160 in^3 airgun, 6 s sweep) across Aleutian basin abyssal plain, showing prominent VAMP 1/2 second deep in section.



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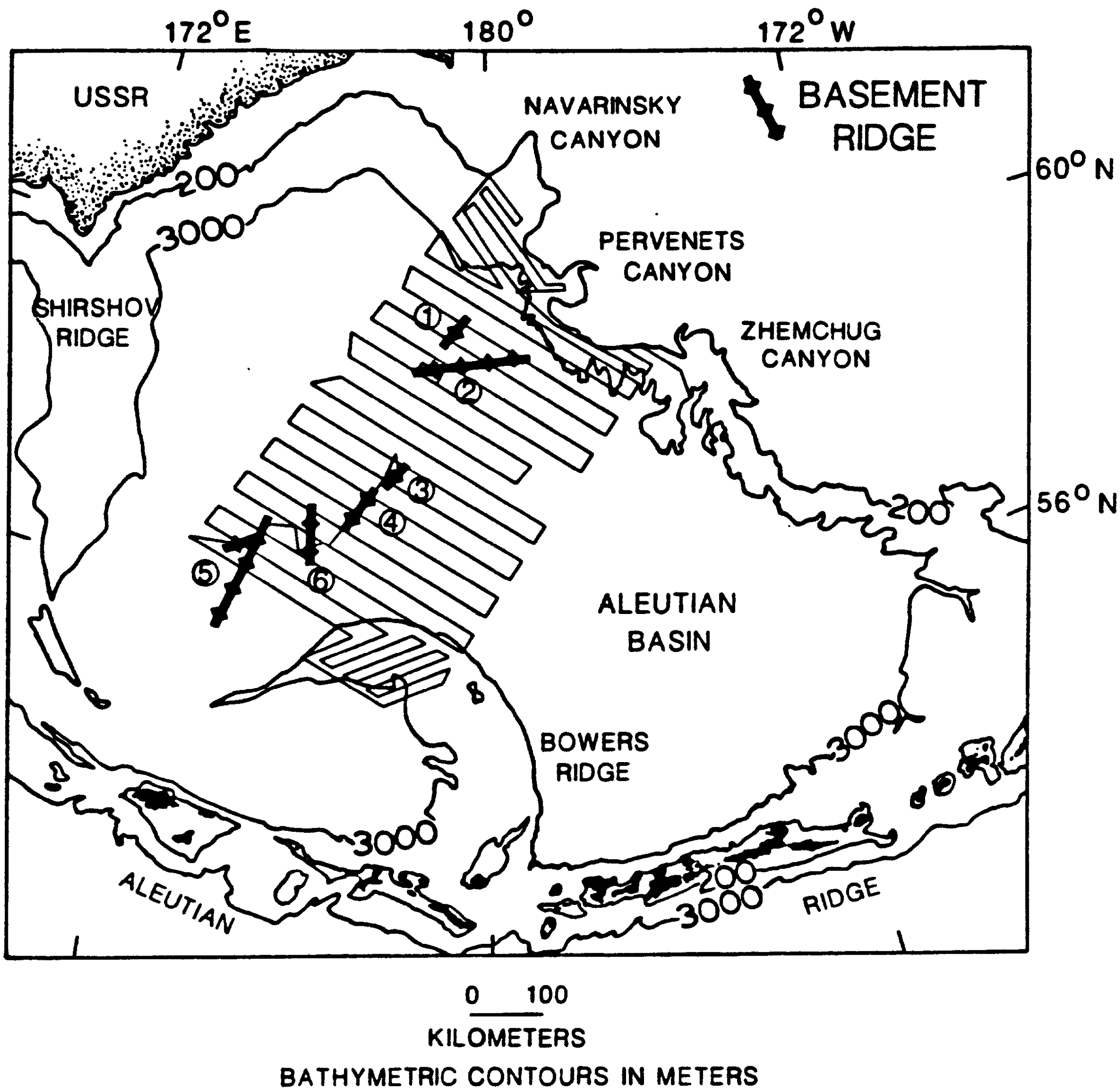

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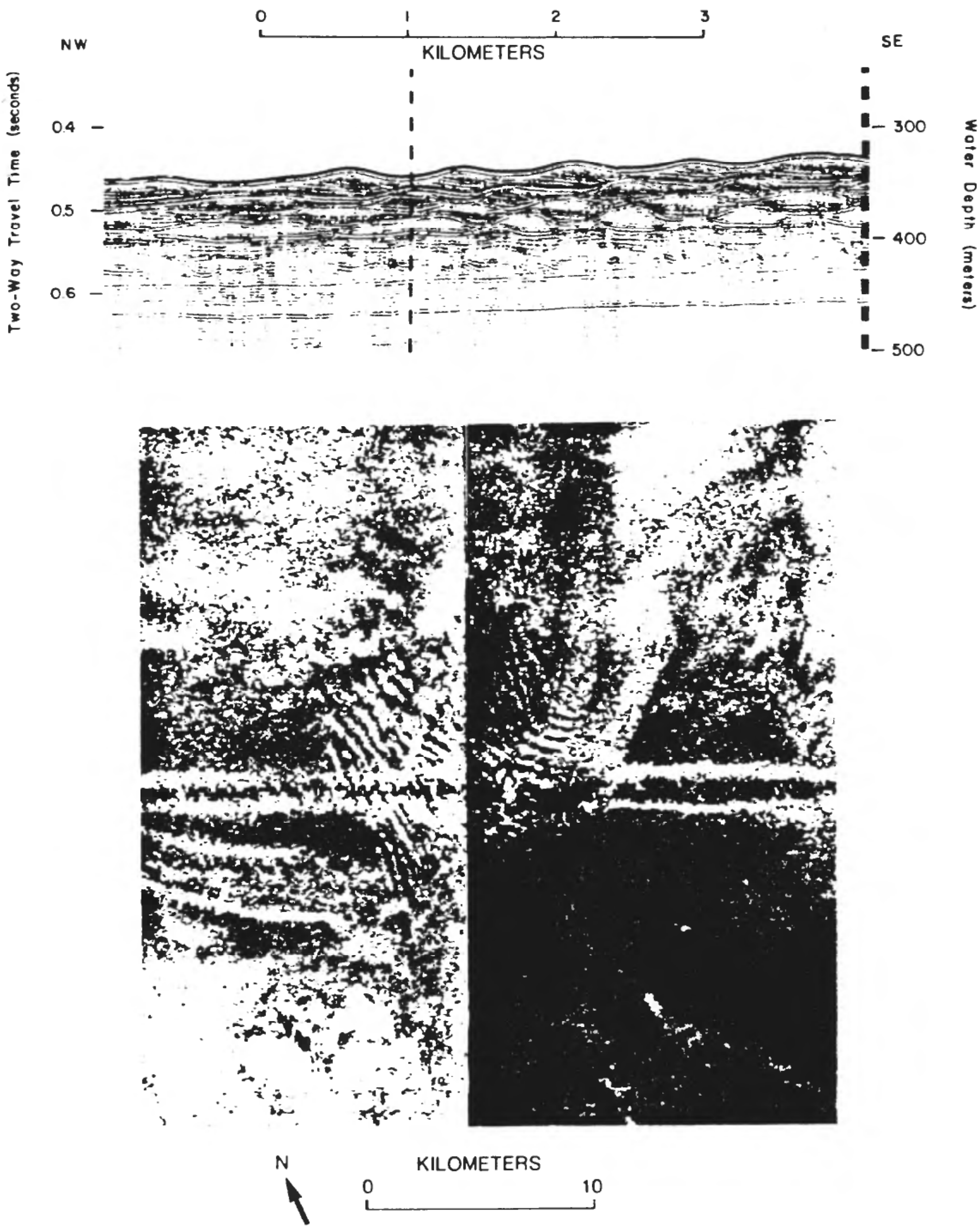

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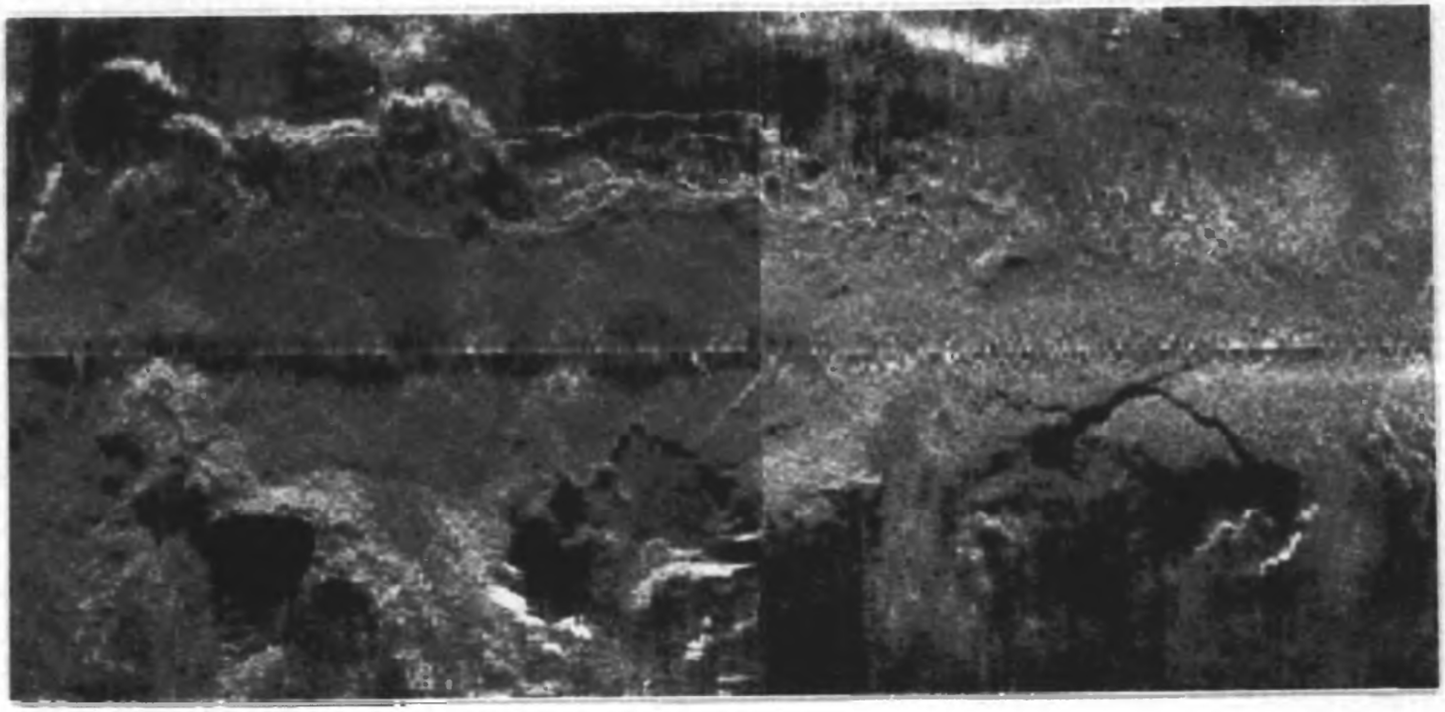

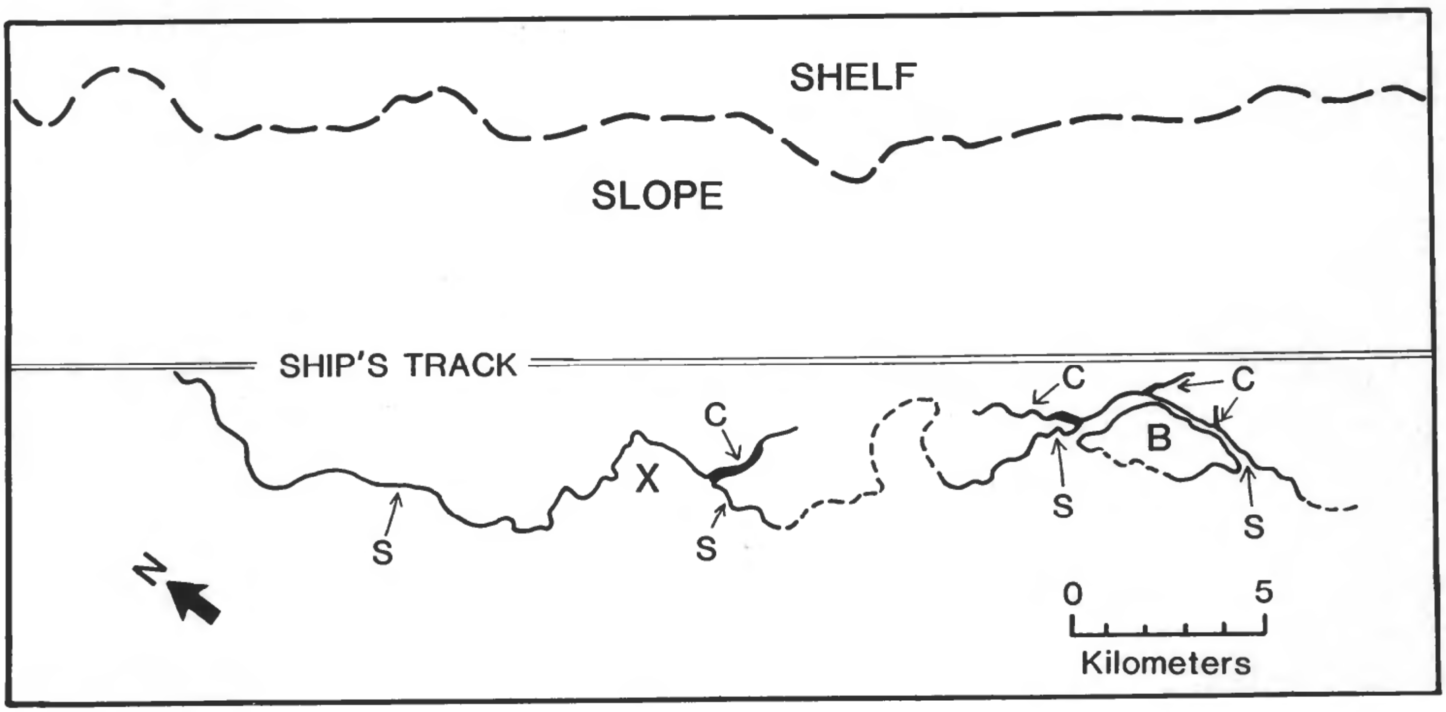

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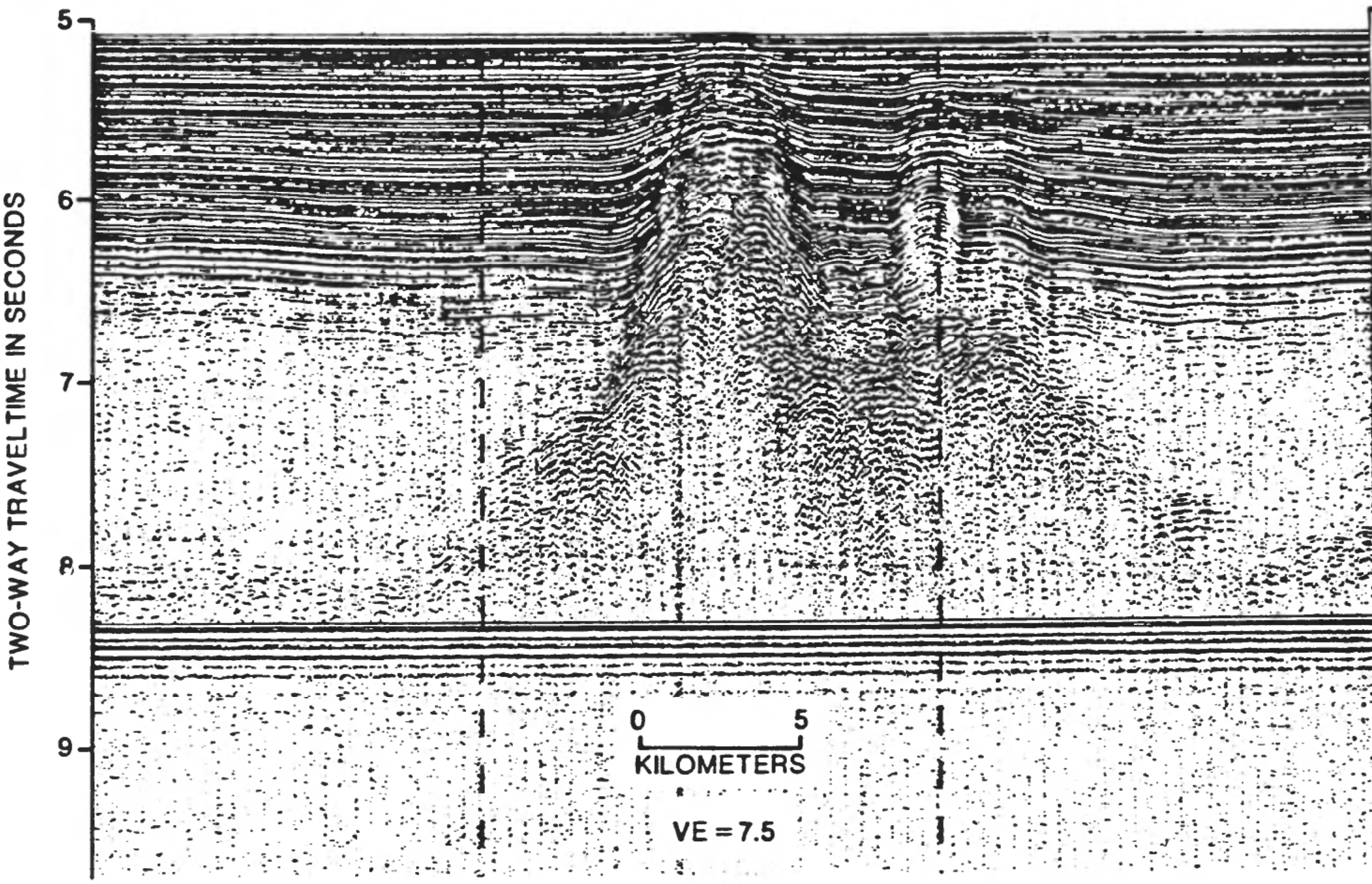

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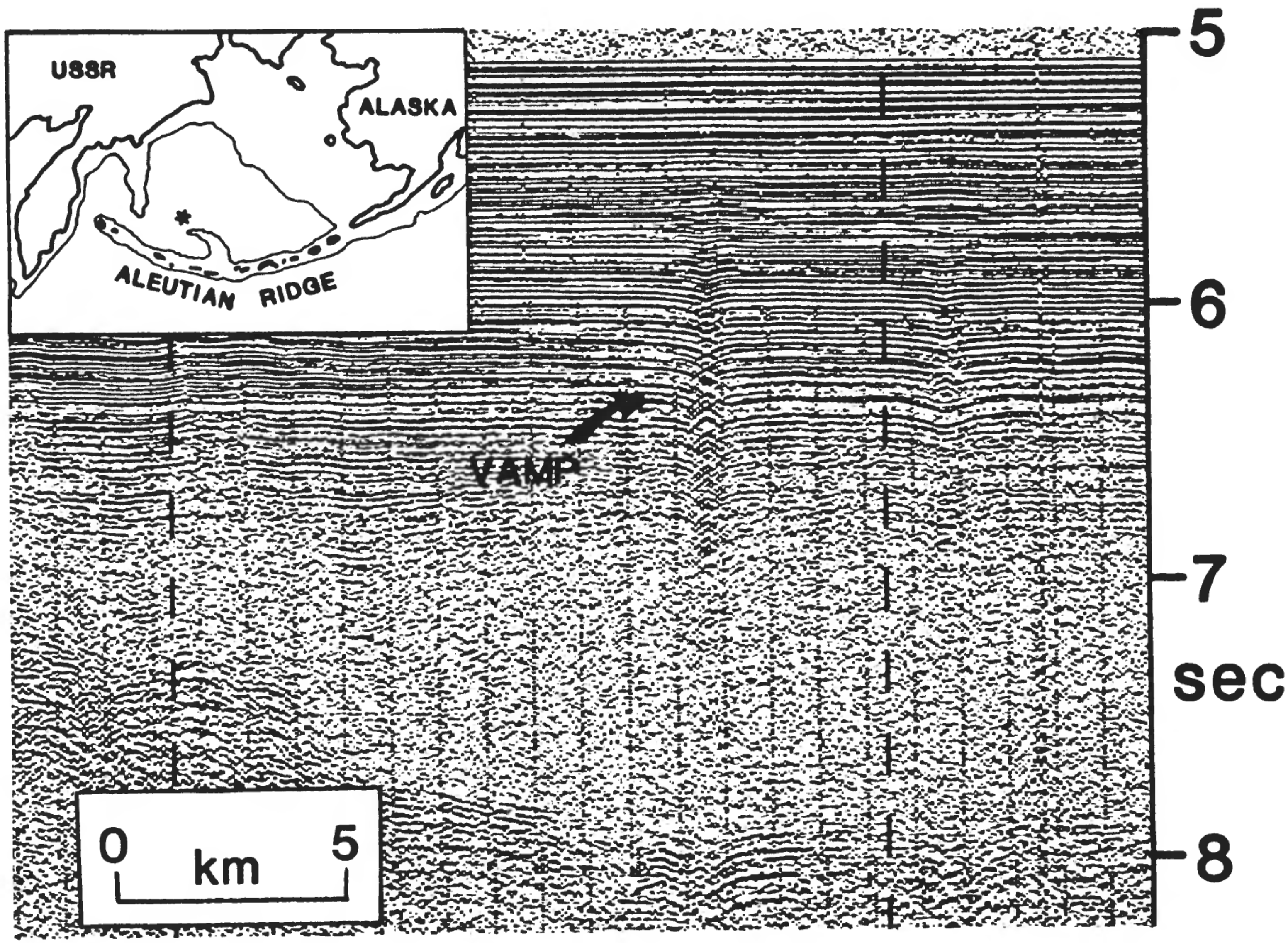

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