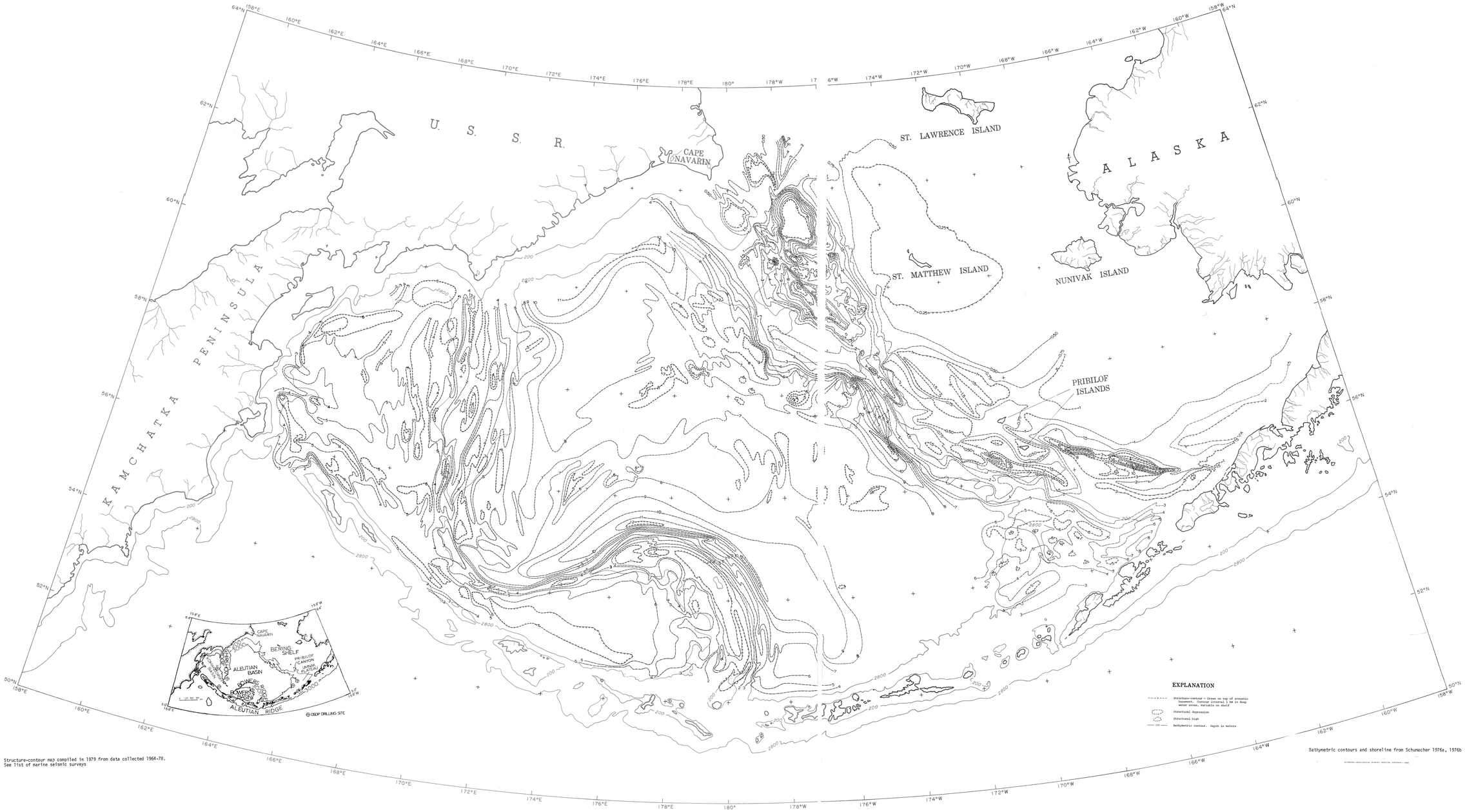
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1165



Structure-contour map compiled in 1979 from data collected 1964-78.
See list of marine seismic surveys

Bathymetric contours and shoreline from Schumacher 1976a, 1976b

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1982

EXPLANATION

- Structure-contour — Drawn on top of acoustic basement. Contour interval 1 km in deep water areas, variable on shelf
- Structural depression
- Structural high
- Bathymetric contour. Depth in meters

DISCUSSION

The reference horizon for the structure-contour map is the acoustic basement observed on seismic-reflection profiles. The depths to this horizon, below sea level, were calculated from the two-way reflection times recorded on the seismic records. For convenience, one for the Bering shelf (water depth less than 200 m) and one for the Bering Sea basin (Aleutian basin, Bowers basin, Komandorsky basin; water depth greater than 200 m) have been used to convert reflection times to depths.

Bering shelf: $SD = WD + 1.200\ T + 2.033\ T^2 - 0.117\ T^3$

Bering Sea basin: $SD = WD + 1.75\ T + 0.911\ T^2 - 0.073\ T^3$

where SD = structure depth: sea level to acoustic basement (km)

WD = water depth (km)

T = one-way reflection time from the sea floor to acoustic basement (s)

These regression equations are based on the velocity-depth information derived from sonobuoy seismic data recorded at locations shown on the Seismic Refraction Station inset map. The regression equation for the Bering Sea basin is the same as that used by Cooper and others (1979).

Acoustic basement: Bering shelf area

Acoustic basement beneath the Bering shelf is generally a major unconformity marking the base of flat lying and undeformed. The reflection velocity for basement rock ranges from 4.0 to 5.5 km/s for the southern shelf area and from 4.9 to 5.5 km/s for the northern shelf. Seismic-reflection profiles show numerous exceptions to this simple model in angular discordance with the overlying section. These dipping reflectors, as well as the high reflection velocities, indicate that the basement complex is in part composed of folded and metamorphosed rocks.

Beneath the outer Bering shelf, the acoustic basement may consist mainly of Mesozoic supracrustal rocks. Upper Jurassic sandstone and siltstone have been recovered at two sites near the Pribilof Islands (Marlow and others, 1976; T. Vallier, written commun., 1978) and late Cretaceous (Campanian) mudstone has been dredged from the north wall of the canyon that bounds the southeast side of the Pribilof Islands platform. Basement is believed to be from Pribilof ridge, an elongate basement structure that parallels the edge of the Bering shelf. Intrusive ultramafic bodies that may intrude Pribilof ridge are exposed on the Pribilof Islands (Barth, 1956) and are in turn cut by a granitic body with a K-Ar age of 50-57 m.y. (Hopkins and Silberman, 1978). The ultramafic rocks are part of a belt that extends from the Aleutian Islands to Kamchatka and strongly suggests that the ultramafic bodies may be of Mesozoic age (Ishbul and others, 1975).

Other rock samples, lithologically similar to the Upper Jurassic sandstone from the Pribilof Island region, have been dredged from the flanks of the basement ridges (Marlow and others, 1976) and from the outer Bering shelf between Pribilof canyon and a point 300 km south of Unalaska Island and delineate the seaward boundary of the large sediment-filled basins that lie between the basement ridges and the landward side of the large shelf basins. The acoustic basement should be Late Mesozoic age. The basement rocks exposed on St. Matthew Island comprise calc-alkalic volcanic rocks and granite that have been dated respectively at 70 m.y. and 65 m.y. (Marlow and others, 1976). An abrupt change in the magnetic anomaly signature occurs at this location, and this change may reflect the juxtaposition of the two different basement rock types. The contact between Mesozoic supracrustal basement rock of the outer shelf and the presumed igneous basement rock of the inner shelf may lie near the landward side of the large shelf basins.

Acoustic basement: Bering Sea basin

Where acoustic basement can be identified beneath the thick sections of flat-lying reflectors, the basement appears as a distinct reflective horizon that commonly, but not everywhere, has a hummocky or irregular appearance. Sonobuoy data indicate that this horizon has a refraction velocity of V_p = 4.8 to 5.0 km/s (Cooper and others, 1979); this velocity range is similar to that of V_p = 4.9 km/s for basalt (Christensen and others, 1973), as well as theoretical magnetic studies in the Aleutian and Bowers basins (Hall and others, 1976) suggests that the basement rock beneath the abyssal parts of the Bering Sea basin is oceanic crust. The acoustic basement beneath Bowers and Shirshov ridges differs from the basement in the abyssal basins in that it consists of altered island arc volcanic rocks (Scholl and others, 1976; Marlow and others, 1976). Dredged rocks from land are volcanic rocks to the oceanic basalt basement rocks is unknown although it probably occurs beneath the steep flanks of the ridges where acoustic reflectors are difficult to trace.

Beneath the continental slope (from Pribilof canyon to Cape Navarin), multichannel seismic data reveal that "oceanic" acoustic basement (inferred from the Aleutian basin) is overlain by a "continental" acoustic basement (inferred from the Bering shelf). These two reflecting horizons overlap in a 20- to 25- km-wide zone near the base of the slope. In the zone of overlap, the "oceanic" basement is characterized by hyperbolic reflectors. Beneath the continental slope, this overlap, if present, is not observed in the single channel seismic data because of the limited depth penetration.

Although the oceanic basement of the Aleutian basin, is thought to be underlain by oceanic crust (Cooper and others, 1979). Although oceanic basalt is the acoustic basement in the Aleutian basin, beneath the abyssal plain a refractor with velocity of V_p = 6.1 to 6.7 km/s appears to be the acoustic basement. A refractor (V_p = 5.2 to 5.5 km/s) lies below the plateau's acoustic basement, and this refractor may be the acoustic basement. Because the acoustic basement is identified from a traceable reflecting horizon, consequently, the acoustic basements that have been mapped beneath the Aleutian basin and beneath Umnak plateau are probably different rock types.

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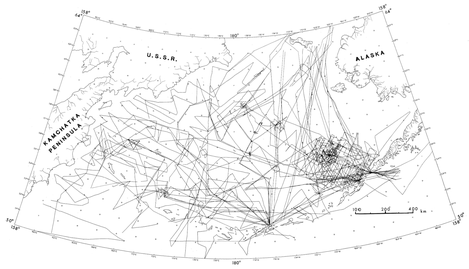
MARINE SEISMIC SURVEYS

	ORGANIZATION	YEAR	NAVIGATION	SEISMIC SYSTEM
R/V Lee	USGS	1978	Satellite, Loran C	Airgun-1326 cu. in.
R/V Lee	USGS	1977	Satellite, Loran C	Airgun-1326 cu. in.
R/V Sea Scandia	USGS	1977	Satellite, Loran C	Aerer 160 kilojoules
R/V Sea Scandia	USGS	1977	Satellite, Loran C	Aerer 160 kilojoules
R/V Lee	USGS	1976	Satellite, Loran C	Aerer 160 kilojoules
R/V Lee	USGS	1976	Satellite, Loran C	Airgun-1326 cu. in.
R/V Sea Scandia	USGS	1976	Satellite, Loran C	Aerer 160 kilojoules
R/V Lee	USGS	1975	Satellite, Loran C	Aerer 160 kilojoules
R/V Bartlett	USN	1972	Satellite, Loran	Aerer 30 kilojoules
R/V Hunt	USN	1972	Satellite, Loran	Aerer 40 kilojoules
R/V Conrad	L-DGO	1971	Satellite	Airgun-25 cu. in.
R/V Eltanin Challenger	NSF (SIO)	1971	Satellite, Loran	Airgun-25 cu. in.
R/V Bartlett	USGS (USN)	1970	Satellite	Aerer 160 kilojoules
R/V Melville	SIO	1970	Satellite	Airgun-40 cu. in.
R/V Conrad	L-DGO	1969	Loran	Airgun-25 cu. in.
R/V Storis	USCG	1969	Satellite	Aerer 80 kilojoules
R/V Hunt	USN	1968	Loran	Aerer 120 kilojoules
R/V Conrad	L-DGO	1968	Loran C, radar	Airgun-25 cu. in.
R/V Hunt	USN	1968	Loran	Aerer 120 kilojoules
R/V Conrad	L-DGO	1967	Loran	Airgun-25 cu. in.
R/V Thompson	USGS	1967	Loran	Aerer 120 kilojoules
R/V Conrad	L-DGO	1966	Loran	Airgun-25 cu. in.
R/V Dayton	USGS (USN)	1965	Loran	Aerer 38 kilojoules
R/V Yaquina	L-DGO	1965	Loran	Airgun-25 cu. in.
R/V Yaquina	L-DGO	1964	Loran	Airgun-25 cu. in.

ORGANIZATIONS

L-DGO: Lamont-Doherty Geological Observatory of Columbia University
USN: United States Navy
USGS: United States Geological Survey
USCG: United States Coast Guard
SIO: Scripps Institution of Oceanography
NSF: National Science Foundation
NOAA: National Oceanic and Atmospheric Administration
GSC: Geological Survey of Canada

TRACKLINES



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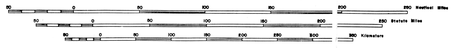


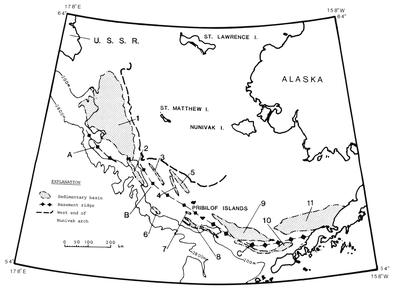
ALBERS EQUAL AREA PROJECTION

STRUCTURE - CONTOUR MAP ON ACOUSTIC BASEMENT IN THE BERING SEA

by

A. K. Cooper, M. S. Marlow, A. W. Parker, and J. R. Childs

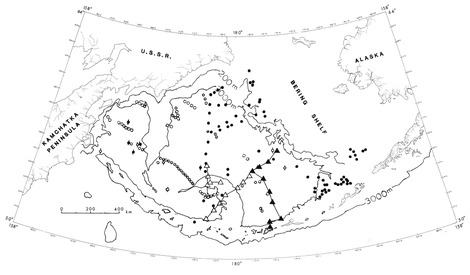
1979



Sedimentary basins, acoustic basement ridges, and Nunivak arch as defined by Marlow and others, (1976, fig.2, table 1).

	FEATURE	DEFINING CONTOUR (km)
1	Navarin basin	2.0
2	Shumchug basin	2.0
3	Walrus basin	1.5
4	Otter basin	1.5
5	Inner basin	1.5
6	Daniel basin	1.5
7	Garden basin	1.5
8	Pribilof basin	2.0
9	St. George basin	3.0
10	Amak basin	3.0
11	Bristol Bay basin	1.5
A	Navarin ridge	
B	Pribilof ridge	
C	Black Hills ridge	

SEISMIC REFRACTION STATIONS



TWO SHIP REFRACTION STATIONS

▲-▲	Shor (1964)	SIO
△-△	Ludwig and others (1971)	L-DGO

SONOBUOY STATIONS

◊	Hamilton and others (1974)	USN, USGS, SIO
◆	Shor and Pommeranz (1976)	SIO
○	Nabokovitz and Cooper (1977) Ludwig and others (1971)	L-DGO
●	Childs and Cooper (1979)	USGS

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