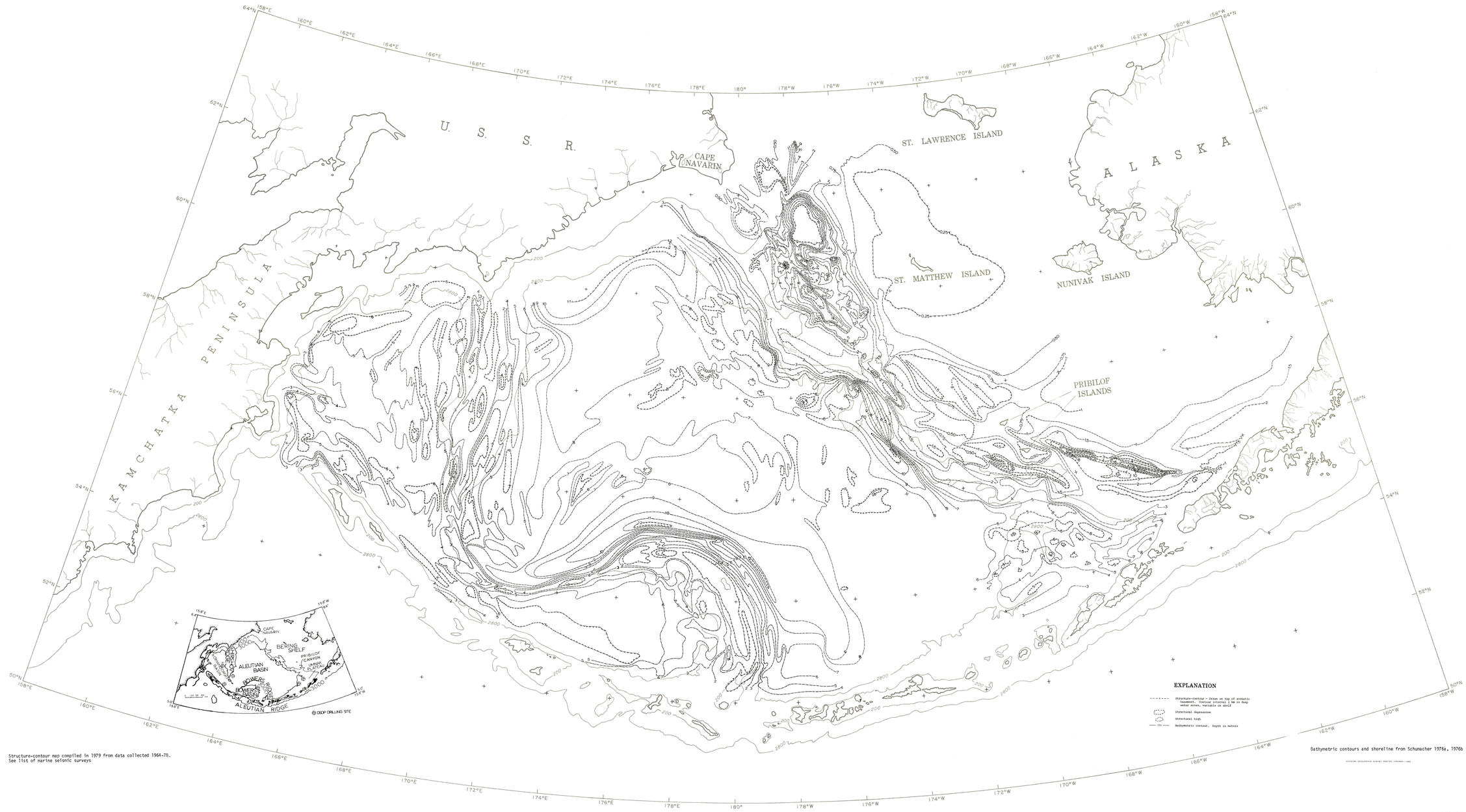
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1165

PROPERTY OF DGGS LIBRARY



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—1980

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, have been determined from time-depth regression equations. The following two equations, 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: $SD = WD + 1.126\ T + 1.033\ T^2 - 0.117\ T^3$

Bering Sea basin: $SD = WD + 1.29\ T + 0.91\ T^2 - 0.07\ T^3$

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 refraction profiles and velocity logs in the Bering Sea region. They are similar to those used by Cooper and others (1977).

Acoustic basement: Bering shelf area

Acoustic basement beneath the Bering shelf is generally a major unconformity above which strata are flat lying and undeformed. The refraction velocity for basement rock ranges from 5.0 to 5.5 km/s for the southern shelf area and from 4.9 to 5.2 km/s for the northern shelf area. Intrabasement reflectors are present and generally dip basinward. The presence of these reflectors, the relatively high velocity of the rock as the high refractive velocities, indicate that the basement complex is in part composed of folded and indurated strata.

Beneath the outer Bering shelf, the acoustic basement may consist mainly of Mesozoic eugeosynclinal rocks. Upper Jurassic ophiolites and ultramafic have been recovered at two sites near the Pribilof Islands (Scarborough and others, 1976; T. Vallier, written commun., 1978) and late Cretaceous (Campanian) andesites has been dredged from the north wall of Pribilof Canyon (Hopkins and others, 1969). These Jurassic and Cretaceous rocks are probably part of the basement complex that underlies the sedimentary rocks on the outer 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 (Barth, 1956; Hill and Gard, 1960). Ultramafic rocks on St. Matthew and Hall Islands have not been dated, however, the structural relation with the granitic body suggests that the ultramafic bodies may be of Mesozoic age (Scholl and others, 1970).

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, 1979). These ridges lie beneath the outer Bering shelf between Pribilof Islands and the Alaska Peninsula and may form the seaward and lateral boundary of the large sediment-filled basins that lie beneath the outer Bering shelf.

Landward of the large shelf basins, the acoustic basement should be Cape Navarin schist, Paleozoic metamorphic rocks on St. Matthew Island complex (ml-whalin volcanic and plutonic rock of late Cretaceous age and earliest Tertiary age (Dutton and others, 1976). An abrupt change in the magnetic character of the basement rocks at the shelf edge may reflect the juxtaposition of the two different basement rock types. The contact between Mesozoic eugeosynclinal basement rock of the outer shelf and the presumed Paleozoic 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 the acoustic basement is oceanic crust (Cooper and others, 1979) and probably of middle Cretaceous age, recovered at DSDP site 192 in the Komandorsky basin (Creager and others, 1973), as well as theoretical magnetic studies in the Aleutian and Bowers basins (Cooper and others, 1976; Hayes and Taylor, 1978). Basement rocks in the abyssal parts of the Bering Sea basin is oceanic basalt. The acoustic basement beneath the Bowers and Shirshov ridges differs from the basement in the abyssal basins in that it is more rugged in appearance and volcanic rocks (Scholl and others, 1970). The location of the transition from the island arc 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 (Marlow and others, 1979) show a prominent reflective horizon in the Aleutian basin is overlain by a 'continental' acoustic basement (traced from the Bering shelf). These two reflecting horizons overlap in a 10- to 20- ke-wide zone near the shelf edge. Where the shallowest of the two acoustic basements has been mapped. In other areas, on the continental slope, this overlap, if present, is not observed in the single channel seismic data that have been used to map acoustic basement.

Umnak plateau, in the southeast corner of the Aleutian basin, is thought to be underlain by oceanic crust (Cooper and others, 1979). Although oceanic basalt is the acoustic basement of the plateau, refraction data (Shor and Pommeral, 1978) show sedimentary horizon (V_p = 4.1 to 4.7 km/s) appears to be the acoustic basement's lower boundary. V_p = 5.2 to 5.5 km/s line below the plateau's acoustic basement, and this refractor is probably oceanic basalt. This inter-basement refractor does not originate from a tectonic reflecting horizon; consequently, the acoustic basements that have been mapped beneath the Aleutian basin and beneath Umnak plateau are probably different rock types.

REFERENCES

Barth, T.F.W., 1956, Geology and petrology of the Pribilof Islands, Alaska: U.S. Geological Survey Bulletin, 1028F, p. 101-160.

Childs, J.R., and Cooper, A.K., 1979, Bering Sea sonobuoy locations 1975-1979: U.S. Geological Survey Open-file Report 79-371.

Cooper, A.K., Childs, J.R., Marlow, M.S., Rehkemeier, P.D., Scholl, D.W., and Ludwig, W.J., 1977, Preliminary isopach and structure contour maps of the Bering Sea basin: U.S. Geological Survey Miscellaneous Field Studies Map MF-927.

Cooper, A.K., Childs, J.R., Scholl, D.W., Marlow, M.S., and Gardner, J.V., 1979, Evolution of Umnak Plateau, Bering Sea [abs.]: EOS Transactions, American Geophysical Union, v. 60, no. 18, p. 246.

Cooper, A.K., Scholl, D.W., and Marlow, M.S., 1976, Mesozoic basaltos in the Bering Sea deepsea basin: Journal of Geophysical Research, v. 81, no. 11, p. 1916.

Cooper, A.K., Scholl, D.W., Marlow, M.S., Childs, J.R., Redden, D.D., and Kvenvolden, K.A., 1976, The Aleutian basin, Bering Sea - A frontier area for hydrocarbon exploration: Proceedings of 10th Offshore Technology Conference, Houston, Texas, v. 1, p. 353-362.

Creager, J.S., Scholl, D.W., and others, 1973, Initial reports of the Deep Sea Drilling Project, v. 19, Washington (U.S. Government Printing Office), 913 p.

Hamilton, E.L., Moore, D.G., Buffington, E.C., Shuraur, P.L., and Curray, J.R., 1974, Sediment velocities from sonobuoys - Bay of Bengal, Bering Sea, Sea of Japan and North Pacific: Journal of Geophysical Research, v. 79, no. 27, p. 2613-2645.

Hopkins, D.M., Scholl, D.W., Adkinson, W.D., Plafker, R.L., Smith, P.J., Wolfe, J., Marincovich, L., Jr., Blackwelder, B.W., and Merklin, R.L., 1969, Late Cretaceous, Tertiary, and early Pleistocene rocks from the continental margin in the Bering Sea: Geological Society of America Bulletin, v. 80, p. 1471-1480.

Hopkins, D.M., and Sildenman, M.L., 1978, Potassium-argon ages of basement rocks from Saint George Island, Alaska: U. S. Geological Survey Journal of Research, v. 6, no. 4, p. 473-478.

Ludwig, W.F., Murauchi, S., Den, N., Ewing, M., Hotta, H., Houtz, R.E., Ibrahi, T., Asanuma, T., Segawara, K., Saito, T., and Ando, S., 1971, Structure of Bowers Ridge, Bering Sea: Journal of Geophysical Research, v. 76, p. 4350-4360.

Marlow, M.S., Cooper, A.K., Scholl, D.W., Vallidy, T.L., and McLean, H., 1979, Description of dredge samples from the Bering Sea continental margin: U.S. Geological Survey Open-File Report 79-1139.

Parton, W.W., Jr., Leopherts, M.A., Miller, T.P., and Scott, R.A., 1976, Age and tectonic significance of volcanic rocks on St. Matthew Island, Bering Sea, Alaska: U.S. Geological Survey Journal of Research, v. 4, no. 1, p. 65-71.

Rabinowitz, P., and Cooper, A.K., 1977, Structure and sediment distribution in the western Bering Sea: Marine Geology, v. 24, p. 309-320.

Schumacher, O., 1976a, Bathymetric map of the Aleutian trench and Bering Sea: U.S. Geological Survey Open-file Map 76-821, 2 sheets (scale 1:2,500,000).

Schumacher, O., 1976b, Bathymetric map of the Gulf of Alaska: U.S. Geological Survey Open-file Map 76-822, 2 sheets (scale 1:2,500,000).

Scholl, D.W., Buffington, E.C., and Marlow, M.S., 1970, Plate tectonics and the structural evolution of the Aleutian-Bering Sea region: in Forbes, R.B., ed., The geophysics and geology of the Bering Sea region: Geological Society of America Memoir 151, 314 p.

Shor, G.G., Jr., 1964, Structure of the Bering Sea and the Aleutian Ridge: Marine Geology, v. 1, p. 213-219.

Shor, G.G., Jr., and Pommeral, D.J., 1978, Seismic refraction measurements in the Umnak Plateau region, Bering Sea: Journal of Geophysical Research, v. 83, no. 2, p. 1260-1266.

EXPLANATION

- Structure-contour - Drawn on top of acoustic basement. Contour interval 0.5 km in deep water areas, variable on shelf
- Structural depression
- Structural high
- Bathymetric contour. Depth in meters

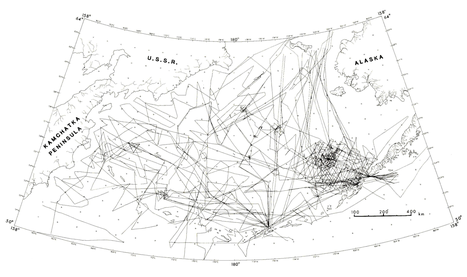
MARINE SEISMIC SURVEYS

	ORGANIZATION	YEAR	NAVIGATION	SEISMIC SYSTEM
R/V Lee	USGS	1978	Satellite, Loran C	Airgun-150% cu. in.
R/V Lee	USGS	1977	Satellite, Loran C	Airgun-150% cu. in.
R/V Sea Rounder	USGS	1977	Satellite, Loran C	Aroez 160 kilojoules
R/V Sea Rounder	USGS	1977	Satellite, Loran C	Aroez 160 kilojoules
R/V Lee	USGS	1976	Satellite, Loran C	Aroez 160 kilojoules
R/V Lee	USGS	1976	Satellite, Loran C	Airgun-150% cu. in.
R/V Sea Rounder	USGS	1976	Satellite, Loran C	Aroez 160 kilojoules
R/V Lee	USGS	1975	Satellite, Loran C	Aroez 160 kilojoules
R/V Hartlett	USN	1972	Satellite, Loran	Aroez 30 kilojoules
R/V Rand	USN	1972	Satellite, Loran	Aroez 60 kilojoules
R/V Conrad	L-DGO	1971	Satellite	Airgun-25 cu. in.
R/V Glomar Challenger	NSF (DSDP)	1971	Satellite, Loran	Airgun-10 cu. in.
R/V Hartlett	USGS (USN)	1970	Satellite	Aroez 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 Stonia	USCG	1969	Satellite	Aroez 80 kilojoules
R/V Rand	USN	1968	Loran	Aroez 120 kilojoules
R/V Conrad	L-DGO	1968	Loran C, radar	Airgun-25 cu. in.
R/V Rand	USN	1968	Loran	Aroez 120 kilojoules
R/V Conrad	L-DGO	1967	Loran	Airgun-25 cu. in.
R/V Thompson	USGS	1967	Loran	Aroez 120 kilojoules
R/V Conrad	L-DGO	1966	Loran	Airgun-25 cu. in.
R/V Davis	USGS (USN)	1965	Loran	Aroez 38 kilojoules
R/V Vema	L-DGO	1965	Loran	Airgun-25 cu. in.
R/V Vema	L-DGO	1964	Loran	Airgun-25 cu. in.

ORGANIZATIONS

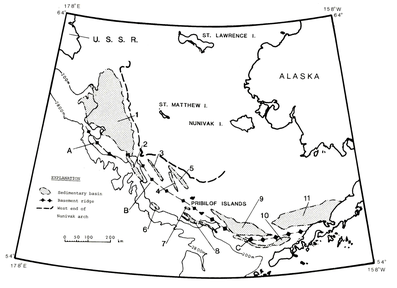
L-DGO: Lamont-Doherty Geological Observatory of Columbia University
USN: United States Navy
USGS: United States Geological Survey
USCG: United States Coast Guard
SIO: Scripps Institution of Oceanography
NSF: National Science Foundation
NOAA: National Oceanic and Atmospheric Administration
GSC: Geological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

TRACKLINES



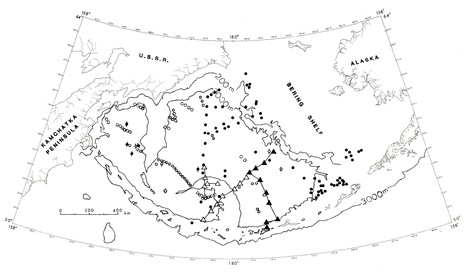
Scale 1:2,500,000

ALBERS EQUAL AREA PROJECTION



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

SEISMIC REFRACTION STATIONS



TWO SHIP REFRACTION STATIONS

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

SONOBUOY STATIONS

S Hamilton and others (1974)	USN, USGS, SIO
♦ Shor and Pommeril (1976)	SIO
○ Rabinowitz and Cooper (1977) Ludwig and others (1971)	L-DGO
● Childs and Cooper (1979)	USGS

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

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

For sale by Distribution Section, U. S. Geological Survey
Federal Bldg., Box 12, 101 Twelfth Avenue, Fairbanks, AK 99701,
and Branch of Distribution, U. S. Geological Survey, Box 25286,
Federal Center, Denver, CO 80225.