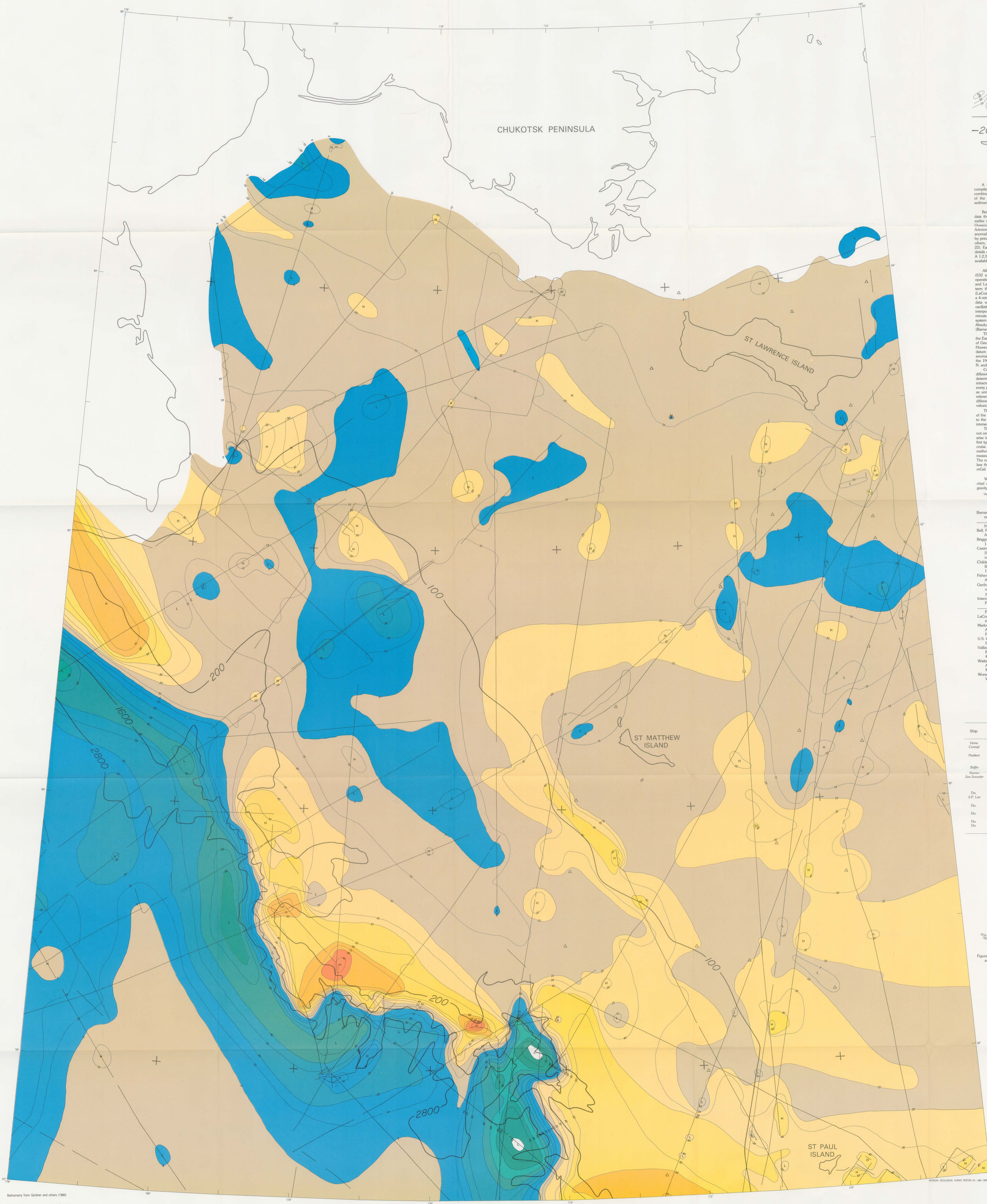

Bathymetry from Gardner and others (1980)

This map is not intended for navigational purposes

SCALE 1:1 000 000

ALBERS EQUAL AREA PROJECTION
BASED ON STANDARD PARALLELS
OF 50° AND 60° NORTH

EXPLANATION

GRAVITY INTENSITY
(milligals)

FREE-AIR GRAVITY CONTOURS (1930 DATUM)—Contour interval 10 milligals. H, L indicate local highs and lows

SHIP TRACKLINE

—200— BATHYMETRIC CONTOUR—In meters

LAND AREA

△ SUBMARINE GRAVITY STATION

ABSTRACT

A free-air gravity anomaly map of the central and northern Bering Sea has been compiled from surface ship gravity data collected by the U.S. Geological Survey (USGS) and combined with previously collected surface-ship and pendulum data. This map covers parts of the Alaskan and Siberian Continental Shelf underlain by the Anadyr and Navarin sedimentary basins.

INTRODUCTION

Between 1975 and 1981, the USGS collected an extensive amount of marine gravity data throughout the Bering Sea. These new data have been combined with those from earlier surveys in the same area (carried out primarily under the auspices of the National Oceanographic and Atmospheric Administration, formerly Environmental Science Services Administration, and Lamont Doherty Geological Observatory) to create a free-air gravity anomaly map of the central and northern Bering Sea. Parts of this area have been covered by previous gravity maps (Watts, 1975; U.S. Coast and Geodetic Survey, 1969; Fisher and others, 1982). The contours in Anadyr Gulf are taken from Marlow and others (1983, fig. 22). Each of the cruises that were used in this compilation are listed in table 1, along with details of the cruise and data collection. Pendulum stations were taken from Worzel (1965). A 1:2,500,000-scale free-air gravity anomaly map of the entire Bering Sea region (fig. 1) is available (Childs and others, 1985).

DATA REDUCTION

All of the USGS data used here were collected with LaCoste-Romberg[1] sea gravimeters (S32 and S53) mounted on two- or three-axis inertial stabilized platforms. The theory of operation and calculation methods are described by LaCoste and others (1967) and Valliant and LaCoste (1976). Gravity values were calculated from spring tension and a correction term that included components due to beam motion and inherent cross-coupling errors (LaCoste and others, 1967). Prior to digital recording, the gravity values were filtered with a 4-minute averaging filter to remove the effects of ship motion, and values for the three-axis data were filtered with an additional 84-minute notch filter to remove Schuler period oscillations (Bell, 1969). Observed gravity values were adjusted for meter drift by linear time interpolation between harbor station ties. Eötvös corrections were calculated from 1- or 2-minute fixes of computer-smoothed navigation. Occasional failure of the navigation recording system necessitated the use of longer intervals picked from hand-smoothed navigation plots. Absolute gravity values were obtained by tying to the Alaskan gravity base-station network (Barnes, 1968), which the USGS extended to harbor stations at ports of call.

The free-air gravity for all of the USGS data was originally calculated with reference to the Earth ellipsoid defined by the 1967 Geodetic Reference System (International Association of Geodesy, 1971) and the IGSN–71 datum (International Association of Geodesy, 1974). However, to facilitate incorporation of the Watts map, free-air values were converted to the datum defined by the 1930 International Gravity formula (Cassinis, 1930). The free-air anomaly with respect to the 1930 datum is more positive than the anomaly with respect to the 1967 datum. The 1930 values exceed the 1967 values by 5.3 milligals (mGal) at 50° N. and 8.5 mGal at 65° N. (Barnes, 1977).

Compiling data from numerous sources requires careful analysis of errors between different data sets. Prior to contouring, nearly 300 trackline crossings were examined to determine the cross-tie discrepancies. These crossings included both intercruise and intracruise (when a trackline crosses itself) intersections. The mean crossing error between every pair of intersecting cruises was calculated. Two of the older cruises were then discarded as unreliable. The most internally consistent and extensive cruise was chosen as a fixed reference, and an offset was calculated for each remaining cruise to minimize its crossing differences with the reference cruise. The offsets ranged from 0.1 to 12.8 mGal (absolute values). These shifts were applied to the free-air gravity for each data set prior to contouring.

The free-air anomalies were initially contoured by a machine algorithm that mapped all of the data onto an orthogonal grid and fit a third-order spline (minimum curvature) surface to the grid values (Briggs, 1974). The machine contours were then modified to accurately intersect the tracklines. The free-air anomalies were contoured at 10-mGal intervals.

The errors in the gravity data arise primarily from navigational uncertainty, which affects not only the positional accuracy but also the calculation of the Eötvös effect. Secondly, errors arise in correlating the relative marine measurements to absolute datum at harbor ties. The first type of errors are random, while the second are systematic (or constant) for a particular cruise. The base-tie inaccuracies would be partly or totally corrected by the correction method described above. Figure 2 is a histogram of the absolute value of the differences measured at 46 trackline intersections on this map after adjustment for cross-tie discrepancies. The root mean square difference was 3.7 mGal. Eighty-one percent of the differences were less than 5 mGal, 96 percent less than 7 mGal, and only 2 percent were greater than 10 mGal.

ACKNOWLEDGMENTS

We would like to thank Mike Marlow, Mike Fisher, Jim Gardner, Tracy Vallier, and other chief scientists of the USGS research vessels *S.P. Lee* and *Sea Sounder* for the use of gravity data collected during their scientific legs.

[1]Any use of trade names is for descriptive purposes only and does not imply endorsement by the USGS.

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Table. 1—*Cruise- and gravity-collection data, central and northern Bering Sea*
[na, not available]

Ship	Year	Cruise	Ports of call	Navigation	Gravimeter	Platform	Correction for cross coupling
Vema	1965	V2111	Adka-Dutch Harbor	Celestial	Gss No. 12	Alidade	No
Conrad	1971	C1406 C1407	Adak-Adak	Satellite	--do--	--do--	Yes
Hudson	1970	HD01	Vancouver-Resolute	--do--	Gss2 No. 17 and vibrating string accelerometer	Anschutz	Do.
Baffin	--do--	na	na	na	na	na	
Rainier	--do--	na	na	na	na	na	
Sea Sounder	1976	S476BS	Dutch Harbor-Nome	Integrated system: Satellite, Loran C	LaCoste and Romberg S–32	Gimbal mounted two-axis	Do.
Do.	1977	S377BS	Nome	--do--	--do--	--do--	Do.
S.P. Lee	1976	L576BS	Kodiak-Dutch Harbor-Nome	--do--	LaCoste and Romberg S–53	--do--	Do.
Do.	--do--	L776BS	Nome-Adak	--do--	--do--	--do--	Do.
Do.	1977	L877BS	Kodiak-Nome	--do--	--do--	Gimbal mounted three-axis	Do.
Do.	1978	L578BS	--do--	--do--	--do--	--do--	Do.
Do.	1980	L680BS	Dutch Harbor-Nome	--do--	--do--	Gimbal mounted two-axis	Do.

Figure 1.—Location map of the Bering Sea indicating the major sedimentary basins (shaded), as defined by the 1.5- or 2-km isopach, and physiographic features.

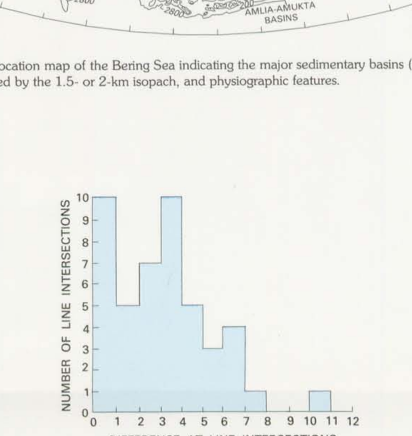

Figure 2.—Histogram of the absolute values of the differences measured at 46 trackline intersections after adjustment for cross-tie discrepancies.

FREE-AIR GRAVITY ANOMALY MAP OF THE CENTRAL AND NORTHERN BERING SEA

By
J. R. Childs, H. W. Magistrale, and A. K. Cooper

1987