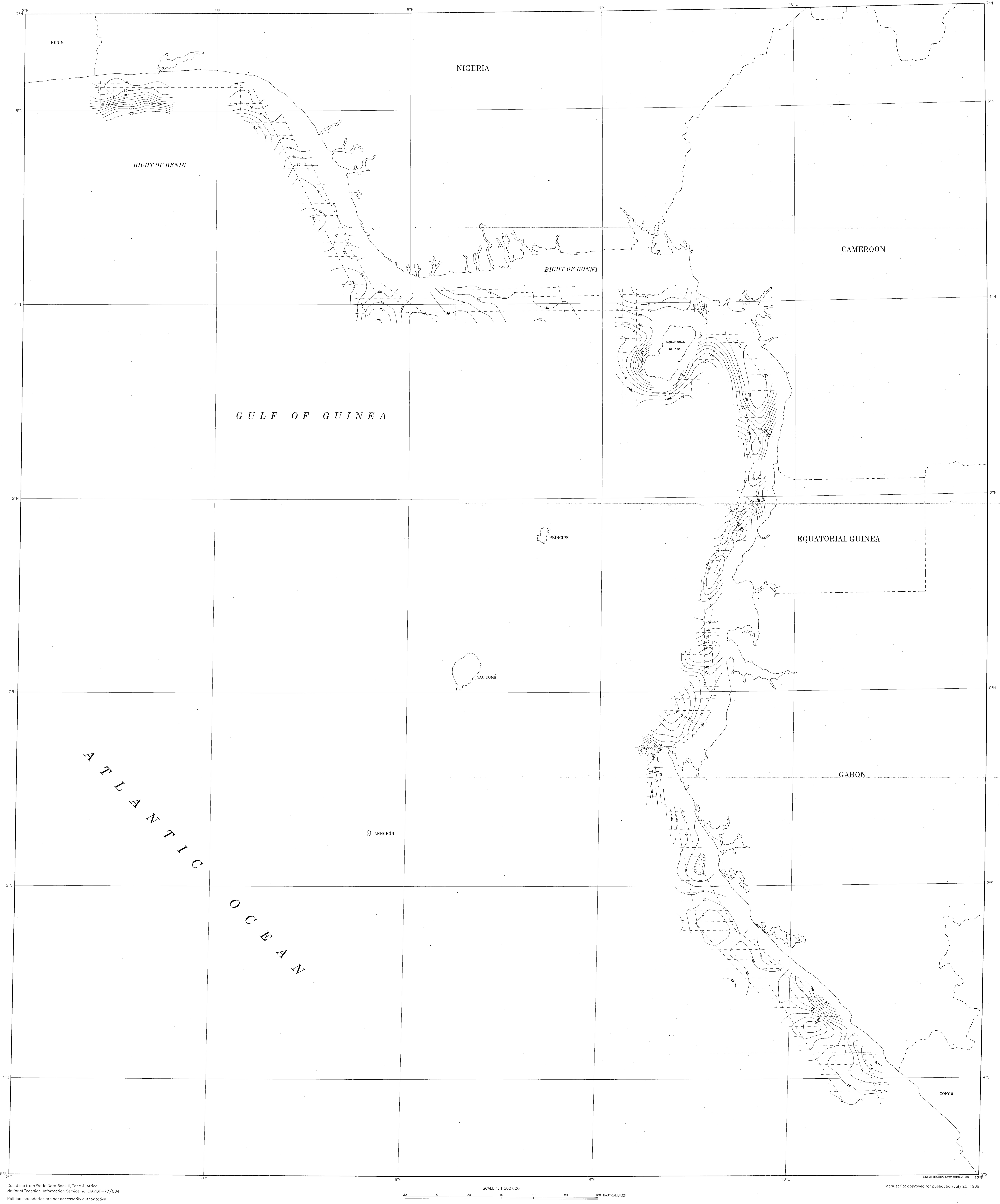
87040
87042

DEPARTMENT OF THE INTERIOR
U. S. GEOLOGICAL SURVEY

Prepared in cooperation with the
DEFENSE MAPPING AGENCY

MISCELLANEOUS FIELD STUDIES
MAP MF-2098-F



Coastline from World Data Bank II, Tape 4, Africa,
National Technical Information Service no. CIA/DF-77/004

Political boundaries are not necessarily authoritative

Lambert Azimuthal Equal Area projection
Central meridian 3° W
Latitude of central point 10.5° N

SCALE 1: 1 500 000

20 0 20 40 60 80 100 NAUTICAL MILES

20 0 20 40 60 80 100 KILOMETERS

Manuscript approved for publication July 20, 1989

EXPLANATION OF MAP SYMBOLS

Free-air gravity contours; interval 10 mgal

Area of decreasing gravity

Ship trackline

INTRODUCTION

This map is one of six in a series presenting marine gravity data off the western coast of Africa (fig. 1). The data, collected by the U. S. Geological Survey (USGS) in 1987 in response to a request from the Defense Mapping Agency, are intended to improve gravity coverage where it has been insufficient or inadequate. The information shown on this and the other three maps that cover the African coast represents a total of approximately 32,000 line kilometers of marine gravity data from Western Sahara south to Gabon. This map shows data collected off the coasts of Nigeria, Cameroon, Equatorial Guinea, and Gabon between September 24 and November 4, 1987.

METHODS

Data were collected aboard the Research Vessel (RV) *Starella*, a converted 73-m stern trawler owned and operated by J. Marr and Sons of Hull, England, under contract to the USGS. Nominal survey speed was 10 knots (18.5 km/hr). Two LaCoste and Romberg (L&R) Air-Sea Gravity Meters (S-26 and S-41) were operated continuously during the surveys. The dual metering provided immediate, or real-time, checks on meter performance and quality control on data collected. Both gravity meters were of standard beam-type configuration that included capacitance readouts, Loh 6200A analog-to-digital converter boxes, and USGS computer processing and recording systems. Ten-second samples of L&R raw spring tension, average beam, and cross-coupling signals were logged and used to compute the raw digital gravity values. The raw digital gravity readings were filtered by three stages of lag-20-s resistive capacitance (RC) filtering in the instrument plus three stages of lead-20-s RC digital filtering. A 5-min symmetrical digital filter was applied in the computer processing. The standard auto-reader analog gravity readings provided a graphic check on the digital computations. All land gravity stations were on the International Gravity Standardization Net (IGSN) 1971 datum. Land gravity values were calibrated to the shipboard values at dockside using a L&R Model G Geodetic Gravity Meter (G-170).

All positions were computed in the World Gravity System (WGS)-84 datum and filtered in exactly the same manner as were the gravity signals. The primary navigation system used during the cruise was a General Electric CVL-12 Correlation Sonar/Sperry Mk-29 MOD 3 Gyrocompass interfaced to a USGS computer system that calculated dead reckoning (DR) positions every 10 s (McCullough and others, 1989). Global Positioning System (GPS) and Transit Satellite fixes were used for updating and control. Elements of a Magnavox S-5000 integrated navigation system were used to convey positioning information to the ship's bridge. The DR system provided precision to about 0.5 percent or about 5 m/25 km root mean square (RMS), after linear drifts between satellite fixes were removed.

Data were recorded digitally on hard disk every 10 s and periodically transferred to tape. Real-time 10-s digital plots of various system parameters were continuously logged. Plotted variables included time; DR and GPS latitudes and longitudes, and their differences; Eotvos correction calculated from DR and GPS; raw and filtered gravity from both meters, and their differences; Eotvos-corrected gravity; ship's speed and direction; and gravity-platform heave and sway acceleration, which was needed to monitor sea-state effects on the gravity meters.

All parameters were monitored continuously by the watchstanders and party chief. With such data, problems with components of the system were readily identified and corrected; if corrections could not be made, traverse lines were rerun immediately. This real-time editing or recapture of data virtually eliminated data loss. Subsequent editing aboard the ship on an IBM-AT XENIX computer system provided gravity and navigation plots, and backup listings of time, positions, and Eotvos-corrected gravity. Line intersection points, crossing values, and statistics were routinely recorded and analyzed. For this and the other three cruises along the Africa coast, the statistics of the line-crossing differences were 1.2 mgal RMS. Base gravity readings taken before and after these cruises established the drift rate for the marine gravimeters (-2.8 mgal in 133 days for S-26; -0.3 mgal in 133 days for S-41). This correction was applied to the data in the laboratory, where the tapes were reformatted, regional gravity field removed, and free-air gravity anomalies calculated. The resulting contour map of free-air gravity anomalies enlarges the existing database, which was sparse for the nearshore area along the coast of Africa (see, for example, Bowin and others, 1982).

MAPPING TECHNIQUE

Eotvos-corrected gravity data (free-air values) were reduced to 6-min samples and gridded using a standard minimum-tension gridding technique. This procedure has two stages: initial estimate, and biharmonic iteration with scattered-data feedback. The initial estimate selects data points within a grid cell by their proximity to the grid node, and averages them using an inverse-distance weighting function that depends on the angular distance between points. Once averaged, the grid nodes are re-evaluated (second stage) using a biharmonic cubic spline function, which is followed by a scattered-data feedback procedure (Dynamic Graphics, Inc., 1988). The grid-cell size for this map is approximately 2700 m on a side. Contour lines are truncated along shore and at the open-ocean margins using zone blanking.

ACKNOWLEDGMENTS

We are indebted to L. Awasika and A. Inusa of Nigeria and T. Nhabay of Sierra Leone for their participation in the cruise and to T. Cocke (U. S. Department of State) and R. Rowland (USGS) for helping to obtain diplomatic clearances. Captains J. Cannan and J. Nichols and the crew of RV *Starella* were most cooperative. C. Ryland (USGS) provided assistance with the preparation of the final map product.

REFERENCES CITED

Bowin, C. O., Warsi, Waris, and Milligan, Julie, 1982, Free-air gravity anomaly atlas of the world: Geological Society of America Map and Chart Series, No. MC-46.

Dynamic Graphics, Inc., 1988, Interactive surface modeling: Berkeley, Calif., Release No. 6.93, 467 p.

McCullough, J. R., Irwin, B. J., and Folger, D. W., 1989, Precise worldwide ship navigation: Sea Technology, v. 30, no. 1, p. 46-50.

Woods Hole Oceanographic Institution Contribution No. 7061

MF-2098-A: Folger, D.W., Irwin, B.J., McCullough, J.R., Bouse, R.M., Polloni, C.F., Dodd, J.E., and O'Brien, T.F., 1990, Map showing free-air gravity anomalies around the Cape Verde Islands, scale 1:750,000.

MF-2098-B: Folger, D.W., McCullough, J.R., Irwin, B.J., Dodd, J.E., Strahle, W.J., Polloni, C.F., and Bouse, R.M., 1990, Map showing free-air gravity anomalies around the Canary Islands, Spain, scale 1:750,000.

MF-2098-C: Folger, D.W., Irwin, B.J., McCullough, J.R., Driscoll, G.R., and Polloni, C.F., 1990, Map showing free-air gravity anomalies off the western coast of Africa: Western Sahara to Senegal (north of 15° north latitude), scale 1:1,500,000.

MF-2098-D: Folger, D.W., McCullough, J.R., Irwin, B.J., Driscoll, G.R., and Polloni, C.F., 1990, Map showing free-air gravity anomalies off the western coast of Africa: Senegal (south of 15° north latitude) to Sierra Leone, scale 1:1,500,000.

MF-2098-E: Folger, D.W., Irwin, B.J., McCullough, J.R., Rowland, R.W., and Polloni, C.F., 1990, Map showing free-air gravity anomalies off the southern coast of west-central Africa: Liberia to Ghana, scale 1:1,500,000.

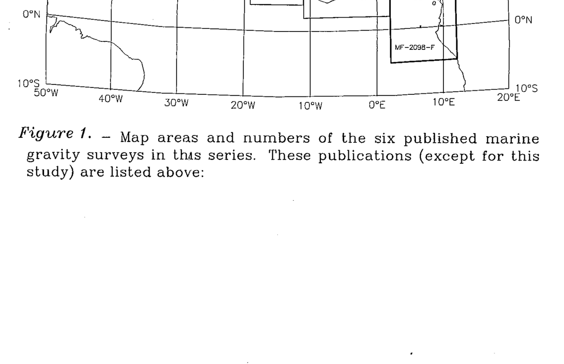


Figure 1. – Map areas and numbers of the six published marine gravity surveys in this series. These publications (except for this study) are listed above:

MAP SHOWING FREE-AIR GRAVITY ANOMALIES OFF THE WESTERN COAST OF AFRICA: NIGERIA TO GABON

By
David W. Folger[1], James R. McCullough[2], Barry J. Irwin[1],
George R. Driscoll[1], Catherine M. Delorey[1], and Christopher F. Polloni[1]

1990

[1] U. S. Geological Survey
[2] Woods Hole Oceanographic Institution

For sale by U.S. Geological Survey, Map Distribution, Box 25286, Federal Center, Denver, CO 80225