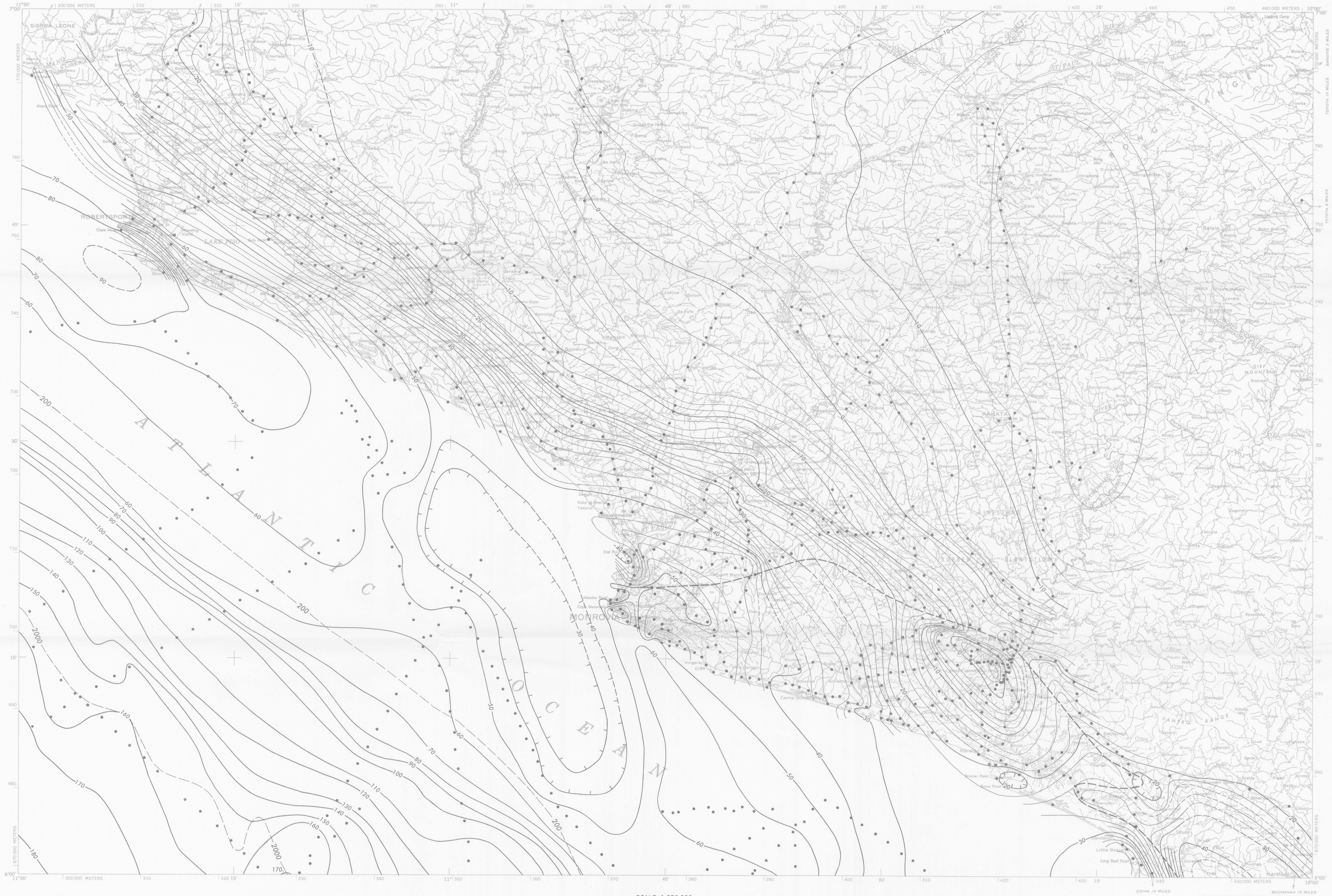
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
REPUBLIC OF LIBERIA
MINISTRY OF LANDS AND MINES

FOLIO OF THE MONROVIA QUADRANGLE, LIBERIA
MAP I-775-E



Base from U.S. Geological Survey, 1968–69

Gravity data compiled in 1971–72

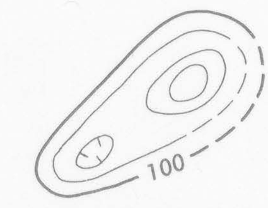
SCALE 1:250,000

5 0 5 10 15 20 25 30 KILOMETERS

5 0 5 10 15 20 MILES

1972 MAGNETIC DECLINATION VARIES FROM 14°10′ WESTERLY FOR THE CENTER OF THE WEST EDGE TO 13°30′ WESTERLY FOR THE CENTER OF THE EAST EDGE. MEAN ANNUAL CHANGE IS 0°06′ EASTERLY

EXPLANATION



GRAVITY CONTOURS – Dashed where approximately located. Hachures indicate closed areas of low gravity. Assumed density of 2.67 g per cc (grams per cubic centimeter). Data are not terrain corrected. Contour interval 2 milligals on land, 10 milligals on water

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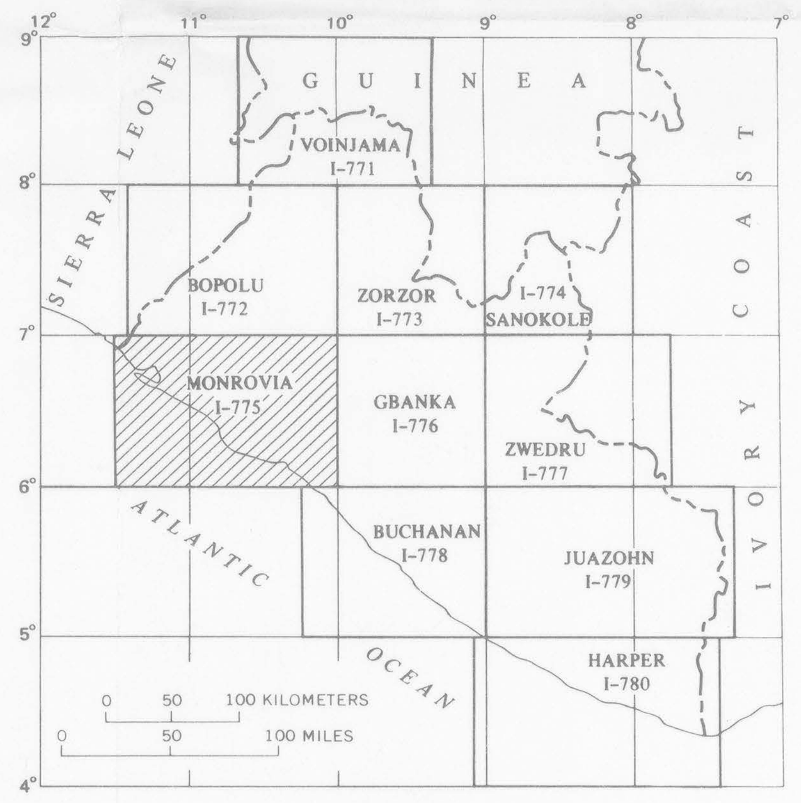
GRAVITY STATION LOCALITY

— — — — — —
APPROXIMATE EASTERN LIMIT OF SEDIMENTARY ROCK (WHITE, 1969)

—— 200 ——
BATHYMETRIC CONTOURS – Approximately located. Depth shown in meters



INDEX MAP OF LIBERIA – Showing location of quadrangle and miscellaneous geologic investigations maps published by the U.S. Geological Survey. Area of I–775 shaded.

INTERPRETATION

By John C. Behrendt, U.S. Geological Survey, and
Cletus S. Wotorson, Liberian Geological Survey

INTRODUCTION

The gravity survey of the Monrovia quadrangle was part of a geologic mapping program undertaken cooperatively by the Liberian Geological Survey and U.S. Geological Survey under the auspices of the Liberian Government and the Agency for International Development, U.S. Department of State. The survey was made in cooperation with the U.S. Army Topographic Command, 72nd Engineering Detachment. The data offshore were observed on USGS International Decade of Oceanographic Exploration (IDOE) cruise leg 5, supported by the National Science Foundation. The geology of the quadrangle has been mapped (Thorman, in press) as part of the cooperative program.

The entire country is heavily forested, access is difficult, outcrops are sparse, and thick laterite is a characteristic feature. The gravity survey is a means of gathering data concerning subsurface mass distribution of rock types and is useful as an aid in extrapolating known geologic information, and in locating potential targets for mineral and petroleum exploration.

Although gravity stations were set along most of the roads in the country, only in the Monrovia quadrangle is the density sufficient for presentation of the data at 1:250,000 scale.

The gravity stations are along roads having level-line and photogrammetrically determined elevations, along the coast and tidewater rivers, and along some roads where altimeters were used for elevation control. The elevations of approximately 80 percent of the stations are accurate to within ±2 m; the rest are probably accurate to within ±5 m. These limits correspond to Bouguer anomaly errors of ±0.4 and ±1.0 mgal, respectively. The gravity stations were located through the use of recent 1:40,000-scale planimetric maps, which were available in preliminary form for the entire area; consquently, position errors are believed to be negligible. A base-station net was established and tied to the North American gravity base network. Terrain corrections could not be made owing to the lack of topographic maps but should be less than 1 mgal in this relatively flat area. Thus, uncertainties in the data are within the contour interval shown. A density of 2.67 g/cm^3 was used in the Bouguer reduction for all gravity data.

GRAVIMETRIC INTERPRETATION

The most apparent feature in the Bouguer gravity map of the Monrovia quadrangle is the 40- to 50-mgal positive anomaly, which parallels the coast. This feature has a gradient of 3 to 4 mgal/km, which is too steep to be more than partly the result of crustal thickening at the continental margin. Continuous data along the shoreline and several widely spaced traverses perpendicular to the shore have traced this anomaly southeastward into Ivory Coast and northwestward into Sierra Leone.

In the Monrovia quadrangle this positive anomaly is associated with metamorphic rocks of the granulite facies, as mapped by White and Leo (1969), and it decreases in amplitude over quartz feldspathic gneisses (compare with Behrendt and Wotorson, 1974b). Sam Rosemblum (written Commun., 1970) found a density 0.2 to 0.3 g/cm^3 greater for the granulites than for the granitic rocks. Probably the granulites were deeper in the crust and were uplifted prior to the time of deposition of the Paleozoic(?) sedimentary rocks (White, 1969). Interestingly, the gravity data show a strong gradient seaward from the surface contact between the granulites and granitic rocks (White and Leo, 1969), suggesting that the contact dips seaward. The possibility of a fault contact along the steep gradient cannot be ruled out.

The gabbro and norite intrusion near Cape Mount at the west end of the coastal anomaly causes a substantial increase in the gravity field to greater than 90 mgal. The area of the intrusion inferred from the magnetic anomaly (Behrendt and Wotorson, 1974a) suggests at least a 20-mgal effect for the gravity anomaly. This corresponds to a thickness of the body of 1.6 to 4.8 km for assumed density contrasts of 0.3 and 0.1 respectively. As the granulite in the area has a density of about 3.0 to 3.1 g/cm^3, the smaller density contrast and greater thickness are more likely. The extension of this anomaly offshore is apparent.

Superimposed on the coastal positive anomaly previously discussed is a negative anomaly roughly centered over Roberts International Airport. A second negative anomaly to the southeast extends beyond the map. These negative anomalies indicate that the Cretaceous Farmington River Formation in basins mapped by White (1969) is of low density and of substantial thickness. In contrast, any possible small gravity effect of the thin Paleozoic(?) sedimentary rocks which make up the remainder of the indicated total sedimentary rock section is masked by gradients associated with the basement. Unfortunately the negative anomalies over these basins are too complexly distorted for a quantitative interpretation, not only by the positive coastal anomaly, but also by another negative anomaly which changes the coastal anomaly in the area of the sedimentary rock. This complexity can be seen more clearly when one considers that the 26-mgal contour east of Bassa Point overlies granite gneiss of the Precambrian basement in this area rather than granulite. If the hypothesis suggested for the coastal positive anomaly is correct, this negative anomaly overlies an area of the basement that was not uplifted and from which the less dense basement rocks were not eroded. The only major break in the positive anomaly along the entire coast occurs over, and adjacent to, the only onshore, downfaulted basins along the Liberian coast. Behrendt and Wotorson (1970) have discussed the anomalies associated with the sedimentary rocks in detail.

The offshore data show several negative anomalies on the continental shelf which we interpret as associated with down-faulted basins containing low-density Cretaceous or younger sedimentary rocks. The negative anomalies on this map, for example the one west of Monrovia defined by the closed 40-mgal contour, correlate with the locations of basins inferred from aeromagnetic data (Behrendt and Wotorson, 1970).

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SIMPLE BOUGUER GRAVITY MAP OF THE MONROVIA QUADRANGLE, LIBERIA

By

John C. Behrendt and Cletus S. Wotorson

1974

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