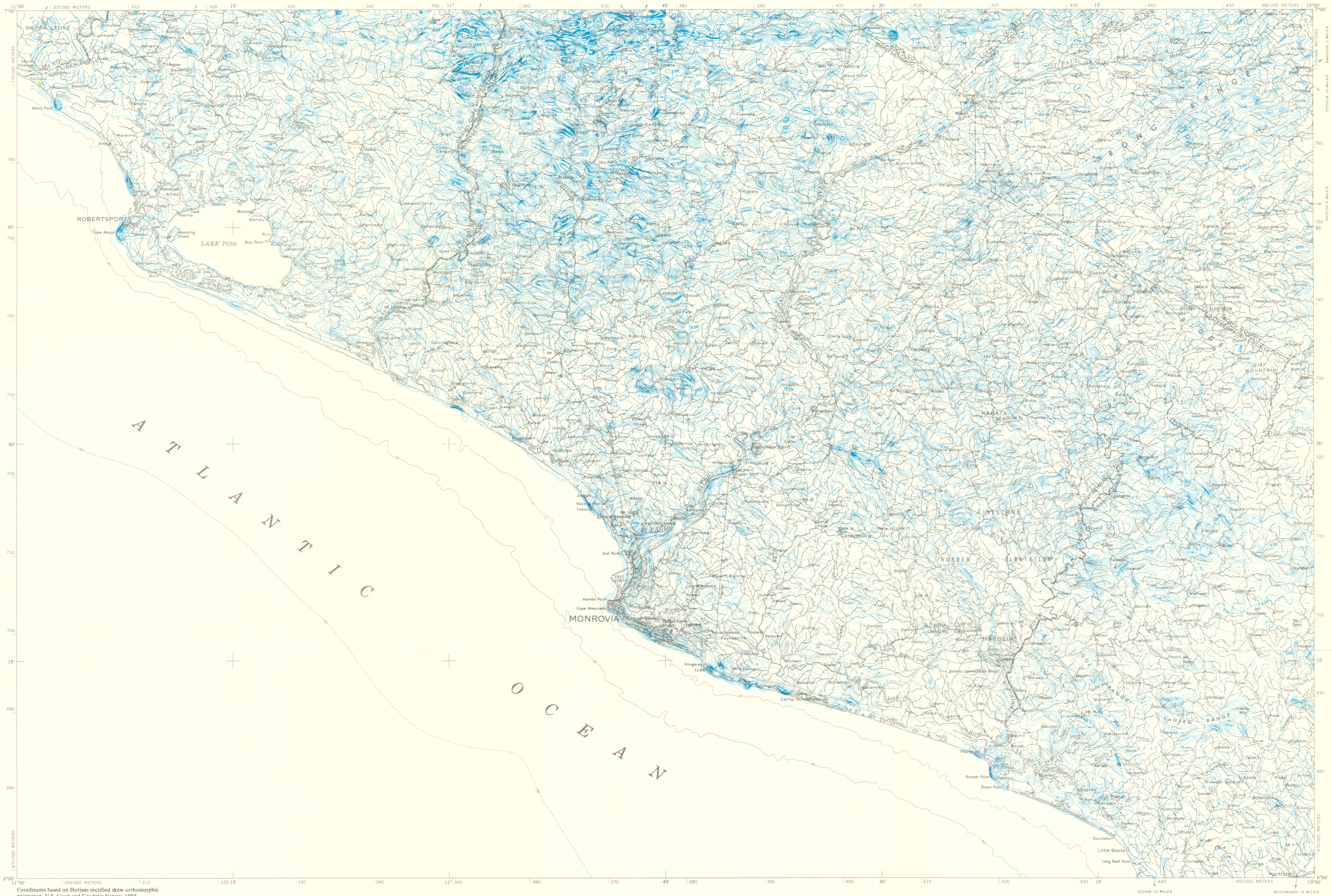
Prepared in cooperation with the
REPUBLIC OF LIBERIA
BUREAU OF NATURAL RESOURCES AND SURVEYS



Coordinates based on Hotines rectified skew orthomorphic projection, U.S. Coast and Geodetic Survey, 1956

SCALE 1:250,000

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°08' EASTERLY

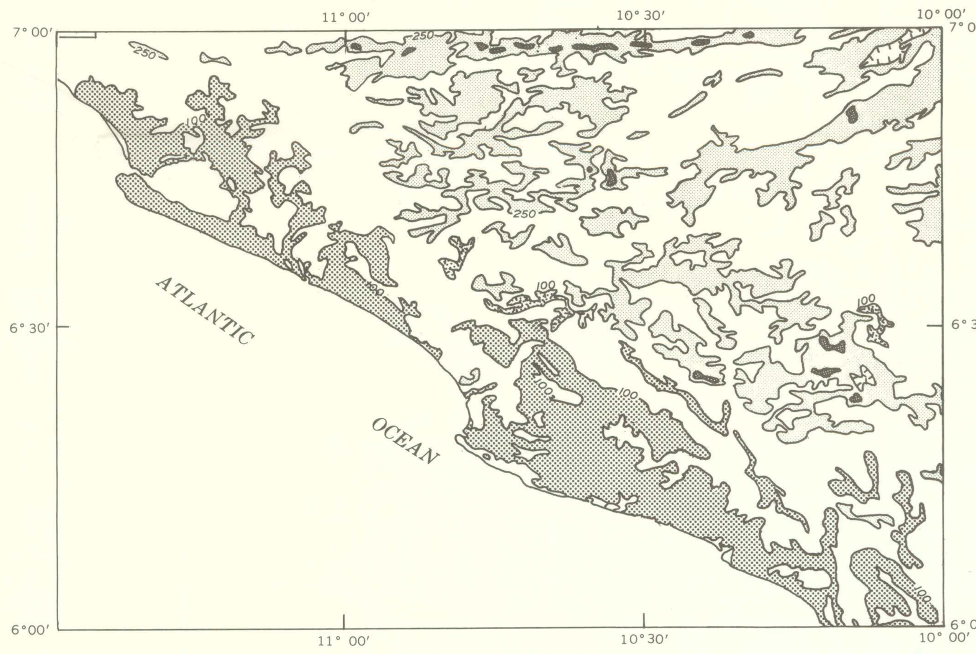
DEPTH CURVES IN FATHOMS—DATUM IS MEAN LOW WATER SPRINGS

EXPLANATION

AERORADIOACTIVITY CONTOURS – Showing aeroradioactivity in counts per second relative to arbitrary datum. Cosmic radiation component was removed. Hachured to indicate closed areas of lower aeroradioactivity. Contour interval 25 and 50 counts per second. Selected contour values shown in larger type

NOTE: For flight-path information see corresponding aeromagnetic map of the same quadrangle, Map I–775–B

Aeroradioactivity survey flown by Lockwood, Kessler, and Bartlet, Inc. at 150 meters above terrain, 1967–68. All data adjusted to 220 meters (approximately 722 feet) above terrain. Flight-line spacing of 0.8 kilometers over land and 4 kilometers over the continental shelf. Geophysical data reduced from original compilation at 1:40,000 scale by Lockwood, Kessler, and Bartlet, Inc., with minor modifications to improve legibility.

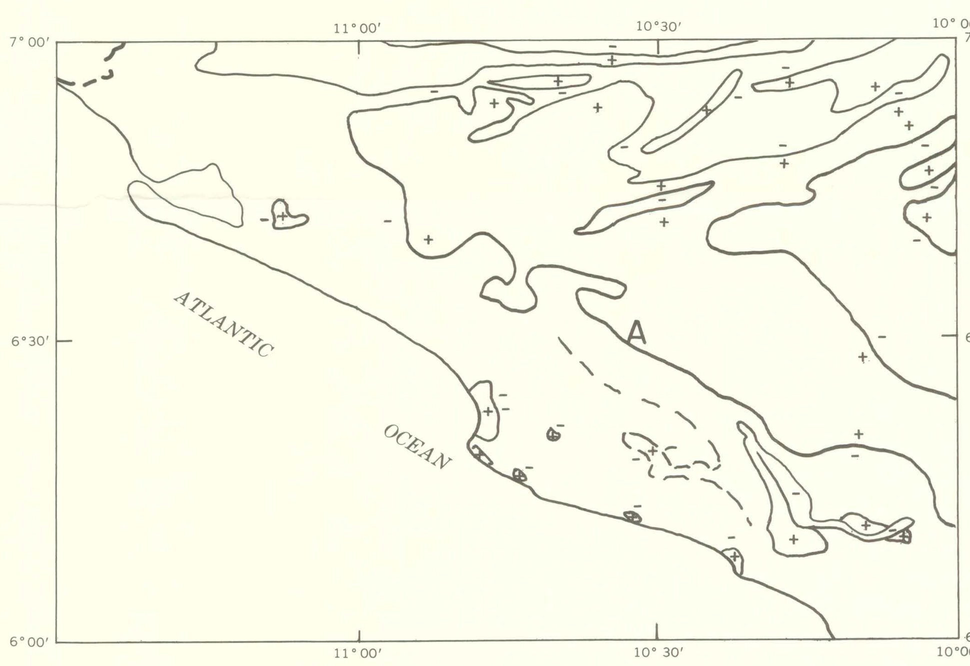


10 0 10 20 30 40 KILOMETERS
10 0 10 20 MILES

EXPLANATION

- >500 COUNTS PER SECOND
- 250–500 COUNTS PER SECOND
- 100–250 COUNTS PER SECOND
- <100 COUNTS PER SECOND

FIGURE 1. – Generalized aeroradioactivity map, Monrovia quadrangle.



10 0 10 20 30 40 KILOMETERS
10 0 10 20 MILES

EXPLANATION

GEOLOGIC CONTACT BASED ON RADIATION LEVEL AND MAGNETIC AMPLITUDE
Dashed where less certain
+ indicates higher radiation, lower magnetic amplitude, and generally more felsic rock
- indicates lower radiation, higher magnetic amplitude, and generally less felsic rock
A generalized contact between granulite (west) and granite gneiss (east)

FIGURE 2. – Suggested geologic contacts in ferred from aeroradiometric and aeromagnetic data, Monrovia quadrangle.

INTERPRETATION

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

INTRODUCTION

Aeromagnetic and total-count gamma radiation surveys were flown simultaneously over Liberia during the 1967-68 dry season. These geophysical surveys were designed to contribute to the geologic mapping program undertaken cooperatively by the Liberian Geological Survey and the U.S. Geological Survey under the auspices of the Liberian Government and the Agency for International Development, U.S. Department of State. The surveys were flown by Lockwood, Kessler, and Bartlett under contract to the Liberian Geological Survey. The geology of the Monrovia quadrangle has been mapped by Thorman (in press) as part of the cooperative program.

The entire country of Liberia is heavily forested, access is difficult, outcrops are sparse, and thick laterite is widespread. Accordingly, throughout large areas aeromagnetic and aeroradioactivity surveys are the only feasible means of gathering virtually continuous data which can be related to near-surface geology, and they are useful in extrapolating geologic observations and in locating potential targets for mineral exploration.

The airborne surveys, which cover the entire country, required approximately 140,000 km of traverse, mostly along north-south lines 0.8 km apart over land and 4 km apart over the continental shelf. Continuous photography and Doppler navigation provided horizontal control; flight altitude was 150 m above mean terrain.

The geophysical data obtained from these airborne surveys are presented, by quadrangle, in these folios of 1:250,000-scale maps that show on separate sheets geographic, geologic, aeromagnetic, and total-count gamma radiation data for each of 10 quadrangles. The index map shows the locations of these quadrangles and their folio number designations. The aeromagnetic map of the Monrovia quadrangle (Behrendt and Wotorson, 1974) should be used in conjunction with this total-count gamma radiation map.

This map shows variations in the natural energy spectrum >0.05 mev (million electron volts). The data have been normalized to an altitude of 220 m above terrain, and the cosmic background was removed by utilizing calibration data obtained over the Atlantic Ocean. The contoured data were adjusted to base-level datums obtained from the east-west control lines. The radioactivity detector used in this survey consisted of three thallium-activated sodium iodide crystals, each 12 cm in diameter and 5 cm thick. The original data were contoured at intervals of 25 and 50 cps (counts per second) referred to 180 cps equivalent to 1 μr/hr.

The gamma radiation generally detected in airborne surveys is that produced by the naturally occurring isotopes of K-40 and the U and Th decay series. Only those isotopes in the uppermost 20-30 cm of rock or soil at the earth's surface can be measured by airborne methods. The distribution of these isotopes is dependent on original bedrock composition modified by the geologic processes of weathering, solution, and erosion. Comparison of gamma radiation data and K_2O analysis for various rock types (Behrendt and Wotorson, 1971) shows that granitic rocks have a high variability in K and in radiation level, ranging from 2 to 5 percent K_2O and from 100 to >500 cps, respectively. Iron-formation, granulite, and other mafic rocks range from 0-1.5 percent K_2O and from 25-200 cps. In general all of the area above 250 cps is granitic terrane, as well as most areas between 100 and 250 cps.

Figure 1 shows the generalized radiation level for the data in this quadrangle. Figure 2 is a map showing possible geologic contacts inferred from the radioactivity and magnetic data.

GEOLOGY

The geology of the Monrovia quadrangle, although incompletely known, has been described and summarized by White and Leo (1969) and White (1969). The terrane in the northeast half of the region is predominantly granite gneiss having an average radiometric age of about 2,700 m.y. in the Liberian age province (Hurley and others, 1971). In the northeast part of this area the rock foliation trends mainly northeast. In a belt parallel to the coast the direction of the trends changes to northwest. The rocks in the northwest-trending belt have been dated at about 550 m.y. and are part of the Pan-African province (Hurley and others, 1971). Granulites crop out in a belt about 20-25 km wide along the coast within the area of the Pan-African province (White and Leo, 1969). White (1969) mapped the Paleozoic(?) Paynesville Sandstone and Cretaceous Farmington River Formation in the coastal area of the Pan-African province. Diabase dikes strike northwest across the map area; White and Leo (1969) report a date of about 185 m.y. for two associated sills in the coastal zone. The coastal dikes and sills intrude the Paynesville Sandstone (White, 1969) and are in turn overlain by the Farmington River Formation.

Metasedimentary iron-formation crops out in an east-west belt in the northern part of the area. The Bomi Hills and Bong iron mines are in this belt. Offerberg and Tremaine (1961) mapped iron-formation in the Goe and Fantro Ranges. Other metasedimentary rocks and amphibolites also crop out in the area, according to White and Leo (1969); these writers show small areas of granite near the east edge of the quadrangle in the Gibi Mountain area.

RADIOMETRIC INTERPRETATION

The radiation data show a moderately high count level, mostly greater than 200 cps, over the granite gneiss terrane in the Liberian age province and a distinctly lower count level over the granulite and sedimentary rock in the Pan-African province, as indicated on figure 1. The radiation level over granite gneiss in this quadrangle is distinctly lower than the radiation level over granite gneiss in the inland central part of Liberia. The diabase sills mapped by White (1969) in the area east of Monrovia have slight radiation anomalies of 125 to 225 cps. Clay deposits mapped by Blade (1970) along the St. Paul River appear as a sinuous positive anomaly with levels greater than 200 cps.

The contact (A, fig. 2) between the more (+) and less (-) felsic rocks can be traced as a difference in radiation level from 125 cps or less, mostly over granulite, to 225 cps over the granite gneiss. Compare with the Bouguer anomaly map (Behrendt and Wotorson, 1974, b). The metasedimentary rocks, including the iron-formation (Behrendt and Wotorson, 1974, a, fig. 1) are apparent in the radiometric data as negative anomalies relative to the adjacent terrane. An interesting anomaly on this map is the 80-km linear east-west feature located just south of lat 7° N. between long 10°15' W. and long 11°15' W. Samples of laminated paragneiss and laterite were collected in this zone and were found to contain 0.2 and 2 percent of monazite and zircon, respectively (S. Rosenblum, written commun., 1970). The 240-275-cps anomalies along the coast are commonly associated with beach deposits of black sand that contain concentrations of monazite and zircon (S. Rosenblum and S. Srivastava, written commun., 1970). These and other radioactive minerals transported by rivers from source areas in the higher background regions of the northern interior may have caused these anomalies; the mineral concentrations may be economically significant. We suggest that the anomalies greater than 750 cps in the interior and those above 250 cps along the beaches may be possible targets for mineral exploration (fig. 1). The diabase dikes are generally not apparent in the radiometric data, but one cuts the east-west positive anomaly shown immediately southeast of lat 7° N., long 11° W. near the north edge of the quadrangle (compare the magnetic and radiometric maps). Diabase sills (White and Leo, 1969) in the area east of Monrovia have positive anomalies where they overlie the Paleozoic sandstone.

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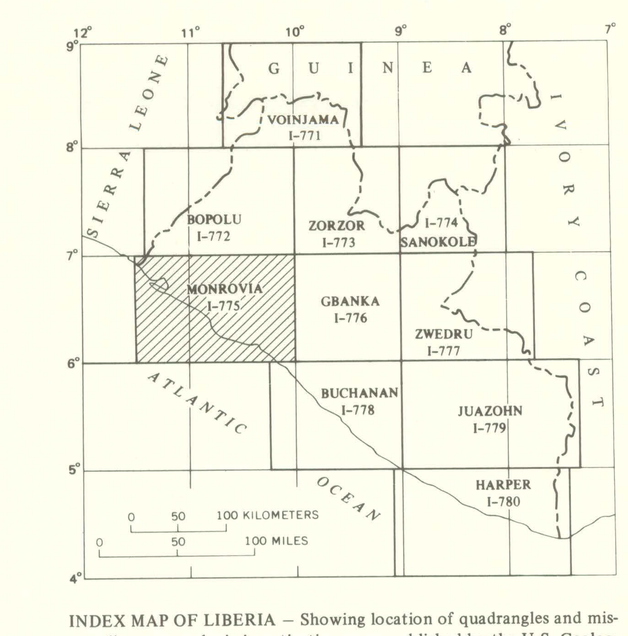

INDEX MAP OF LIBERIA – Showing location of quadrangles and miscellaneous geologic investigation maps published by the U.S. Geological Survey. Area of I–775 shaded.

TOTAL-COUNT GAMMA RADIATION MAP OF THE MONROVIA QUADRANGLE, LIBERIA

By
John C. Behrendt and Cletus S. Wotorson

1974

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