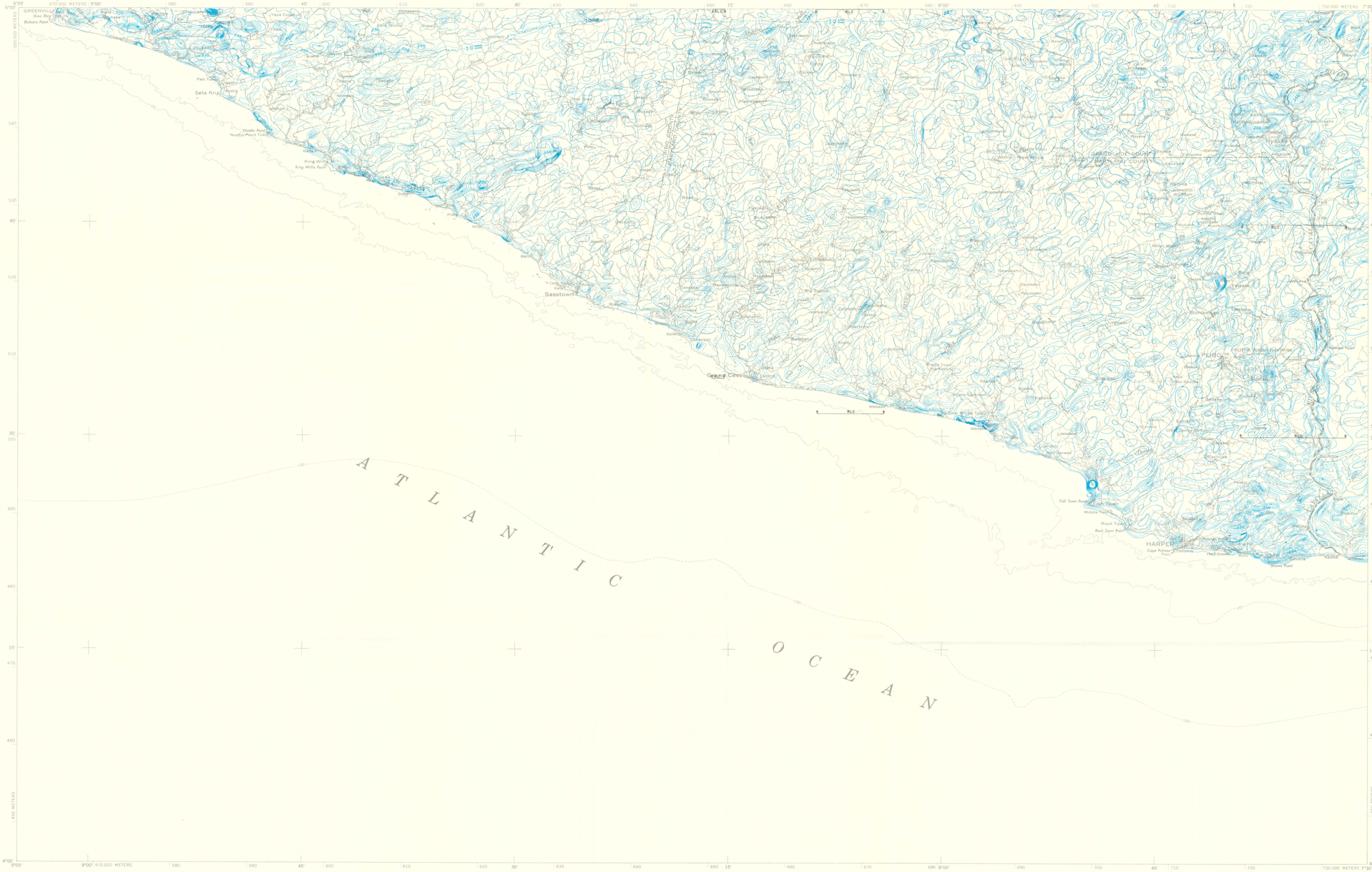
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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

FOLIO OF THE HARPER QUADRANGLE, LIBERIA
MAP I–780–C



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

SCALE 1:250,000

5 0 5 10 15 20 25 30 KILOMETERS
5 0 5 10 15 20 MILES

1971 MAGNETIC DECLINATION VARIES FROM 13°10' WESTERLY FOR THE CENTER OF THE WEST EDGE TO 12°20' WESTERLY FOR THE CENTER OF THE EAST EDGE. MEAN ANNUAL CHANGE IS 0°06' EASTERLY

DEPTH CURVES IN FATHOMS—DATUM IS MEAN LOW WATER SPRINGS

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NOTE: Country boundaries indefinite

EXPLANATION

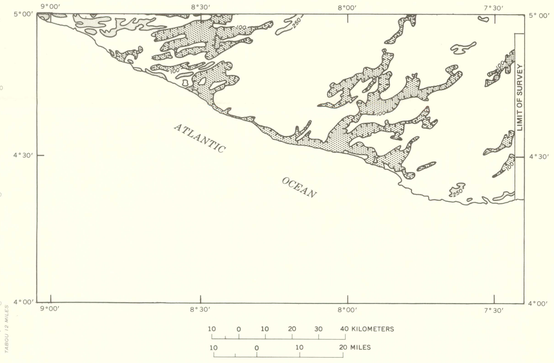
AERORADIOACTIVITY CONTOURS – Showing aeroradioactivity in counts per second relative to arbitrary datum. Cosmic radiation component was removed. Hachured to indicate closed areas of lower aeroradioactivity. Contour interval 25 and 50 counts per second. Selected contour values shown in larger type

RLC

NOTE: North-south lineations, marked RLC on map, may be due to radiation level changes after rainfall

NOTE: For flight-path information see corresponding aeromagnetic map of the same quadrangle, Map I–780–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 and4 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.



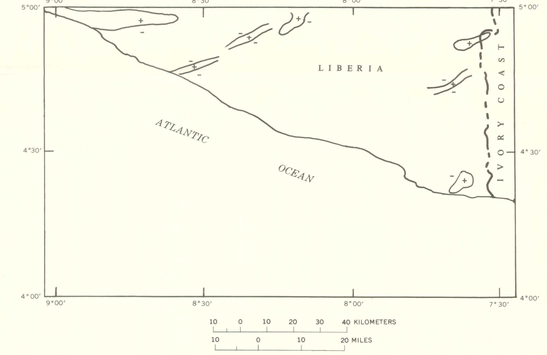
EXPLANATION

250–500 COUNTS PER SECOND

100–250 COUNTS PER SECOND

<100 COUNTS PER SECOND

FIGURE 1. – Generalized aeroradioactivity map, Harper quadrangle.



EXPLANATION

+ / – GEOLOGIC CONTACT BASED ON RADIATION LEVEL AND MAGNETIC AMPLITUDE

\+ indicates higher radiation, lower magnetic amplitude, and generally more felsic rock

– indicates lower radiation, higher magnetic amplitude, and generally less felsic rock

FIGURE 2. – Suggested geologic contacts inferred from aeroradiometric and aeromagnetic data, Harper 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 Harper quadrangle has been mapped by Brock and others (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 aeroradiometric 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 Harper 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 $\mu r/hr$.

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 rocks of the Harper quadrangle are within the Eburnean age province (about 2,000 m.y.) (Hurley and others, 1971) and comprise chiefly isoclinally folded migmatites (P. Dion and H. J. van Griethuysen, oral commun., 1970) with associated amphibolite, iron-formation, and some granite and granite gneiss. Dips range from 40° to 70° southeast, and repeated sequences of these rock types are observed (P. Dion, oral commun., 1970). Diabase dikes are located in a zone about 50 km inland in the northeast corner of the quadrangle and trend northwest from Ivory Coast to Sierra Leone. A coastal zone of diabase dikes (176–192-m.y. age) extends into the west edge of the quadrangle. Behrendt and Wotorson (1970) discussed the geophysical evidence for the existence of basins containing sedimentary rocks of probable Cretaceous age or younger on the continental shelf. The radiometric ages of the diabase dikes imply that they were syntectonic with rifting prior to the separation of Africa from South and North America. Sedimentary deposition accompanied by block faulting occurred later on the continental shelf.

RADIOMETRIC INTERPRETATION

The radiation level in this area is generally low as compared with a large part of Liberia. A high-level zone (fig. 1) at the west edge of the area is probably the result of granitic rocks. The lineation associated with isoclinal folds is apparent in the radiation data. Various higher radiation levels (>250 cps) are shown scattered throughout the interior of the quadrangle (fig. 1) and are almost certainly associated with granite gneiss or granite. The local high-amplitude anomalies along the coast are probably due to beach deposits containing radioactive minerals, which may be of economic importance. Similar anomalies along the coast in western Liberia are associated with concentrations of monazite (Behrendt and Wotorson, unpub. data; S. Rosenblum, written commun., 1970). A number of suggested geologic contacts are shown on figure 2; these are inferred from the radiometric and magnetic data (Behrendt and Wotorson, 1974).

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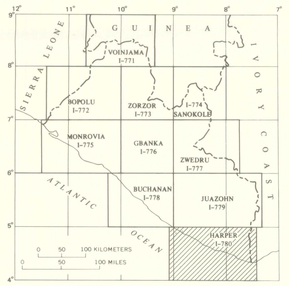

INDEX MAP OF LIBERIA – Showing location of quadrangles and miscellaneous geologic investigation maps published by the U.S. Geological Survey. Area of I–780 shaded.

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

By
John C. Behrendt and Cletus S. Wotorson

1974

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