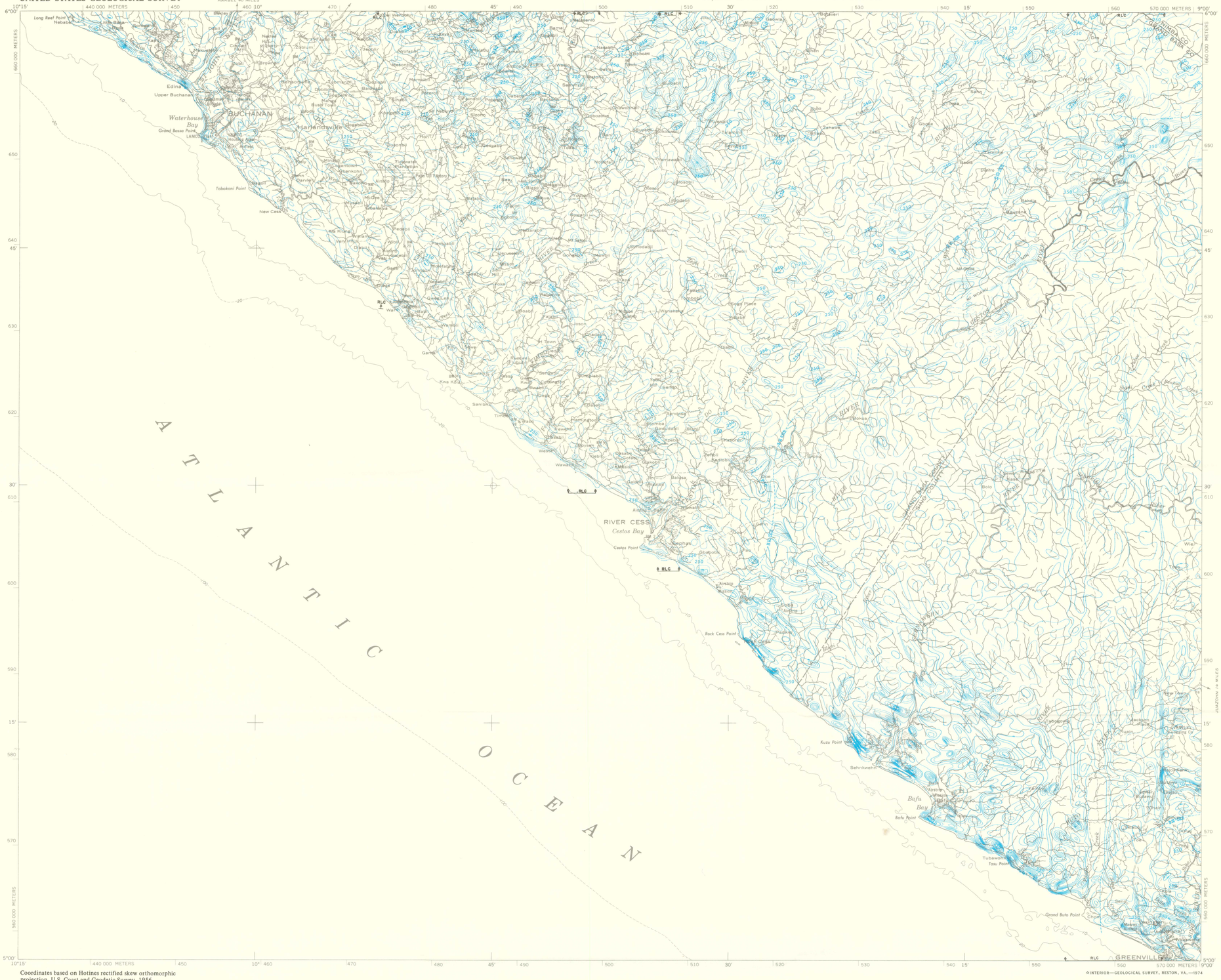
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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

FOLIO OF THE BUCHANAN QUADRANGLE, LIBERIA
MAP I–778–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

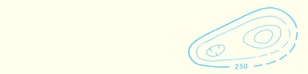
1970 MAGNETIC DECLINATION VARIES FROM 13°50' WESTERLY FOR THE CENTER OF THE WEST EDGE TO 13°20' WESTERLY FOR THE CENTER OF THE EAST EDGE. MEAN ANNUAL CHANGE IS 0°06' EASTERLY

DEPTH CURVES IN FATHOMS—DATUM IS MEAN LOW WATER SPRINGS

NOTE: Country boundaries indefinite

◆INTERIOR—GEOLOGICAL SURVEY, RESTON, VA.—1974

EXPLANATION



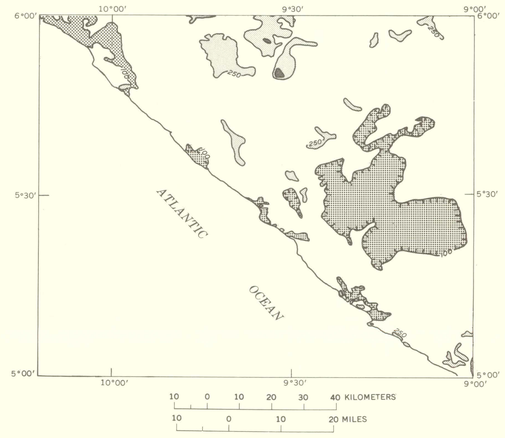
AERORADIOACTIVITY CONTOURS – Showing aeroradioactivity in counts per second relative to arbitrary datum. Cosmic radiation component was removed. Hachured to indicate closed areas of lower aeroradioactivity. Contour interval 25 and 50 counts per second. Selected contour values shown in larger type

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–778–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

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

FIGURE 1. – Generalized aeroradioactivity map, Buchanan quadrangle.

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

FIGURE 2. – Suggested geologic contacts inferred from aeroradiometric and aeromagnetic data, Buchanan 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 Buchanan quadrangle has been mapped by Tysdal (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 Buchanan 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

Geologic maps covering the Buchanan quadrangle have been published by White and Leo (1969) and Offerberg and Tremaine (1961). The boundary between the predominantly northeast-trending granite gneiss of the Liberian age province (about 2,700 m.y.) (Hurley and others, 1971) and the northwest-trending granite gneiss and granulites of the Pan-African age province (about 550 m.y.) is approximately indicated by Behrendt and Wotorson (1974, fig. 1). The boundary between the Liberian age province and the Eburnean age province (about 2,000 m.y.) is in the southeast corner of the quadrangle. Metasedimentary rocks and amphibolite are also known in the area. A zone of northwest-tending diabase dikes, of probable 176–192 m.y. age (White and Leo, 1969), crosses the quadrangle nearly parallel to the Atlantic coast. These dikes were probably intruded at the time of the separation of Africa from South America (Behrendt and Wotorson, 1970). Basins that are bounded by block faults, occur on parts of the continental shelf of sedimentary rocks of probable Cretaceous and Tertiary age, (Behrendt and Wotorson, 1970).

RADIOMETRIC INTERPRETATION

The general trend observed in the radioactivity map of the Buchanan quadrangle is similar to that shown on the magnetic map except for the pronounced north-south lineations that are probably due to radiation-level changes after rainfall. The radiation level of the quadrangle is very low when compared with radiation levels in central Liberia where substantially higher values are over granite gneiss terrane (fig. 1). A large low-amplitude area (fig. 1) is in the eastern part of the quadrangle. The radioactivity and magnetic data suggest a fairly mafic terrane, possibly amphibolite or metasedimentary rock containing little potassium feldspar, Th, and U. The radioactivity map should prove useful in mapping boundaries between more and less felsic rock units; inferred contacts are shown in figure 2. The only high anomaly in the quadrangle is near lat 5°50' N., long 9°30' W. (fig. 1). Here the amplitude is 600 cps; probably granitic rock is the source. Localized anomalies of 200–300 cps along the Atlantic coast (fig.1) are probably caused by beach deposits. S. Rosenblum (written commun., 1970) has identified monazite and zircon in similar beach deposits in northwest Liberia.

The iron-formation and other inferred metasedimentary rocks (Behrendt and Wotorson, 1974, fig. 1) in the northeastern part of the quadrangle have low radiation levels. The contact shown in the southeast corner of figure 2 separates granitic rocks with radiation levels of more than 250 cps from granitic rock of less than 250 cps and is associated with a prominant boundary within the Eburnean age province (Behrendt and Wotorson, 1971; 1974). The geologic contacts shown in figure 2 suggest that there may be two general radiation levels associated with two types of granite gneiss.

REFERENCES

Behrendt, J. C., and Wotorson, C. S., 1970, Aeromagnetic and gravity investigations of the coastal area and continental shelf of Liberia, West Africa, and their relation to continental drift: Geol. Soc. America Bull., v 81, no. 12, p. 3563–3574.

———— 1971, An aeromagnetic and aeroradioactivity survey of Liberia, West Africa: Geophysics, v. 36, no. 3, p. 590–604.

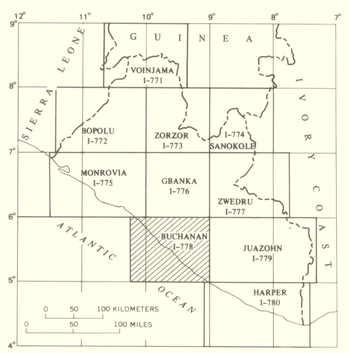
———— 1974, aeromagnetic map of the Buchanan quadrangle, Liberia: U.S. Geol. Survey Misc. Geol. Inv. Map I-778-B, scale 1:250,000.

Hurley, P. M., Leo, G. W., White, R. W., and Fairbairn, H. W., 1971, Liberian age province (about 2,700 m.y.) and adjacent provinces in Liberia and Sierra Leone: Geol. Soc. America Bull., v. 82, no. 12, p. 3483–3490.

Offerberg, J., and Tremaine, J., 1961, Report on Liberian-American Mining Company Joint Venture's geological investigations in Liberia between Nimba and Lower Buchanan along the railroad concession area: W-Reklam/Caslon Press Boktr. AB, Stockholm, 74 p.

Tysdal, R. G., in press, Geologic map of the Buchanan quadrangle, Liberia: U.S. Geol. Survey Misc. Geol. Inv. Map I-778-D, scale 1:250,000.

White, R. W., and Leo, G. W., 1969, Geologic reconnaissance in western Liberia: Liberian Geol. Survey Spec. Paper 1, 18 p.



INDEX MAP OF LIBERIA – Showing location of quadrangles and miscellaneous geologic investigation maps published by the U.S. Geological Survey. Area of I–778 shaded.

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

By

John C. Behrendt and Cletus S. Wotorson

1974

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