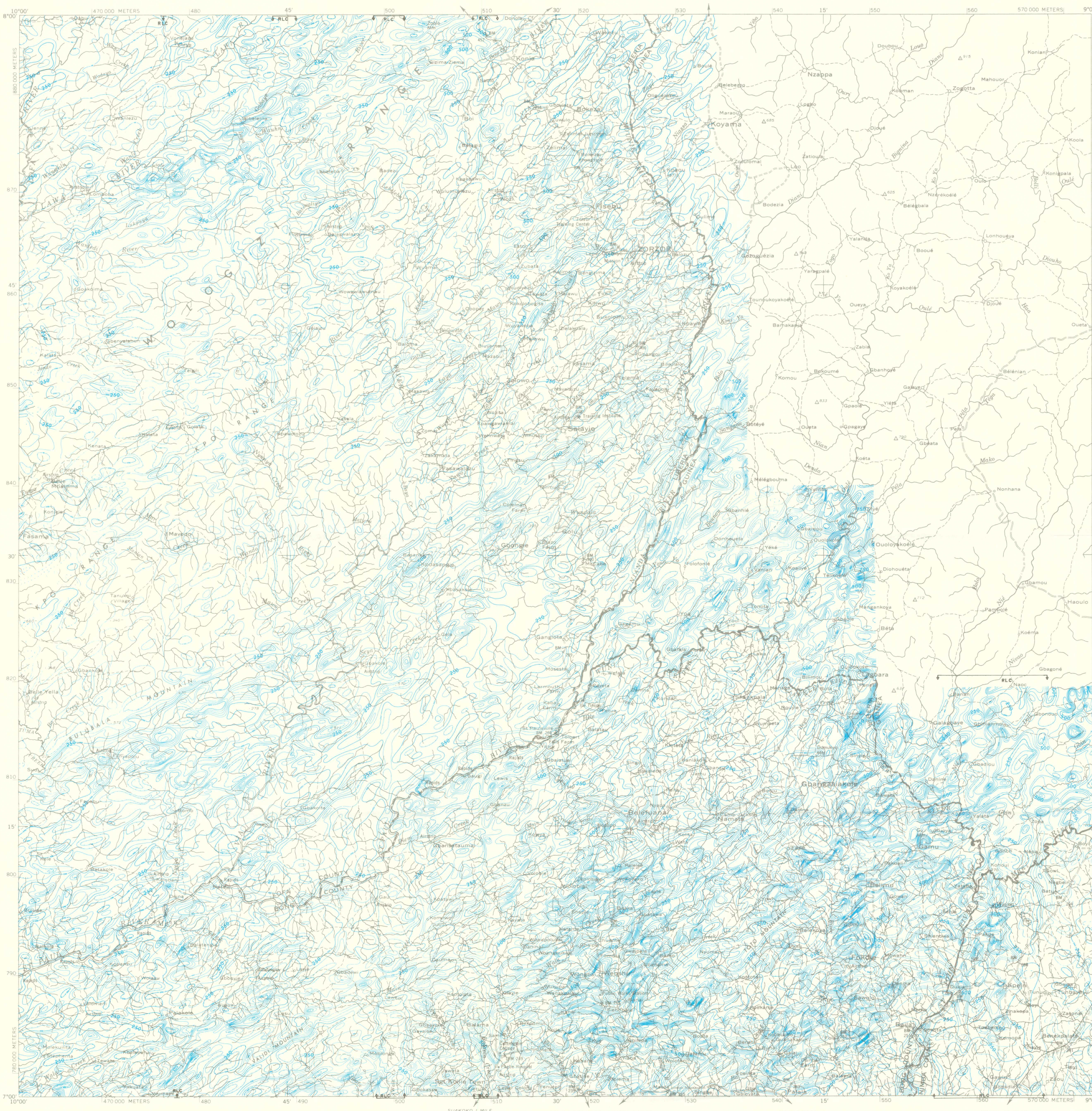
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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

FOLIO OF THE ZORZOR QUADRANGLE, LIBERIA
MAP I-773 C



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

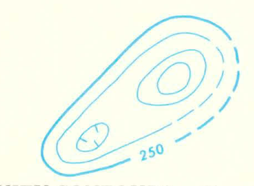
SCALE 1:250,000

1970 MAGNETIC DECLINATION VARIES FROM 12°40' WESTERLY FOR THE CENTER OF THE WEST EDGE TO 12°10' WESTERLY FOR THE CENTER OF THE EAST EDGE. MEAN ANNUAL CHANGE IS 0°06' EASTERLY

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

NOTE: Country boundaries indefinite

EXPLANATION



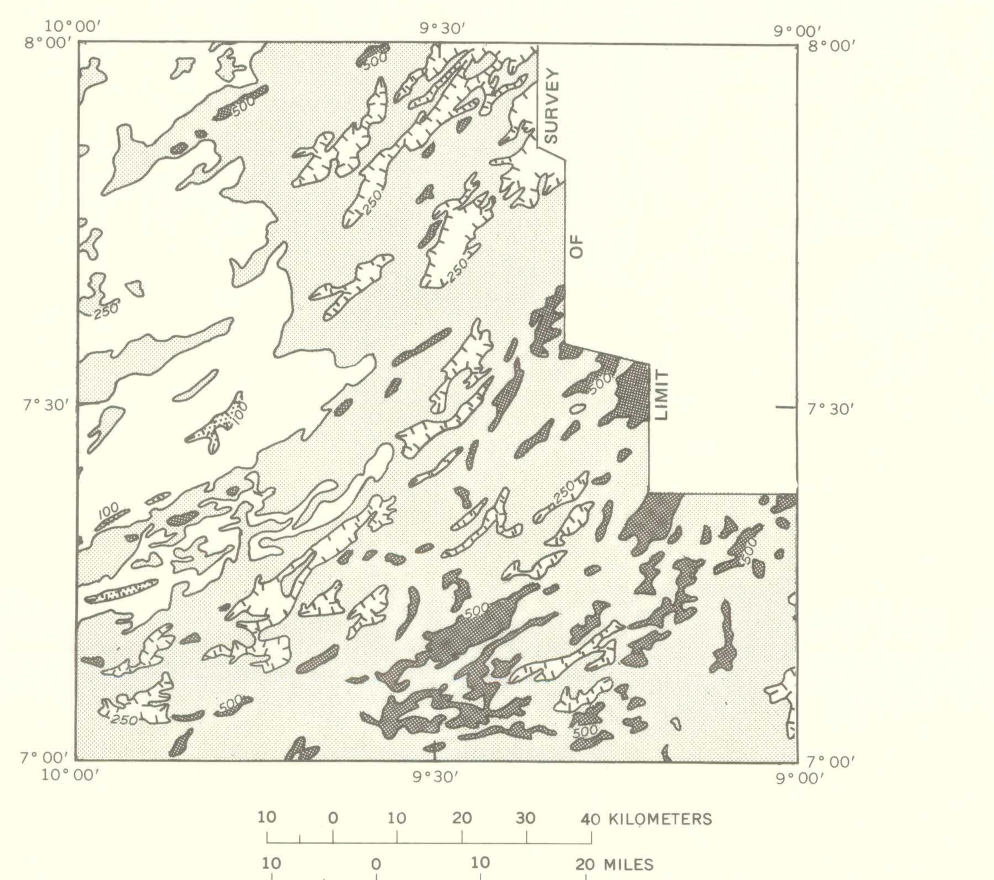
AERORADIOACTIVITY CONTOURS – Showing aeroradioactivity in counts per second relative to arbitrary datum. Cosmic radiation component was removed. Hachured to indicate closed areas of lower aeroradioactivity. Contour interval 50 counts per second. Selected contour values shown in larger type

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-773-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. Geophysical data reduced from original compilation at 1:40,000 scale by Lockwood, Kessler, and Bartlet, Inc., with minor modifications to improve legibility.



EXPLANATION

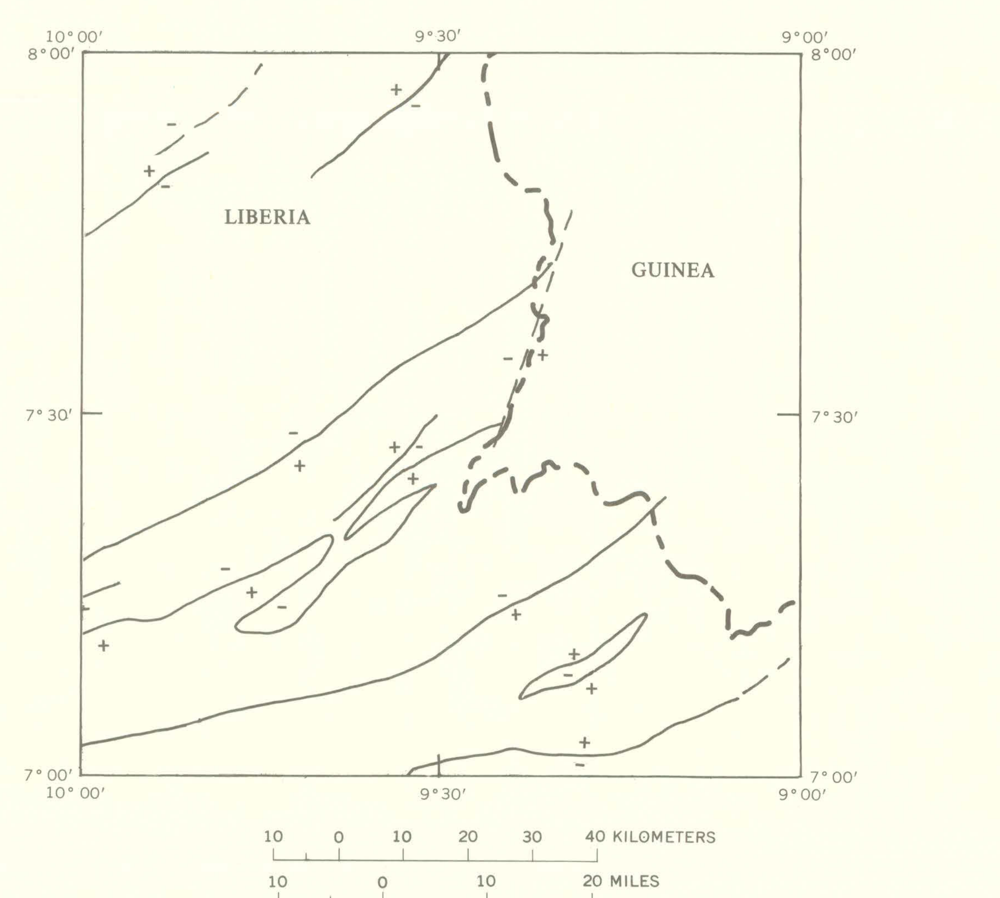
>500 COUNTS PER SECOND

250–500 COUNTS PER SECOND

100–250 COUNTS PER SECOND

<100 COUNTS PER SECOND

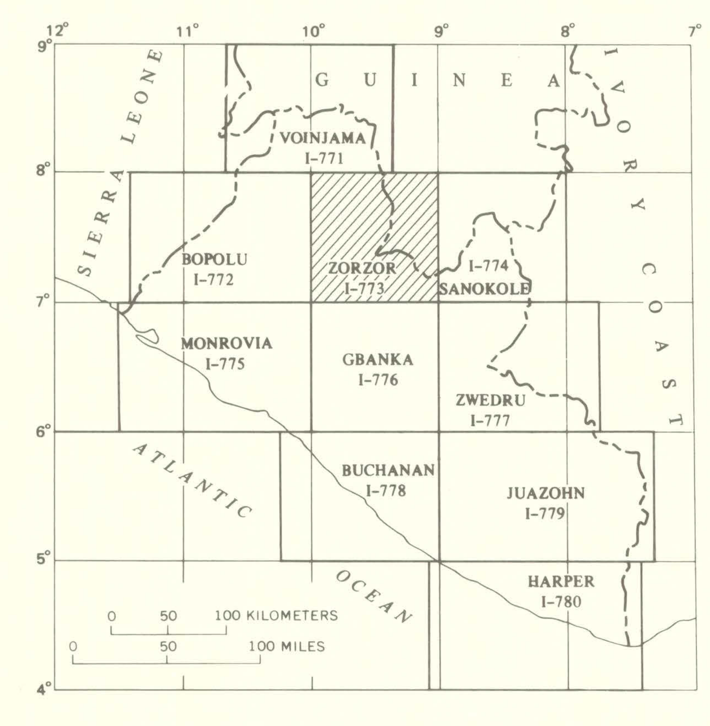
FIGURE 1. – Generalized aeroradioactivity map, Zorzor quadrangle.



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, Zorzor quadrangle.



INDEX MAP OF LIBERIA – Showing location of quadrangles and miscellaneous geologic investigation maps published by the U.S. Geological Survey. Area of I-773 shaded.

INTERPRETATION

By John C. Behrendt, U.S. Geological Survey, and
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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 Zorzor quadrangle has been mapped by Seitz (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 Zorzor quadrangle (Behrendt and Wotorson, 1974, a) 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

Bedrock in the Zorzor quadrangle has been mapped as predominantly granitic gneiss, which has the northeast foliation typical of the Liberian age province (about 2,700 m.y.) (White and Leo, 1969; Hurley and others, 1971). Also mapped are areas of metasedimentary rocks, iron-formation (itabirite), amphibolite, and diabase dikes.

RADIOMETRIC INTERPRETATION

The interpretation of the radiometric data is complicated by the existence of areas with suppressed count rate caused probably by rain showers. These areas show up as linear negative anomalies along several groups of north-south flight lines. Despite the introduction of some possible interpretive error due to these zones, this radiometric map has a number of interesting features. In general the predominant northeast trends noted in the aeromagnetic map (Behrendt and Wotorson, 1974, a) are also shown by the radioactivity contours. Several geologic contacts are indicated on the basis of the radioactivity and magnetic data (fig. 2). Most of the quadrangle has values of more than 200 cps although there are several areas of lower count. Presumably the high-count areas indicate the presence of somewhat felsic rocks. The metasedimentary rocks associated with the iron-formation have generally low levels of radioactivity; compare this map with high-amplitude magnetic anomalies as shown on the magnetic map. The lower radiation in the northwest one-third of the quadrangle (fig. 1) is typical of the radiation level over granite gneiss in western Liberia; the higher levels in the rest of the area are characteristic of the granite gneiss terrane of central Liberia (Behrendt and Wotorson, 1971). A large area in the southeast part of the quadrangle (fig. 1) that has more than 400 cps and low-amplitude (<50 gammas) magnetic anomalies is interpreted as being another more felsic type of granite gneiss. Also in the southeast are numerous areas (fig. 1) of 20-50 km² with very high radioactivity of more than 500 cps. The highest anomalies are more than 1,000 cps and many are above 750 cps.

This map must be used cautiously in mapping bedrock geology because some of the anomalies are due to placer deposits along the St. John River. For example, along the river near the southeast corner of the quadrangle south of the highway crossing at Baila, on the inside curve of two meanders anomalies of 500 cps are observed; these are almost certainly caused by stream deposition of radioactive minerals. Several more such anomalies of lower amplitude occur to the south in the Gbanka quadrangle (Behrendt and Wotorson, 1974, b) and invariably on the inside curve of meanders. This suggests that the source area of these placer deposits is in the more felsic bedrock to the north and that the associated radioactive minerals (such as monazite and zircon) are heavy and not carried very far downstream. These anomalies may be economically significant and should be investigated.

REFERENCES

Behrendt, J. C., and Wotorson, C. S., 1971, An aeromagnetic and aeroradioactivity survey of Liberia, West Africa: Geophysics, v. 36, no. 3, p. 590-604.

——— 1974, a, Aeromagnetic map of the Zorzor quadrangle, Liberia: U.S. Geol. Survey Misc. Geol. Inv. Map I-773-B, scale 1:250,000.

——— 1974, b, Total-count gamma radiation map of the Gbanka quadrangle, Liberia: U.S. Geol. Survey Misc. Geol. Inv. Map I-776-C, 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.

Seitz, J. F., in press, Geologic map of the Zorzor quadrangle, Liberia: U.S. Geol. Survey Misc. Geol. Inv. Map I-773-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.

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

By

John C. Behrendt and Cletus S. Wotorson

1974

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