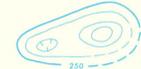


EXPLANATION

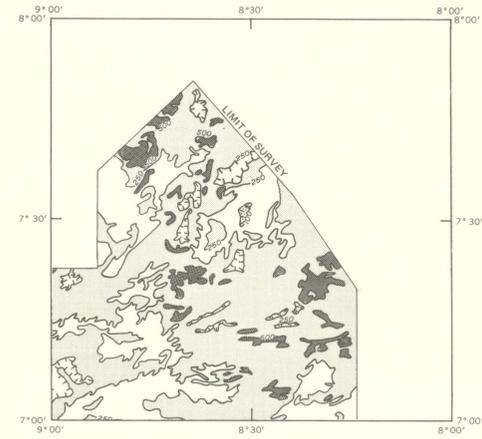


AERORADIOACTIVITY CONTOURS - Showing aeroradioactivity in counts per second relative to arbitrary datum. Cosmic radiation component was removed. Hatched to indicate closed areas of lower aeroradioactivity. Contour interval 50 counts per second. Selected contour values shown in larger type

NOTE: For flight-path information see corresponding aeromagnetic map of the same quadrangle, Map I-774-B

Aeroradioactivity survey flown by Lockwood, Kessler, and Bartlett, 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 Bartlett, Inc., with minor modifications to improve legibility.

INDEX MAP OF LIBERIA - Showing location of quadrangle and miscellaneous geologic investigations maps published by the U.S. Geological Survey. Area of I-774 shaded.



EXPLANATION

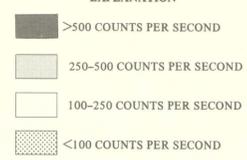
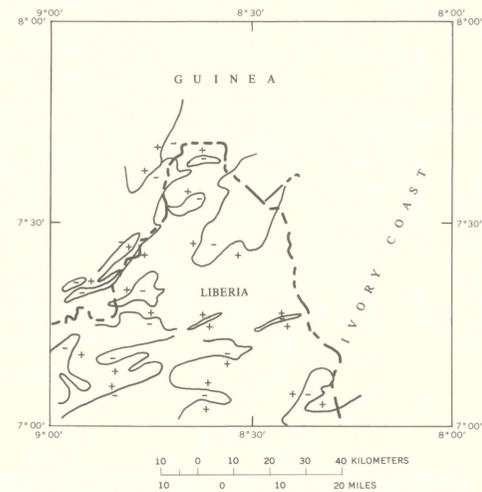


FIGURE 1. - Generalized aeroradioactivity map, Sanokole quadrangle.



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, Sanokole quadrangle.

INTERPRETATION
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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 Sanokole quadrangle has been mapped by Force and Berge (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 Sanokole quadrangle (Behrendt and Woterson, 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 150 cps equivalent to 1 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 K₂O analysis for various rock types (Behrendt and Woterson, 1971) shows that granitic rocks have a high variability in K and in radiation level, ranging from 2 to 5 percent K₂O and from 100 to >500 cps, respectively. Iron-formation, granite, and other mafic rocks range from 0.1-5 percent K₂O 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.

Most of the Sanokole quadrangle has been mapped as granitic gneiss (Offerberg and Tremaine, 1961). Linear zones of iron-formation, in places associated with amphibolite or phyllite, are scattered throughout the quadrangle. The iron-formation in the Nimba Range has ore bodies currently being mined. Some granite, as distinguished from the granitic gneiss, was mapped for about 30 km south of the Nimba Range along the Ivory Coast border; granitic rock is common elsewhere throughout the area. Diabase dikes of unknown age are reported throughout the quadrangle but are not as abundant as in other areas in Liberia. Hurley, Leo, White, and Fairbairn (1971) include the quadrangle within the Liberian age province (about 2,700 m.y.).

RADIOMETRIC INTERPRETATION

The radiometric data for the Sanokole quadrangle show a high background, largely greater than 250 cps (fig. 1). Many anomalies are greater than 500 cps and some exceed 750 cps. This quadrangle has probably the highest average background of any of the quadrangles in Liberia and is on the regional high associated with the predominantly granitic terrane in the center of the country (Behrendt and Woterson, 1971). The instruments went off scale (>800 cps) north of the quadrangle in Guinea (see A on map) just south of lat 7°45' N., long 8°45' W. A number of anomalies in this area seem to be possible targets for economic exploration. The radiation level is lower over the amphibolite and iron-formation, as expected. A number of geologic contacts are suggested by differentiating between areas below and above 250 cps (figs. 1 & 2) and by comparing the radiometric map with the magnetic map (Behrendt and Woterson, 1974). The northeast grain is typical of the Liberian age province.

REFERENCES

Behrendt, J. C., and Woterson, C. S., 1971, An aeromagnetic and aeroradiometric map of Liberia, West Africa: *Geophysics*, v. 36, no. 3, p. 590-604.

1974, Aeromagnetic map of the Sanokole quadrangle, Liberia: U.S. Geol. Survey Misc. Geol. Inv. Map I-774-B, scale 1:250,000.

Force, E. R., and Berge, J. W., in press, Geologic map of the Sanokole quadrangle, Liberia: U.S. Geol. Survey Misc. Geol. Map I-774-D, scale 1:250,000.

Hurley, P. M., Leo, G. W., White, R. W., and Fairbairn, H. W., 1971, Iron-formation in the Nimba Range has ore bodies currently being mined, 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 investigation in Liberia between Nimba and Lower Buchanan along the railroad concession area: W-Rekan, Caslon Press Boktr. AB, Stockholm, 74 p.

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

By
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1974
PREPARED UNDER THE JOINT SPONSORSHIP OF THE
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