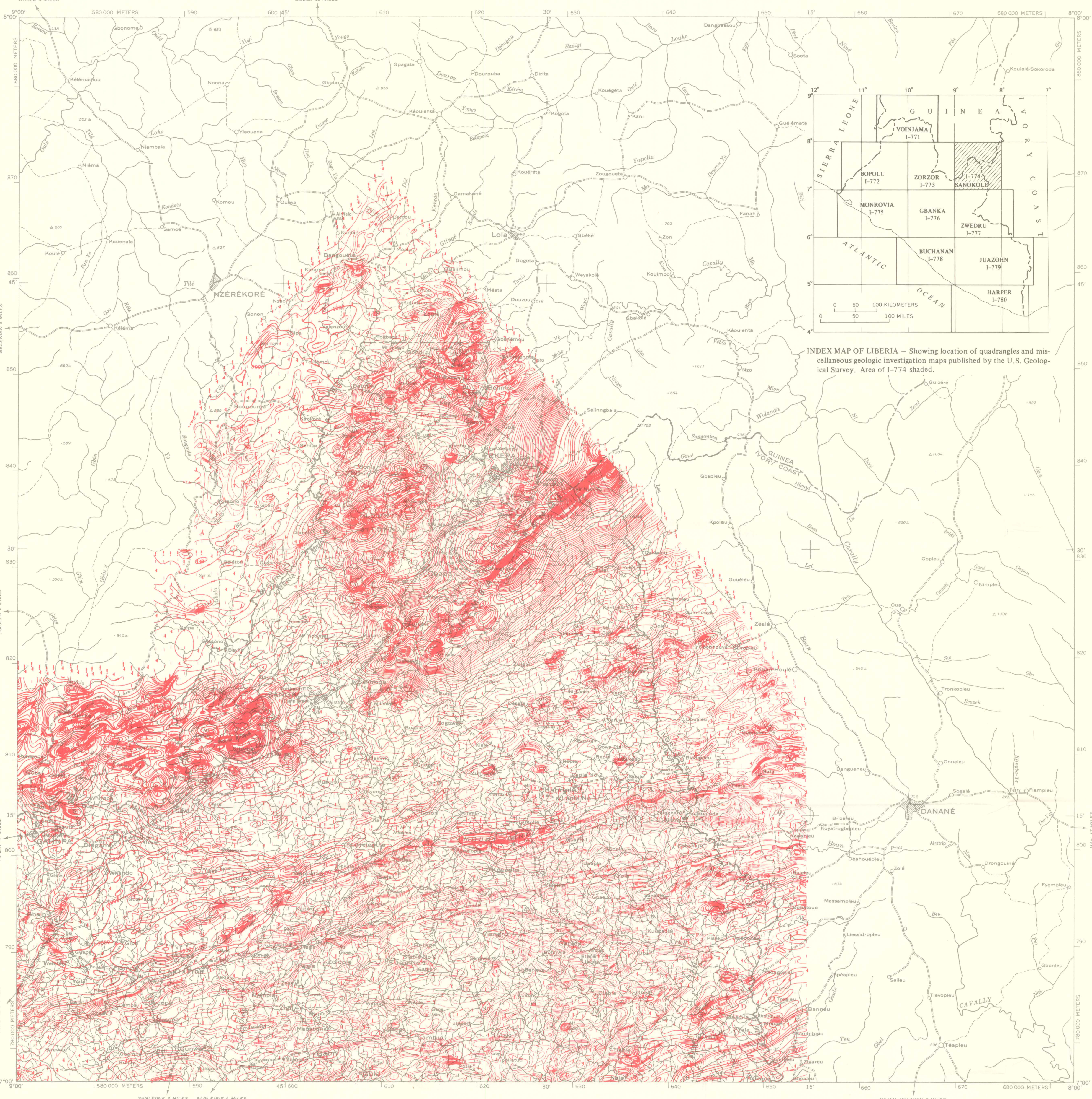
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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

FOLIO OF THE SANOKOLE QUADRANGLE, LIBERIA
MAP I-774-B



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

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

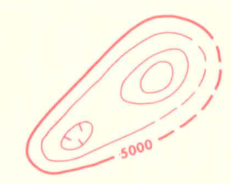
SCALE 1:250,000

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

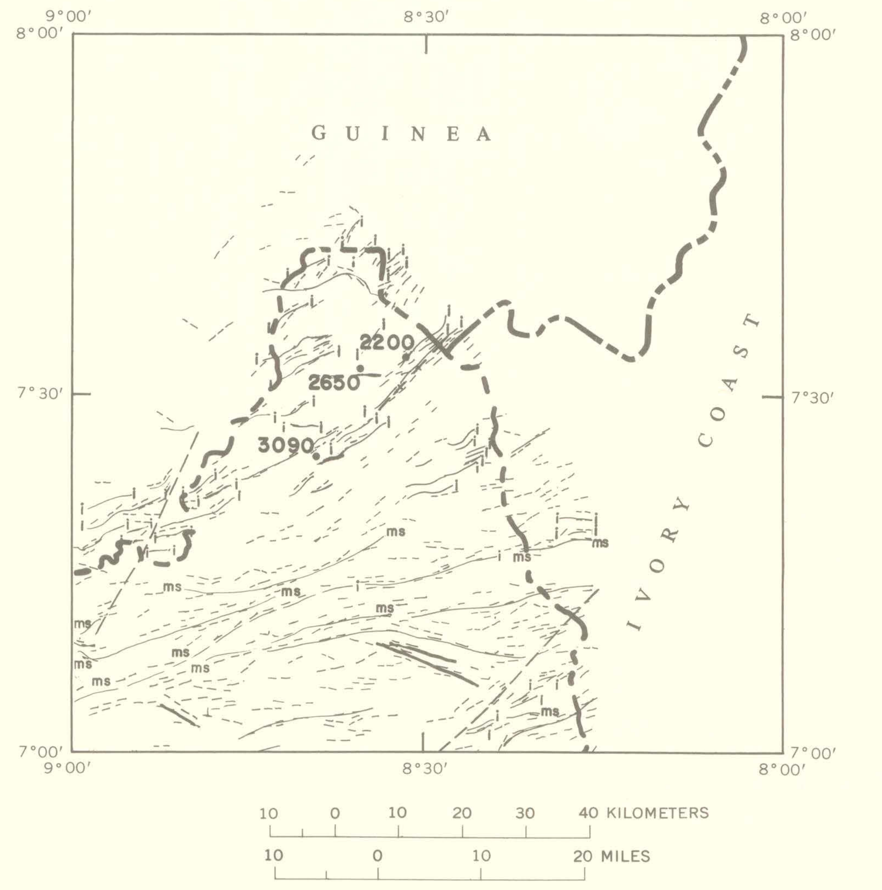
EXPLANATION



MAGNETIC CONTOURS – Showing total intensity magnetic field of the earth in gammas relative to arbitrary datum. Regional magnetic gradient not removed. Hachured to indicate closed areas of lower magnetic intensity. Contour intervals are 10, 50, 250, and 1,000 gammas. Selected contour values shown in larger type

FLIGHT PATH

Aeromagnetic survey flown by Lockwood, Kessler, and Bartlet, Inc. at 150 meters above terrain, 1967–68. Flight-line spacing of 0.8 kilometers over the 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

TREND DIRECTION OF SHORT WAVELENGTH MAGNETIC ANOMALIES – Assumed to be associated with near-surface geology and interpreted as indicative of rock foliation directions.

LOCATION OF LONG LINEAR MAGNETIC ANOMALIES – Interpreted as being caused by diabase dikes.

POSSIBLE FAULT – Suggested by linear change in magnetic or radiomagnetic contour

LINEAR MAGNETIC ANOMALIES – Caused by magnetization contrasts interpreted as geologic structures that may include folds, faults, and contacts

ms

MAGNETICALLY DETERMINED LINEAR STRUCTURE – Inferred to be locally associated with magnetic metasedimentary rocks including schist, quartzite, amphibolites, iron-formation, paragneiss, and migmatite. May include folds, faults, and contacts

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MAGNETICALLY DETERMINED LINEAR STRUCTURE – With anomaly greater than 1,000 gammas interpreted as being caused by magnatite iron-formation. May include folds, faults, and contacts

•2200

RADIOMETRIC AGE DETERMINATION – In m.y. from Hurley and others (1971)

FIGURE 1. – Tectonic map, Sanokole quadrangle. Construction is based primarily on magnetic data.

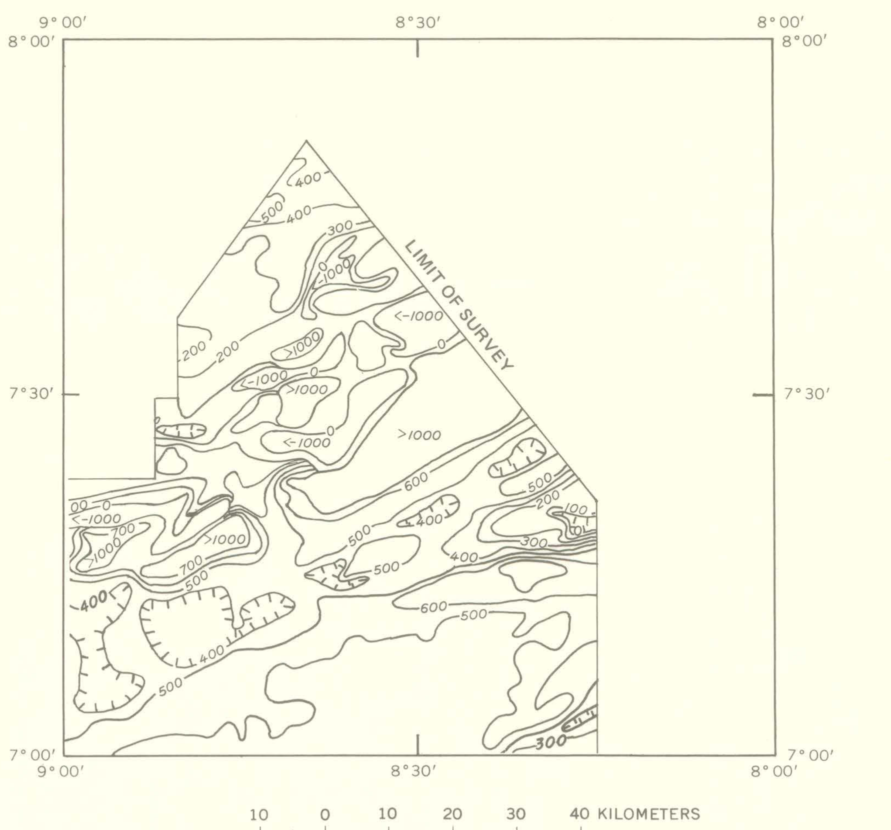

FIGURE 2. – Residual total magnetic intensity map. Compiled by removing the main earth from the map and smoothing to generalized short wavelength anomalies. G. Andreasen and P. Zabel assisted in computer processing. Hachures indicate closed areas of lower magnetic intensity. Contour interval 100 gammas, except for areas of extreme anomaly.

INTERPRETATION

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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 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. Temporal variations in the magnetic field measured with a fluxgate magnetometer were removed by adjustment at crossings of east-west control lines. Varied contour intervals of 10, 50, 250, and 1,000 gammas were used, depending on horizontal gradient.

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 total-count gamma radiation map of the Sanokole quadrangle (Behrendt and Wotorson, 1974,) should be used in conjunction with this aeromagnetic map.

Figure 1 shows the tectonic interpretation for the area covered by this map. The interpretation is based primarily on aeromagnetic data, but partly on aeroradiometric data and readily available geologic information (White and Leo, 1969; Liberian Geol. Survey, unpub. data).

Figure 2 shows part of the residual total magnetic intensity map of Liberia obtained by digitizing the data from the map area on a 1-minute grid, tying to an absolute survey (Lowrie and Escowitz, 1969) by a constant of +25,980±35 gammas, and removing Cain's "Field G" (Cain and others, 1965).

GEOLOGY

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 granite gneiss, was mapped for about 30 km south of the Nimba Range along the Ivory Coast border; granitic rock is common elsewhere in the quadrangle. 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.) on the basis of ages indicated on figure 1.

AEROMAGNETIC INTERPRETATION

Some of the highest magnetic anomalies in Liberia are in the Sanokole quadrangle. The iron-formation in the Nimba Range has amplitudes as high as 18,000 gammas; some anomalies as great as 12,000 gammas are north of Kitoma in the western part of the quadrangle. Many other high-amplitude anomalies of 1,000 gammas or more are over areas that Offerberg and Tremaine (1961) mapped as iron-formation, and over other areas which we interpret as iron-formation (fig. 1).

In general the iron-formation and the magnetic anomalies have conformable trends, which appear to be related to the general northeast strike associated with Liberian age rocks (Behrendt and Wotorson, 1971). However, this conformity changes at the north end of the quadrangle where Offerberg and Tremaine (1961) show roughly north-south foliation in the amphibolite and iron-formation, whereas the magnetic lineation of the high-amplitute anomalies, though varying, is more east-west and northeast. If a north-south lineation exists in the magnetic field of Liberia, it may not have been detected by the 0.8-km-spaced north-south flight lines. Also, very high amplitude north-south anomalies would not be expected in a magnetic field of zero inclination. The east-west and northeast magnetic lineations are real and are related to magnetic rock at a shallow depth.

As mentioned previously, the Nimba anomaly is one of the largest in Liberia. One might suspect that the broad gradient on the southeast flank of the anomaly is indicative of greater depth of origin here than the steeper northwest flank, but a model calculated for a two-dimensional body with the same trend as the Nimba anomaly showed that this is not necessarily true. A vertical-sided, infinitely deep, northeast-trending body in a horizontal field with an inclination of magnetization of 135°, will have an anomaly with a positive component displaced to the southeast of the body, and a negative component displaced to the northwest of the body. The positive amplitude is greater than the negative, and the gradient to the southeast is much broader. Therefore, it is possible that the broad gradient on the southeast flank of the Nimba anomaly is the result of a high inclination of magnetization. It is also important to point out that there may be variations due to topographic relief, for the Nimba Range was crossed at altitudes of 100-150 m whereas the ground on either side of the range was flown at altitudes of several hundred meters.

There is a good correlation between the foliation direction of the granitic gneiss mapped by Offerberg and Tremaine (1961) and the grain of the magnetic map. Although there is a general northeast trend to this grain, east-west lineation, particularly in the southern half of the magnetic map, is common.

We have indicated on figure 1 a structural feature (fault?) trending east-northeast sinuously across the area from near the southwest corner of the quadrangle to just north of lat 7°15′N. Offerberg and Tremaine (1961) show basic metamorphic rocks and some iron-formation along this trend; these rocks probably are the sources of the associated high-amplitude magnetic anomalies. South of this structural feature the contour interval is mostly 10 gammas and the amplitudes of the anomalies are low. North of the fault(?) anomalies of 50-200 gammas are common.

Examination of the residual map (fig. 2) reveals a pattern of broad positive and negative anomalies, 20-30 km in width and 100-200 gammas in amplitude, that is part of a regional pattern extending across Liberia into Ivory Coast.

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AEROMAGNETIC MAP OF THE SANOKOLE QUADRANGLE, LIBERIA

By
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1974

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