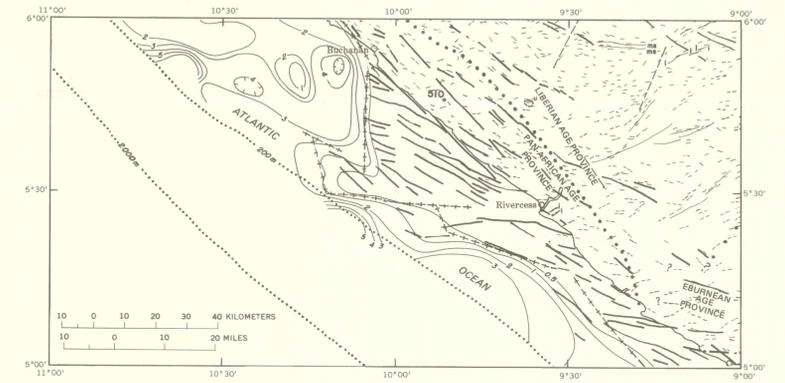


EXPLANATION

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, 25, 250, and 1,000 gammas. Selected contour values shown in larger type

FLIGHT PATH

Aeromagnetic survey flown by Lockheed, Kessler, and Bartlett, 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 Lockheed, Kessler, and Bartlett, 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

SIGNIFICANT CHANGE IN MAGNETIC AND/OR RADIOMETRIC CONTOURS — Inferred to be a geologic boundary of unspecified origin or type. Queried where uncertain

POSSIBLE FAULT — Suggested by linear change in magnetic or radiometric contour

PROBABLE FAULT — Suggested by linear change in magnetic or radiometric contour

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

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

MAGNETICALLY DETERMINED LINEAR STRUCTURE WITH ANOMALY GREATER THAN 1,000 GAMMAS — Interpreted as being caused by magnetite iron-formation. May include folds, faults, and contacts

NONLINEAR MAGNETIC ANOMALY IN THE RANGE OF -1000 TO -2000 GAMMAS — Interpreted as possible mafic or ultramafic intrusion. Queried where uncertain

RADIOMETRIC AGE DETERMINATION IN M.Y. — From Hurley and others (1971)

CONTOURS — Showing depth to magnetic basement in meters relative to sea level

APPROXIMATE LOCATION — Of 200-meter bathymetric contour

INFERRED BOUNDARY SEPARATING PAN-AFRICAN AGE PROVINCE TO SOUTHWEST FROM LIBERIAN AGE PROVINCE TO NORTHEAST

FIGURE 1. — Tectonic map, Buchanan quadrangle. Construction is based primarily on magnetic data.

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

SCALE 1:250,000

1970 MAGNETIC DECLINATION VARIES FROM 17°02' WESTERLY FOR THE CENTER OF THE WEST EDGE TO 17°30' WESTERLY FOR THE CENTER OF THE EAST EDGE. MEAN ANNUAL CHANGE IS 0'08" EASTERLY

DEPTH CURVES IN FATHOMS—DATUM IS MEAN LOW WATER SPRINGS

NOTE: Country boundaries indefinite

INTERPRETATION

By John C. Behrendt, U.S. Geological Survey, and Cletus S. Woterson, 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 Lockheed, Kessler, and Bartlett under contract to the Liberian Geological Survey. The geology of the quadrangle has been mapped by Tydal (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. Vertical 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 Buchanan quadrangle (Behrendt and Woterson, 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 Koovits, 1969) by a constant of +25,980±35 gammas, and removing Cain's "Field G" (Cain and others, 1965).

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 granitic gneiss of the Liberian age province (about 2,700 m.y.) (Hurley and others, 1971) and the northwest-trending granitic gneiss and granulite of the Pan-African age province (about 500 m.y.) is approximately indicated in figure 1 on the basis of the magnetic data. The boundary between the Liberian age province and the Eburean age province (about 2,000 m.y.) is in the southeast corner of the quadrangle. Metasedimentary rocks and amphibolites are also known in the area. A zone of north-west-trending diabase dikes, of probably 176-182-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 Woterson, 1970).

Basins of sedimentary rocks of probable Cretaceous age, that are bounded by block faults, occur on parts of the continental shelf (Behrendt and Woterson, 1970; and fig. 1).

AEROMAGNETIC INTERPRETATION

The most conspicuous feature of the magnetic data is the contrast between the shallow-origin anomalies associated with near-surface basement rocks on land, and the smooth anomalies of deeper origin associated with the magnetic basement rocks underlying the sedimentary rocks on the continental shelf. A shallow upfaulted block with a basement depth less than 0.5 km is apparent offshore from Buchanan and separates two basins as indicated in figure 1. Anomalies are associated with the coastal zone of diabase dikes that cross the offshore splay of the fault block, but the gradient-trending dikes in the northeast corner of the quadrangle are part of the zone that crosses Liberia from Sierra Leone to Ivory Coast. A prominent 4,000-gamma anomaly is east of the town of River Cess. Such a high-amplitude anomaly is suggestive of iron-formation. Linear structural features (fig. 1) inferred from high-amplitude anomalies are shown as metasedimentary rocks and iron-formation in the northeastern part of the quadrangle. The eastern part of the quadrangle appears to contain rocks more mafic than those in the western part, as shown by more numerous moderately high-amplitude magnetic anomalies and a low radiation level (see Behrendt and Woterson, 1974).

Examination of the residual map (fig. 2) reveals broad positive and negative anomalies, 20-30 km in width and 100-200 gammas in amplitude, that are part of a regional pattern extending across Liberia into Ivory Coast. Magnetic surveys (Strangway and Vogt, 1970) over the Guyana Shield in South America show a similar pattern. If these anomalies originated during the Precambrian, they greatly pre-date the separation of Africa and South America. The residual magnetic map (fig. 2) shows a transition from the long-wavelength northeast-trending anomalies to northwest trends that may be associated with diabase intrusions (or basaltic flows) beneath the sedimentary rocks on the continental shelf.

REFERENCES

Behrendt, J. C., and Woterson, 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.
Cain, J. C., Daniels, W. E., Henricks, S. J., and Jensen, D. C., 1965, An evaluation of the main magnetic field, 1940-62. *Jour. Geophys. Research*, v. 70, no. 15, p. 3647-3674.
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.
Lowrie, A., and Koovits, E., ed., 1969, *Kano & Global ocean floor analysis and research data series: U.S. Naval Oceanographic Office*, v. 1, 971 p.
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/Carlson Press Bokser, A.S. Stockholm, 74 p.
Strangway, D. W., and Vogt, P. R., 1970, Aeromagnetic tests for continental drift in Africa and South America. *Earth and Planetary Sci. Letters*, v. 7, p. 429-435.
Tydal, 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.

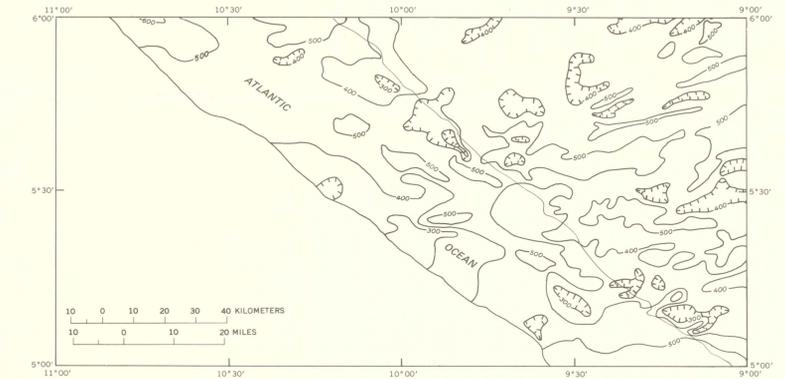


FIGURE 2. — Residual total magnetic intensity map. Compiled by removing the main earth from the map and smoothing to generalized short wavelength anomalies. G. Andreasen and P. Zabel assisted in computer processing. Hachures indicate closed areas of lower magnetic intensity. Contour interval 100 gammas,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

AEROMAGNETIC MAP OF THE BUCHANAN QUADRANGLE, LIBERIA

By
John C. Behrendt and Cletus S. Woterson
1974

PREPARED UNDER THE JOINT SPONSORSHIP OF THE
GOVERNMENT OF LIBERIA AND THE AGENCY FOR INTERNATIONAL
DEVELOPMENT, U.S. DEPARTMENT OF STATE