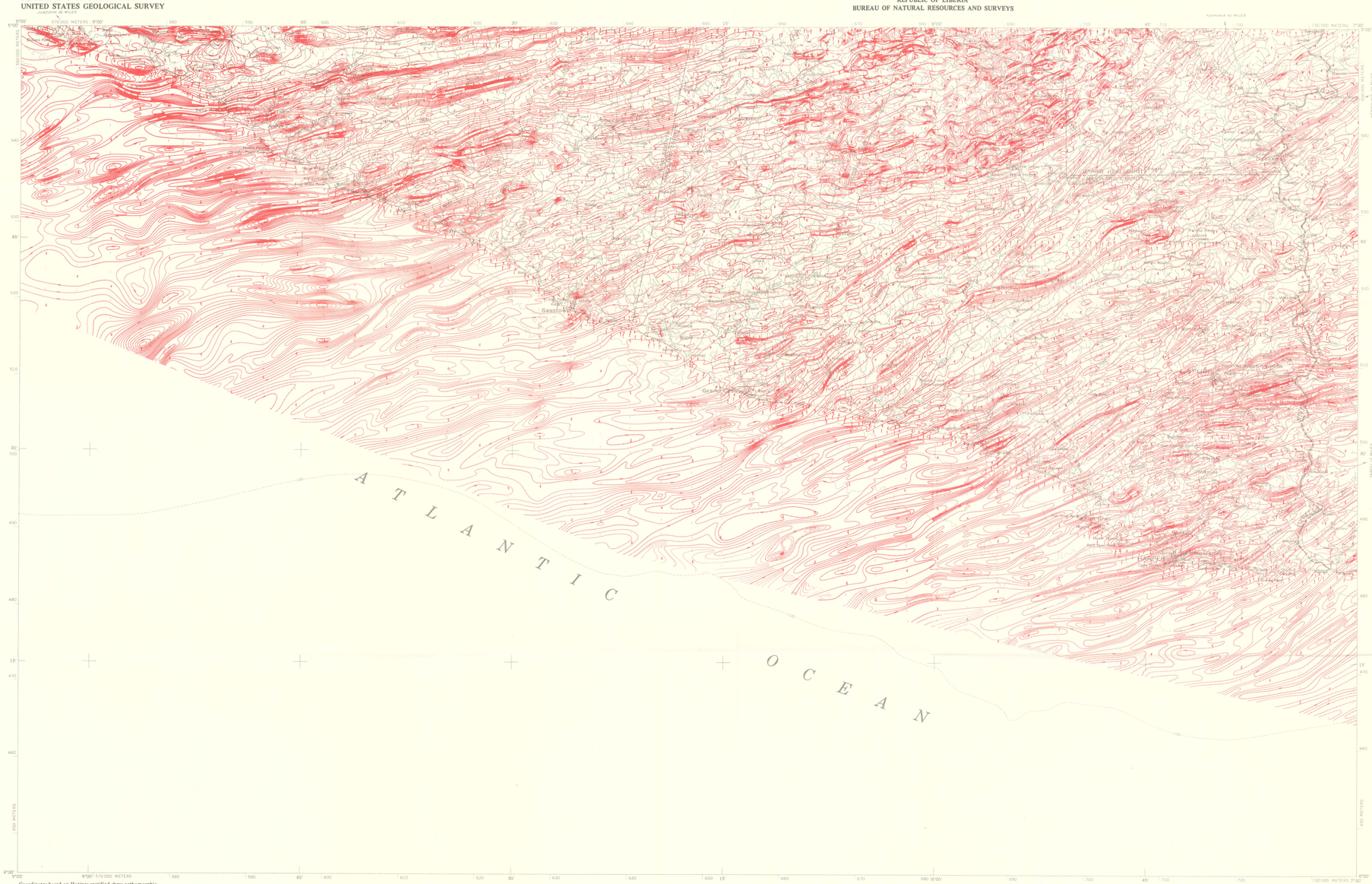
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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

FOLIO OF THE HARPER QUADRANGLE, LIBERIA
MAP I-780-B



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

SCALE 1:250,000

1971 MAGNETIC DECLINATION VARIES FROM 13°10' WESTERLY FOR THE CENTER OF THE WEST EDGE TO 12°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

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 land and 4 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.

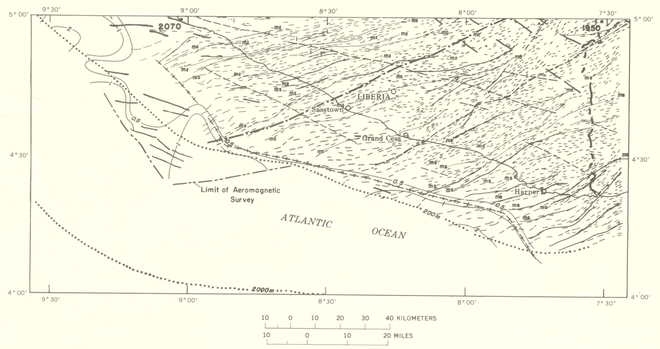


FIGURE 1. – Tectonic map, Harper quadrangle. Construction is based primarily on magnetic data.

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 location uncertain

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

rhs

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

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

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

FAULT – Associated with geologically known fault. Suggested by linear in magnetic or radiometric contour change

2

CONTOURS – Showing depth to magnetic basement in km relative to sea level

200 m

APPROXIMATE LOCATION – Of 200-meter bathymetric contour

2070

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

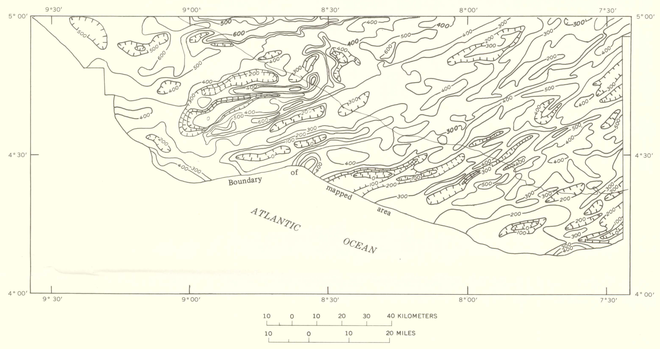


FIGURE 2. – Residual total magnetic intensity map. Compiled by removing the main earth from the map and smoothing to generalized short wavelength anomalies. G. Andreasen and P. Zabel assisted in computer processing. Hachures indicate closed areas of lower magnetic intensity. Contour interval 100 gammas,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

INTERPRETATION

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 Harper quadrangle has been mapped by Brock and others (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 gamma radiation map of the Harper 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

The rocks of the Harper quadrangle are within the Eburnean age province (about 2,000 m.y.) (Hurley and others, 1971) and comprise chiefly isoclinally folded migmatites (P. Dion and H. J. van Griethuysen, oral commun., 1970) with associated amphibolite, iron-formation, and some granite and granite gneiss. Dips range from 40° to 70° southeast, and repeated sequences of these rock types are observed (P. Dion, oral commun., 1970). Diabase dikes are located in a zone about 50 km inland in the northeast corner of the quadrangle and trend northwest from Ivory Coast to Sierra Leone. A coastal zone of diabase dikes (176–192-m.y. age) extends into the west edge of the quadrangle. Behrendt and Wotorson (1970) discussed the geophysical evidence for the existence of basins containing sedimentary rocks of probable Cretaceous age or younger on the continental shelf (fig. 1). The radiometric ages of the diabase dikes imply that they were syntectonic with rifting prior to the separation of Africa from South and North America. Sedimentary deposition accompanied by block faulting occurred later on the continental shelf.

AEROMAGNETIC INTERPRETATION

The most obvious feature in the magnetic data is the linear east-northeast to northeast trends, which we infer to be associated with the isoclinal folds of the tectonic activity. These linear features, caused by magnetization contrasts between different rock units, suggest geologic structure and have been interpreted as such in figure 1. High-amplitude anomalies between Saastown and Greenville are probably associated with iron-formation within the migmatites in this area. The offshore magnetic data indicate a deeper magnetic basement underlying the continental shelf in the western part of the quadrangle in contrast to the generally shallow magnetic basement underlying most of the area. Several of the linear anomalies over the continental shelf are interpreted as being caused by diabase dikes (fig. 1). The inland dike zone has associated linear northwest-trending anomalies shown near the northeast corner of the quadrangle (fig. 1).

The residual magnetic map (fig. 2) shows northeast-trending linear anomalies spaced about 10 km apart, possibly associated with isoclinal folds. These anomalies are superimposed on 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 over the Guyana Shield in South America show a similar pattern (Strangway and Vogt, 1970), as would be expected if the anomalies in West Africa originated during the events of Liberian age (about 2,700 m.y.). The general northeast trend of anomalies in this quadrangle changes to north-west offshore at the western edge of the map, possibly this change is caused by diabase intrusions and basalt flows in the area.

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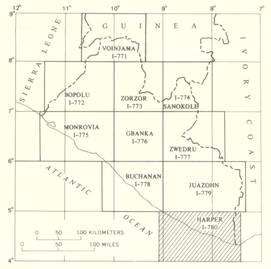

INDEX MAP OF LIBERIA – Showing location of quadrangle and miscellaneous geologic investigations maps published by the U.S. Geological Survey. Area of I–780 shaded.

AEROMAGNETIC MAP OF THE HARPER QUADRANGLE, LIBERIA

By
John C. Behrendt and Cletus S. Wotorson

1974

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