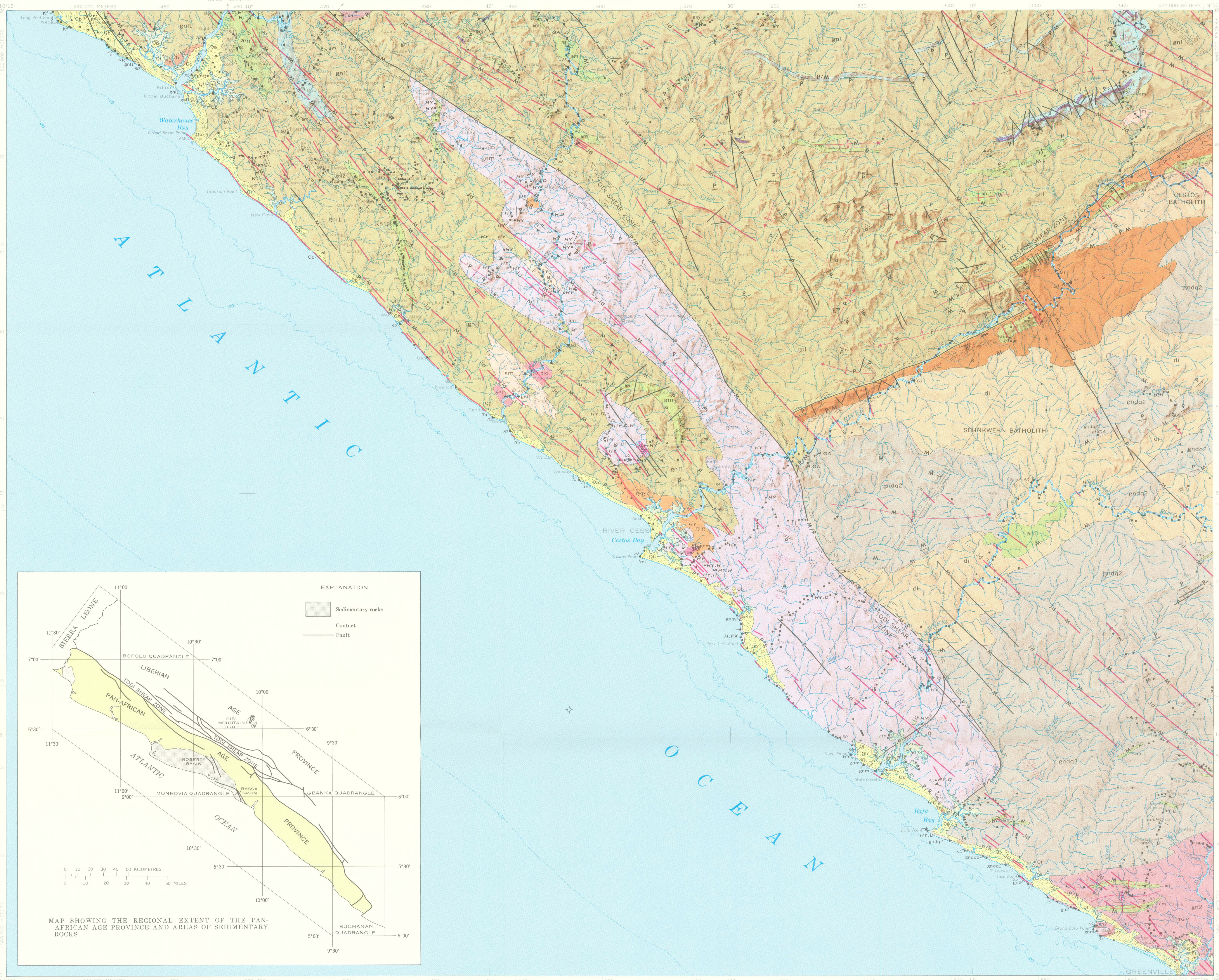
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

REPUBLIC OF LIBERIA
MINISTRY OF LANDS AND MINES
LIBERIAN GEOLOGICAL SURVEY

FOLIO OF THE BUCHANAN QUADRANGLE, LIBERIA
MAP I-778-D



MAP SHOWING THE REGIONAL EXTENT OF THE PAN-AFRICAN AGE PROVINCE AND AREAS OF SEDIMENTARY ROCKS

Base compiled by photo-planimetric methods from aerial photographs taken 1968-69. Controlled from 1953 1:40,000-scale photomosaics by Aero Service Corporation
Hotine's Rectified Skew Orthomorphic projection and rectangular coordinates

Shaded relief geographic map available as map I-778-A

INTERNATIONAL BOUNDARIES SHOWN ON THIS MAP ARE NOT NECESSARILY AUTHORITATIVE

SCALE 1:250,000

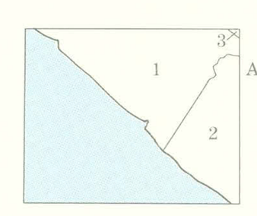
5 0 5 10 15 20 25 30 KILOMETRES

5 0 5 10 15 20 MILES

1970 MAGNETIC DECLINATION VARIES FROM 13°50′ WESTERLY FOR THE CENTER OF THE WEST EDGE TO 13°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

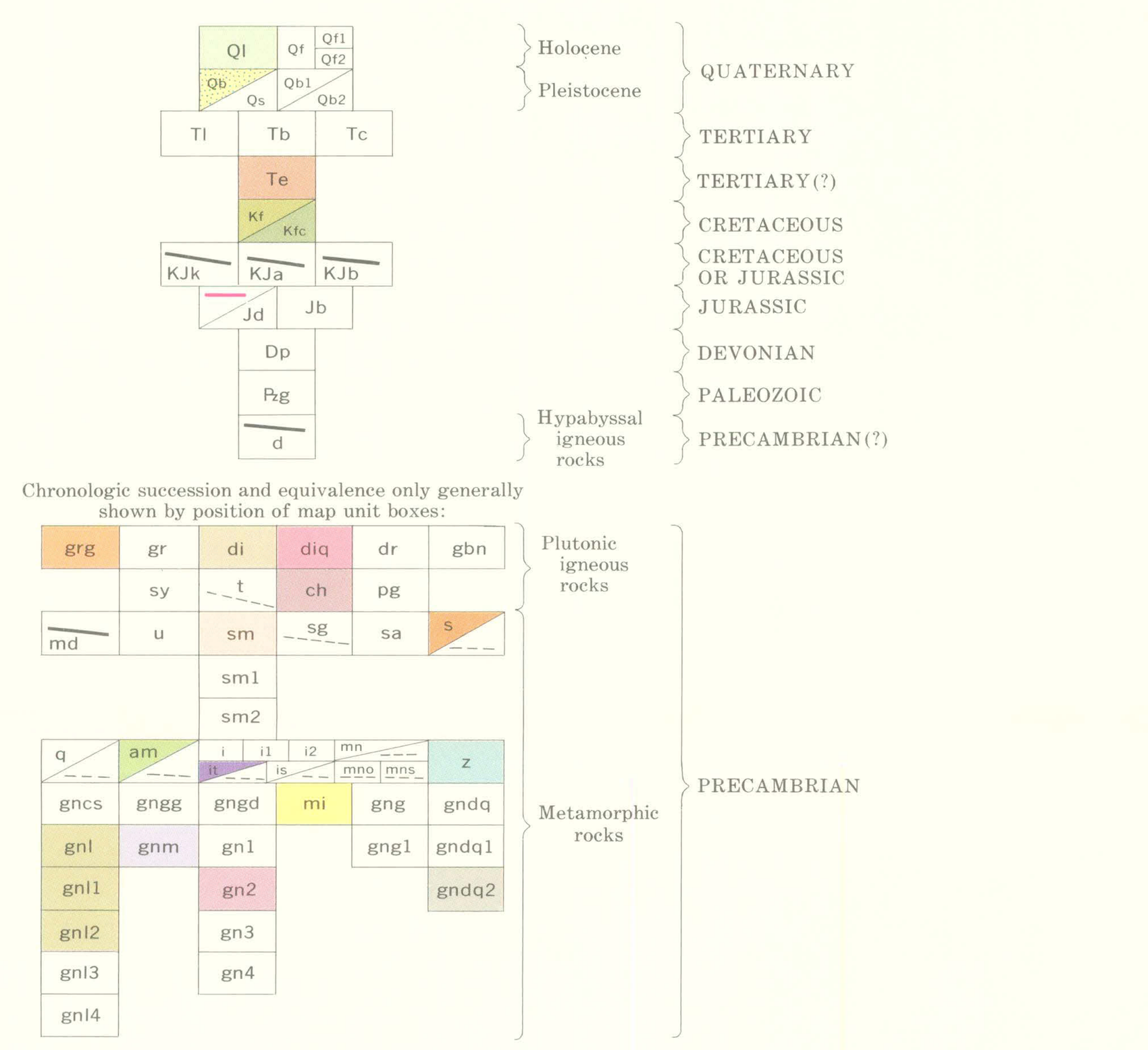
Interior—Geological Survey, Reston, Va.—1977—G75239



EXPLANATION

Rock symbols in the correlation diagram are standard for all of Liberia. Only rock units present in this quadrangle are shown in color in the correlation diagram.

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

The names of igneous and metamorphic rocks are based on composition as follows:

Igneous rock	*Metamorphic rock*	*Percent potassium feldspar of total feldspar*	*Percent quartz in rock*
Granitic rocks, undivided	*Granite gneiss*	>10	>10
Granite	*Granite gneiss*	>50	>10
Granodiorite	*Granodiorite gneiss*	>10 and <50	>10
Dioritic rocks, undivided	*Diorite gneiss*	<10	
Quartz diorite	*Quartz diorite gneiss*	<10	>10
Diorite	*Diorite gneiss*	<10	<10

Metamorphic rocks classified according to this scheme are not necessarily igneous in origin. Leucocratic (light colored) and melanocratic (dark colored) are used for gneiss units of variable or complex composition for which mineralogic classification is not applicable.

Ql — LAGOONAL AND BEACH DEPOSITS—Unconsolidated silt, sand, and mud of present coastal marshes and, locally, river levees

Qb — BEACH DEPOSITS—Unconsolidated sands. Includes white well-sorted nearly pure quartz sands of savannahs and yellowish-brown poorly sorted fine- to coarse-grained sand in beach ridges and some sand flats. Also includes local present-day beach sands

Te — EDINA SANDSTONE—Brownish-yellow medium- to coarse-grained locally conglomeratic quartz sandstone. Commonly well-sorted and locally cross-bedded. Beds cemented by clayey limonitic material

Kf — FARMINGTON RIVER FORMATION—Brown to dark-green sandstone consisting of poorly sorted to moderately sorted fine- to coarse-grained angular to subrounded grains of quartz, feldspar, mafic minerals, and lithic fragments in matrix of quartz, chlorite, sericite, and calcite. Fragments of gastrapod and pelecypod shells and carbonatized plant debris present locally

Kfc — FARMINGTON RIVER FORMATION CONGLOMERATE—Dark-green, contains well-rounded cobbles of granitic rock, gneiss, amphibolite, quartz, quartzite, and diabase in sandy matrix. Moderately well cemented

Jd — DIABASE—Dark-gray, chiefly diabasic but locally gabbroic in texture. Consists primarily of calcic plagioclase and clinopyroxene with minor amounts of magnetite and ilmenite. Locally contains orthopyroxene. Forms dikes

ch — CHARNOCKITE—Olive-green medium- to coarse-grained massive hypersthene-bearing granite. Minerals include potassium feldspar, plagioclase, quartz, hypersthene, and hornblende

di — DIORITE—Gray-green to dark-gray medium- to coarse-grained hornblende diorite. Hornblende content averages about 20-30 percent of rock. Massive, forms rounded outcrops

diq — QUARTZ DIORITE—Medium- to coarse-grained massive biotite quartz diorite

grg — GRANITE—Light-gray to pink medium- to coarse-grained hypidiomorphic biotite granite. Generally massive. Locally, outcrops of coarse-grained granite contain megacrysts of potassium feldspar

z — COMPOSITE UNIT—Comprises rock units associated with itabirite, and itabirite, for which there is insufficient data or the units are too small to map separately. Also includes: iron silicate rocks (for example, grunerite-hornblende-garnet-quartz schist), quartzite and quartz-rich schists, pelitic schist, and gneiss. Amphibolite is commonly present in the unit and actinolite schist occurs locally

it — IRON-FORMATION, OXIDE FACIES (ITABIRITE)—Dark-gray, brown- to brick-red finely laminated quartz-hematite magnetite rock

am — AMPHIBOLITE—Black fine- to coarse-grained foliated to massive rock consisting of about equal amounts of plagioclase and hornblende. Quartz and garnets abundant in some outcrops. Typically resistant, forming ridges. Spheroidal weathering is common

q — QUARTZITE—Fine- to coarse-grained quartz rock of probably metasedimentary origin. Quartz content commonly greater than about 95 percent; minor minerals include chlorite, graphite, magnetite, garnet, or feldspar. Locally includes as much as 30 percent feldspar

s — SCHIST—Mainly pelitic schists, but also locally includes mica schist and hornblende schist. Major minerals are staurolite, quartz, and feldspar, mainly plagioclase; minor minerals include garnet and biotite. Unit is generally weakly resistant

sm — MICA SCHIST—Well-foliated fine to coarsely crystalline schist. Dominant minerals are biotite, quartz, plagioclase. Locally contains minor hornblende. Commonly not resistant

mi — MIGMATITE—Original country rock is fine- to coarse-grained rock of quartz diorite to granodiorite composition, but may be any other metamorphic rock. Later formed rock is fine- to coarse-grained and ranges in composition from granitic to dioritic; texture may be pegmatitic, aplitic, or granitic

gn2 — COMPOSITE GNEISS UNIT 2—Unit is dominated by light- to dark-colored fine- to medium-grained graphite-biotite quartz diorite gneiss. Graphite content ranges from a trace to 20 percent. Contains sillimanite and(or) garnets locally. Interbedded quartzite present locally. Amphibolite bodies common and locally contain clinopyroxene or orthophyroxene

gnm — MELANOCRATIC GNEISS—Unit includes differing amounts of the following: dark-greenish-gray hypersthene-diopside-hornblende-plagioclase gneiss; amphibolite with and without pyroxenes; and dioritic to granodiorite gneiss

gnl — LEUCOCRATIC GNEISS—Light-colored medium- to coarse-grained biotite- and locally hornblende-bearing gneiss largely of quartz diorite composition, but locally granodiorite composition. Amphibolite bodies are common. Includes minor quartzite, itabirite, and schist

gnl1 — LEUCOCRATIC GNEISS UNIT 1—Similar to above but contains more granodiorite gneiss and has abundant, large amphibolite bodies

gnl2 — LEUCOCRATIC GNEISS UNIT 2—Light- to medium-colored medium-grained micaceous kyanite- and sillimanite-bearing gneiss. Commonly deeply weathered

gndq2 — QUARTZ DIORITE GNEISS—Dark-colored medium- to coarse-grained hornblende quartz diorite gneiss. Hornblende locally ranges from 20 to 35 percent of rock. Biotite quartz diorite gneiss is present locally

Map symbols are standard for the geologic quadrangle maps of Liberia (I-771-D to I-780-D). Not all symbols are used on any one map.

Letter symbol within contact, fault, or other structural symbol indicates source of information used in locating contact: M, aeromagnetic data; P, photointerpretation; R, near-surface radiometric data; G, gravity data; and P/M, combination source (predominant source given first). Segments without letter symbol were located by surface traverses. Break in line indicates change in source of information.

Where rock units are present only as marker beds within other formations, they are shown in black (see below) with the appropriate unit symbol.

Contact—Showing direction of dip where known

Fault—U, upthrown side; D, downthrown side; dip where known

Thrust fault—Sawteeth on upper plate

Fault zone or shear zone

Fault intruded by dike

Antiform—Showing trace of crestal plane and direction of plunge; degrees of dip and plunge given where known

Overturned antiform

Synform—Showing trace of trough plane and direction of plunge; degrees of dip and plunge given where known

Overturned synform

Strike and dip of axial plane of minor fold
- Inclined
- Vertical

Strike and dip of beds
- Inclined
- Vertical
- Horizontal

Strike and dip of foliation—Open symbol indicates foliation transecting earlier foliation or bedding; solid symbol indicates relation to bedding unknown
- Inclined, degree of dip given where known
- Vertical
- Horizontal

Strike and dip of parallel layering or bedding and foliation
- Inclined
- Vertical
- Horizontal

Strike of foliation, no dip determined

Strike and dip of joints
- Inclined
- Vertical
- Horizontal

Strike and dip of planar features determined from photointerpretation (P) or aeromagnetic data (M)—One, two, three, or four ticks indicate gentle, medium, steep, or vertical dip

Bearing and plunge of lineation formed by minor fold. Barbed arrow indicates crinkle axis or intersecting foliation; solid arrow indicates bearing and plunge of mineral lineation

Structural trend or lineation based on photointerpretation

Structural trend based on aeromagnetic data

Observed outcrop

Marker bed distinguished by rock symbol (q) or index mineral (AD)

Index minerals:

AD, andalusite	EN, enstatite	K, kyanite
AN, anthophyllite	EP, epidote	M, muscovite
AU, augite	EU, eulite	PY, pyrite
B, biotite	GA, garnet	PX, pyroxene
CL, chlorite	GP, graphite	S, sillimanite
CG, cummingtonite-grunerite	H, hornblende	ST, staurolite
D, diopside	HY, hypersthene	TA, tremolite-actinolite
	IL, ilmenite	

Sand, gravel, clay, or placer pit—B, barite; D, diamond; G, gold

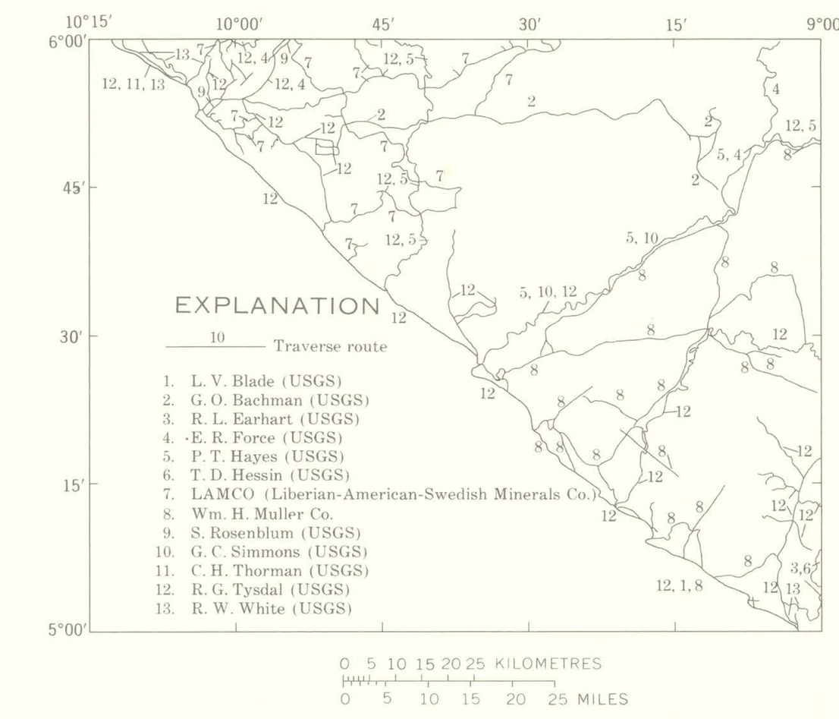
Mine or quarry—S, building stone or road metal; C, clay; I, iron

Prospect pit—B, barite; K, kyanite

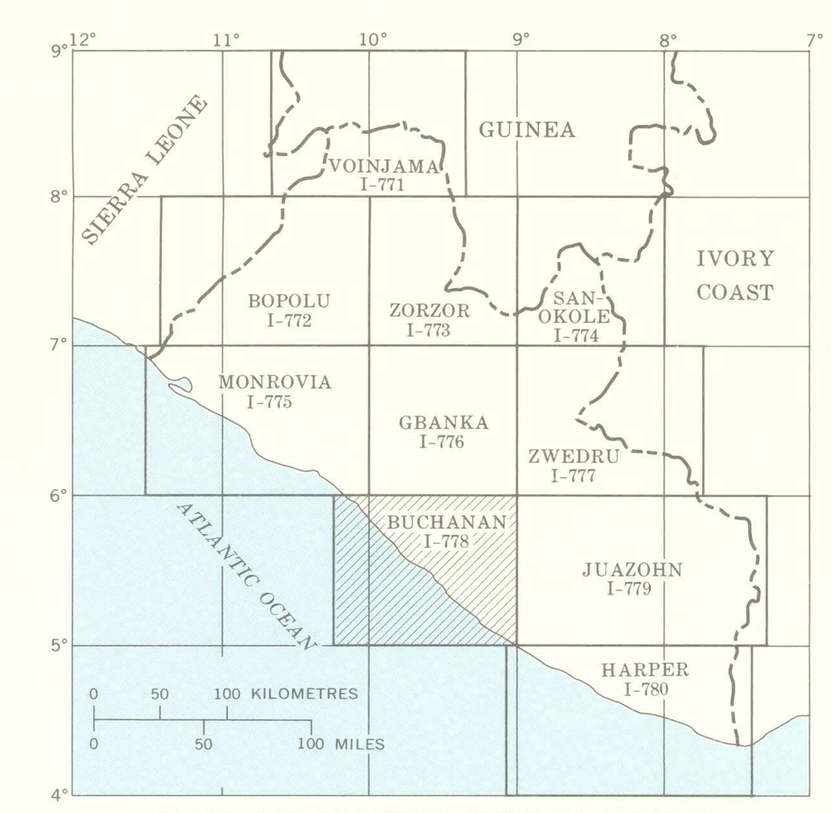
Drill site for offshore well, abandoned

Fossil locality
- Invertebrate
- Plant

K2600 Radiometric age in millions of years—K, potassium-argon; R, rubidium-strontium; F, fission track. Reset age given in parentheses where applicable



SOURCES OF FIELD DATA



INDEX MAP OF LIBERIA SHOWING LOCATION OF QUADRANGLES IN THIS SERIES

INTRODUCTION

Liberia was mapped by geologic and geophysical methods during the period 1965 to 1972 as part of a program undertaken cooperatively by the Liberian Geological Survey (LGS) and the U.S. Geological Survey (USGS) under the sponsorship of the Government of Liberia and the Agency for International Development, U.S. Department of State. The resulting geologic and geophysical maps are being published in ten folios, each covering one quadrangle (see index map).

The Buchanan quadrangle was systematically mapped by the author from September 1971 to July 1972. The work included reconnaissance field mapping, compilation of data compiled by project and company geologists, photointerpretation, and interpretation of aeroradiometric and aeromagnetic and gravity maps. As the freshest and most continuous outcrops are mainly along rivers, the main traverses were made via rubber boats traversing the Timbo, Cestos, and Sehnkwehn Rivers. Observations were also made along trails and the few motor roads in the quadrangle. Extensive use was made of the reconnaissance data provided by the Liberian-American Mining Company (LAMCO) (Offerberg and Tremaine, 1961) for the westernmost part of the quadrangle, and by the Muller Company (unpub. repts; van Griethuysen, 1970) for the eastern part. Total-intensity aeromagnetic and total-count gamma radiation maps (Behrendt and Wotorson, 1974a, c) were also used to distinguish and delineate map units.

ROCKS

The quadrangle is part of the Guinean Shield of West Africa; it is characterized by low-lying topography dotted with hills in the coastal area, contains mountains a few hundred metres high inland, and has a thick cover of saprolite and laterite that supports a dense rain forest. Bedrock consists largely of gneiss and diorite, with lesser schist, amphibolite, iron-formation, and diabase. Sandstone, beach, and lagoon deposits and fluvatile sediments overlie the shield rocks in the coastal area. Crystalline rock units are designated on the map by a symbol appropriate for the dominant rock type; order of discussion below has no stratigraphic significance. Three metamorphic age provinces recognized by Hurley and others (1971) are represented in the Buchanan quadrangle; the Liberian, 2,700 m.y.; Eburnean, 2,000 m.y.; and Pan-African, 550 m.y.

METAMORPHIC ROCKS

Metamorphic rocks are here classified according to the ratio of potassium feldspar to total feldspar, on the basis of igneous rock terminology combined with appropriate modifers (see map explanation). An igneous origin is not necessarily implied, however. Rocks that do not fit this scheme are given other descriptive names (for example, leucocratic gneiss).

Quartz diorite gneiss

The unit (gndq2) underlies areas having some of the lowest topographic relief in the quadrangle and is characterized by a paucity of outcrops. Where observed, most of the outcropping rocks of the unit are dark hornblende-quartz diorite gneiss, which locally grades into amphibolite. Quartzite is interbedded northwest of New Town (Muller Company, unpub. data, 1969). Near the coast, gneiss ranging in composition from biotite quartz diorite to granodiorite crops out, along with amphibolite and local areas of migmatite.

Leucocratic gneiss

Three leucocratic gneiss units (gnl) have been mapped in the quadrangle. Leucocratic gneiss is largely quartz diorite in composition, with lesser amounts of granodiorite gneiss. Other rocks that cannot be separated at the map scale, such as itabirite, amphibolite, quartzite, and schist, are included in the unit. Many of the gneisses are granitoid, the foliation defined by alinement of biotite, or, locally, hornblende.

Rocks in the area northeast of the Todi shear zone and northwest of the Cestos shear zone are probably largely dioritic, based on a few observations made near the margins of the area and on the low magnetic values (Behrendt and Wotorson, 1974a). This is one of the largest areas in Liberia that has low to moderate (100-250 cps) radioactivity, as well as part of the largest area of lowest radioactivity (100 cps) over basement rocks (see generalized total-count gamma radiation map, Behrendt and Wotorson, 1974c).

Unit gnl1 contains gneisses ranging from granodiorite to quartz diorite in composition. Amphibolite is common and is mapped separately where possible. Locally interbedded in the gneiss are schist, itabirite, and quartzite. Sillimanite- and kyanite-bearing leucocratic gneiss (gnl2) is present east of Buchanan but forms few outcrops. Its areal extent is inferred in part from the occurrence of sillimanite and (or) kyanite in the heavy minerals of saprolite.

Melanocratic gneiss

The unit (gnm) is distinguished by medium- to dark-colored orthopyroxene- and clinopyroxene-bearing hornblendic rocks that are mainly dioritic in composition. These rocks form discontinuous bodies interbedded with gneiss that ranges from biotite-quartz diorite to granodiorite in composition. Amphibolite is also present and is mapped separately where possible. The gneiss makes up more than half the rock in the northwestern part of the unit, but dark rocks dominate the southeastern part of the unit.

Composite gneiss

The only composite gneiss unit (gn2) in the quadrangle is dominated by graphite-bearing biotite-quartz diorite gneiss that is a continuation of the graphite-bearing gneiss belt of the Juazohn quadrangle (Tysdal, 1977). In the Greenville area, the gneiss contains sillimanite and garnet. Amphibolite forms the least weathered outcrops on the road north from Greenville, and at least one of these contains clinopyroxene. Local interbedded quartzite contains minor graphite.

Migmatite

Migmatite (mi) was observed and mapped mainly in large surf-cut outcrops along the coast, probably in part because outcrops elsewhere are commonly too poor to show this gross texture. The migmatite commonly contains gneissic country rock of quartz diorite to granodiorite composition, interlayered with amphibolite. Granitic material appears to have invaded the country rock, separating blocks of it into isolated rafts. South of River Cess, gray diorite dikes crosscut the migmatite at a high angle; a still younger dike of granitic composition cuts across the diorite dikes.

Schist

Schistose rocks commonly crop out along rivers, but few are exposed elsewhere. Biotite schist (sm) near the mouth of the Timbo River grades into gneiss adjacent to a quartz diorite pluton. Some of the schist (s) along the Cestos River is composed of quartz, plagioclase, and biotite. Much of it, however, is pelitic and is composed of quartz, biotite, plagioclase, staurolite, and garnet.

Quartzite

Quartzite (q) beds are commonly 1 to 2 metres thick and form resistant outcrops flanked by saprolite or laterite. In one outcrop on the coast south of Buchanan, a white feldspathic quartzite was noted. Some of the quartzite beds in the southeasternmost part of the quadrangle contain graphite.

Amphibolite

Most amphibolite (am) forms tabular bodies that range from a few centimetres to hundreds of metres in thickness and are parallel to the foliation of the country rock. Some, however, trend at a high angle to regional foliation, as is evident near the Tidewater Plantation 20 km southeast of Buchanan; these may be metamorphosed diabase dikes. Many amphibolite bodies are too small to show at the map scale. A negative magnetic anomaly of 100 to 300 gammas characterizes most of the amphibolite bodies (see Behrendt and Wotorson, 1974a), but anomalies are very low over the two largest bodies near Buchanan.

Iron-formation

Magnetite-hematite itabirite (it) is the predominant kind of iron-formation in the quadrangle. It is commonly associated with iron-silicate rocks, quartzite, and amphibolite, and forms long, narrow ridges marked by large negative magnetic anomalies.

The largest area of itabirite is in Kaba Mountain and the mountain to the north. Moderate magnetic anomalies in the mountainous south-central part of the area of leucocratic gneiss (gnl) may be caused by itabirite of low magnetite content.

Composite unit

Composite unit (z) comprises iron-formation and associated rocks that are individually complex and too small to map separately at the map scale. Rock types include iron silicates, amphibolite, and locally, actinolite schist, quartzite, minor itabirite, pelitic schist, and leucocratic gneiss.

IGNEOUS ROCKS

Two batholiths of diorite are prominent in the eastern part of the quadrangle, and small quartz diorite and granite bodies crop out in the central part. Diabase dikes occur in two belts, one near the coast and the other in the northeasternmost part of the quadrangle.

Granite

The granite (grg) exposed at the mouth of the Cestos River is homogeneous and hypidiomorphic; a faint alinement of biotite near its margins defines vague foliation. Contacts with adjacent rocks are sharp at the two places where observed, and the pluton interrupts the general trend of foliation.

The granite pluton on the Timbo River (about lat. 5°45′ N., long. 9°45′W.) contains megacrysts of potassium feldspar that are commonly 2 cm across, along with quartz and minor biotite. The pluton is only about 200 metres in diameter, appears to interrupt the trend of the surrounding quartz diorite gneisses, and is marked by a positive radiometric anomaly (see Behrendt and Wotorson, 1974b).

Diorite

Hornblende diorite (di) forms the Sehnkwehn and Cestos batholiths. The rocks are massive except where sheared or near the margins where they are foliated and grade into gneissic country rock. The large amphibolite body south of Kase (on the Sehnkwehn River) may be a roof pendant of the Sehnkwehn batholith.

Quartz diorite

Two small quartz diorite plutons are present near the mouth of the Timbo River and are composed of 2 to 3 percent biotite and 20 to 30 percent quartz, the remainder being plagioclase. The rock forms rounded outcrops and is unfoliated except near local shear zones. Only one contact was observed and it appeared to be conformable.

Charnockite

Charnockite (ch) in the Buchanan quadrangle consists of potassium feldspar, plagioclase, quartz, hypersthene, and hornblende. Grain size is commonly medium to coarse, but along the margins the charnockite is fine grained and contains garnets (Force and Dunbar, 1977). Boulders of spheroidally weathered massive rock form the typical outcrops.

Diabase

Northwest-trending diabase dikes (Jd) of Early Jurassic age (Gromme and Dalrymple, 1972) range in thickness from about 2 m to more than 50 m; most are vertical or dip steeply. Some of them are definitely in fault zones; most of them probably follow fault zones, although some may occupy joints. The dikes contain sufficient magnetite to cause moderate to strong aeromagnetic anomalies.

SEDIMENTARY ROCKS

Sedimentary rocks in the coastal area of the Buchanan quadrangle have been delineated largely on the basis of interpretation of aerial photographs. The radiometric data (Behrendt and Wotorson, 1974c) were used to outline some beach deposits.

Farmington River Formation

The Farmington River Formation (Kf, Kfc) (White, 1972) consists of sandstone, conglomeratic sandstone, and thin shaly interbeds along the coast northwest from near Edina. Most of the formation in the Buchanan quadrangle is graywacke and arkose. The formation forms part of a basin that probably contains a section of Cretaceous rocks which, on the basis of geophysical data, is about 1.5 km thick (Behrendt and Wotorson, 1970). A Cretaceous age assignment was made on the basis of spores and pollen (White, 1972).

Edina Sandstone

The Edina Sandstone (White, 1972) is preserved mainly near the mouths of major rivers, is unconformable on older, weathered formations, and is overlain by unconsolidated sediments. Near Bafu Bay isolated outcrops of the sandstone are less than 1 metre thick, but near Edina, White (1972) measured a thickness of about 8 metres. The age of the Edina is uncertain; the formation is younger than the Farmington River Formation, and is assigned a Tertiary(?) age.

Beach deposits

Beach deposits (Qb) are composed mainly of unconsolidated deposits of white quartz sand that form a veneer in savannahs near the coast. Brown sand as much as 2 metres thick was observed locally beneath the white sand near Buchanan and Bafu Bay. Rosenblum and Srivastava (1970) described similar white sand in the Monrovia area.

The unit also includes beach ridges and intervening lagoon deposits between River Cess and Greenville (see van Griethuysen, 1970). The ridges range to 5 m in height, 100 m in length, and trend parallel to the coast. The sand layers, which are mostly quartz, dip toward the ocean at about 5°. Auger drilling showed that heavy minerals (mainly ilmenite, zircon, rutile, and monazite) constitute about 2 percent of the sand and are locally concentrated into lenses. These deposits cause radiometric anomalies (Behrendt and Wotorson, 1974c). Most of the auger holes reached clay and (or) peat, which probably overlies bedrock.

Lagoonal deposits

Lagoonal deposits (Ql) include Holocene silt, sand, and clay deposits that are being formed today or that were formed in the recent past. These sediments are derived from the sea via tides and become trapped by mangrove roots. The mapped limits of this unit are based largely on interpretation of aerial photographs.

STRUCTURE

Many of the structural observations were made by use of aerial photographs and geophysical interpretations.

FOLDS

Broad mesoscopic folds, both synform and antiform, characterize the Buchanan quadrangle, but synforms are the more common. Aerial photographs and magnetic maps (Behrendt and Wotorson, 1974a), in addition to field data, were used extensively to delineate the folds. Mesoscopic isoclinal folds were noted only in the composite gneiss unit gn2 in the southeasternmost part of the quadrangle. These isoclinal folds exhibit a distinct pattern of alternating narrow linear magnetic highs and lows.

FAULTS AND SHEAR ZONES

Two directions of faulting are prominent in the quadrangle. Northeast-trending faults, represented by the Cestos shear zone, are older than northwest-trending faults. The Cestos shear zone is a near-vertical structure separating melanocratic gneiss, diorite, and schist to the east from leucocratic gneiss on the west. The sheared rocks are commonly more resistant to erosion than nonsheared rocks and control the course of the Cestos River; they range from protomylonite to ultramylonite. Topographic features are strongly alined within the zone, and folds to the west terminate abruptly at the margin of the zone. Magnetic linearity marks the zone and contrasting magnetic patterns occur on opposite sides of it.

The Todi shear zone (Thorman, 1972; 1977) trends northwest and commonly dips steeply southwestward or is vertical. Rocks observed along the zone include both protomylonite and mylonite. The sheared rocks are commonly resistant to weathering and erosion, more so than nonsheared rocks, and form prominent and abundant outcrops in the river beds.

Long segments of individual faults within the shear zone are defined by (1) abrupt change in magnetic pattern and, locally, a coincident change in radiometric intensity; (2) strongly alined drainage pattern; (3) abrupt change in strike of rocks across the shear zone; and (4) near the Cestos River, by abrupt truncation of a prominent northeast-trending ridge. The location of the southeastern end of the shear zone is uncertain.

The Geni fault (named after the Geni Mountain, which it truncates) is a major structure that has strong expression on the residual magnetic map of Behrendt and Wotorson (1974b). It offsets the Cestos shear zone and associated magnetic anomalies. Faults having left- or right-lateral offsets trend parallel to the Geni fault. Sheared and (or) brecciated rocks were noted along some of the faults, and diabase dikes intrude many of them.

FOLIATION AND BEDDING

Foliations shown reflect compositional layering or schistosity but the relation to bedding is generally unknown. Foliations interpreted from aerial photographs are generally parallel to compositional layering where field checked.

METAMORPHISM

Rocks of the amphibolite facies characterize most of the quadrangle, and range in grade from the biotite zone to the staurolite-, kyanite-, and sillimanite-zones. Many gneisses are quartzofeldspathic, containing about 5 percent biotite, and thus do not have indicator minerals. Interbedded rocks containing indicator minerals, however, commonly are indicative of the amphibolite facies of metamorphism. Hornblende is common in some gneisses.

Rocks of the granulite facies crop out southwest of the Todi shear zone and, locally, southeast of it. Hypersthene, diopside, and locally augite, all commonly associated with hornblende, are present locally in the melanocratic gneiss unit. Other rocks in the unit were probably subjected to the same temperature and pressure conditions as the pyroxenic rocks but were not of the correct composition to form indicator minerals of the granulite facies. Possibly the pyroxenic rocks contained less water than the other rocks prior to metamorphism; thus pyroxenes were formed instead of other mafic minerals.

AGE PROVINCES

Three age provinces are recognized in Liberia (Hurley and others, 1971; White and Leo, 1970), based chiefly on whole-rock Rb-Sr dating. All three provinces are present in the Buchanan quadrangle. The rocks southwest of the Todi shear zone are assigned to the Pan-African age provinces (about 550 m.y.). One K-Ar date of 510 m.y. was obtained on a hornblende mineral separate from a gneiss near Buchanan. Rocks of unit gn2 are Eburnean (about 2,000 m.y.), based on a 2,070 m.y. whole-rock Rb-Sr date obtained on rock from 2 km southeast of Greenville, in the Harper quadrangle (Hurley and others, 1971). The remainder of the quadrangle probably includes rocks of both the Liberian (2,700 m.y.) and Eburnean age provinces.

MINERAL RESOURCES

Diamonds are mined on a small scale in placers near Chom at Grand Buto Point. Heavy minerals in the beach sands between Bafu Bay and Greenville may be of commercial value (van Griethuysen, 1970).

REFERENCES

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By

Russell G. Tysdal

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