FRENCH GUIANA

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HISTORICAL BACKGROUND

Until the second world war no general work had been published on the geology of French Guiana. Systematic study of the subsoil began only in 1946, under the auspices of the Office of Overseas Scientific Research.

In 1949 the first study of the northern part of the country was published (B. Choubert, 1949). The southern part has been explored by M. E. Aubert de la Rüe who has just published the account of his traverses (Aubert de la Rüe, 1953).

Starting in 1950, periodical contacts were established between the three Guianas, with the object of establishing correlations between the various formations. One of the results of this collaboration was the presentation, at the Nineteenth International Geological Congress in Algiers, in 1952, of the first geologic map of the three Guianas, on a scale of 1:2,000,000 and accompanied by an explanatory text (Choubert, Schols, and Bracewell, 1954).

In 1952 the permanent geologic mission of the Office of Overseas Scientific Research in French Guiana became one of the branches of a multiple research organization: l'Institut Français d'Amerique Tropicale.

Finally, in 1953, the preparation of a regular geologic map was begun. The first sheet (Cayenne region) is now in press.

GEOLOGY

Naturally, in this country covered with almost impenetrable forests, the preparation of a geologic map faces numerous obstacles. The most difficult to surmount is the scarcity of outcrops away from the river valleys. A serious study is nevertheless possible, thanks to complete coverage with vertical aerial photographs taken by the national geographic institute during recent years.[1]

The geology of Guiana is characterized by the presence of old terranes of various degrees of metamorphism, which may be referred with high probability to the Precambrian. These are covered, along the coasts, by transgressive marine Quaternary strata. So far no fossils older than Quaternary have been found. Distribution and trend of the major geologic units are shown on the map (Fig. 1).

GUAYANAN PRECAMBRIAN

The Guayanan Precambrian may be divided into several systems, which may be outlined as follows.

Ile de Cayenne system (Choubert, 1954b).—This system is the oldest now known. Of undoubted sedimentary origin, the series which constitute it are made up of fine-grained amphibolites, with or without garnet, pyroxenitic or amphibolitic quartzites, pyroxene hornfels, and feldspathic amphibolites with pyroxene and biotite. This system also includes feldspathic gneisses and grades in places into migmatites. It contains rocks of magmatic origin, such as diorites and gabbros, generally recrystallized and showing orientation. Study of the migmatites shows that there are several phases of granitization.

In addition to the rocks listed above, this group contains limestone layers which

[1] *See* the works of J. Hurault, I.G.N.

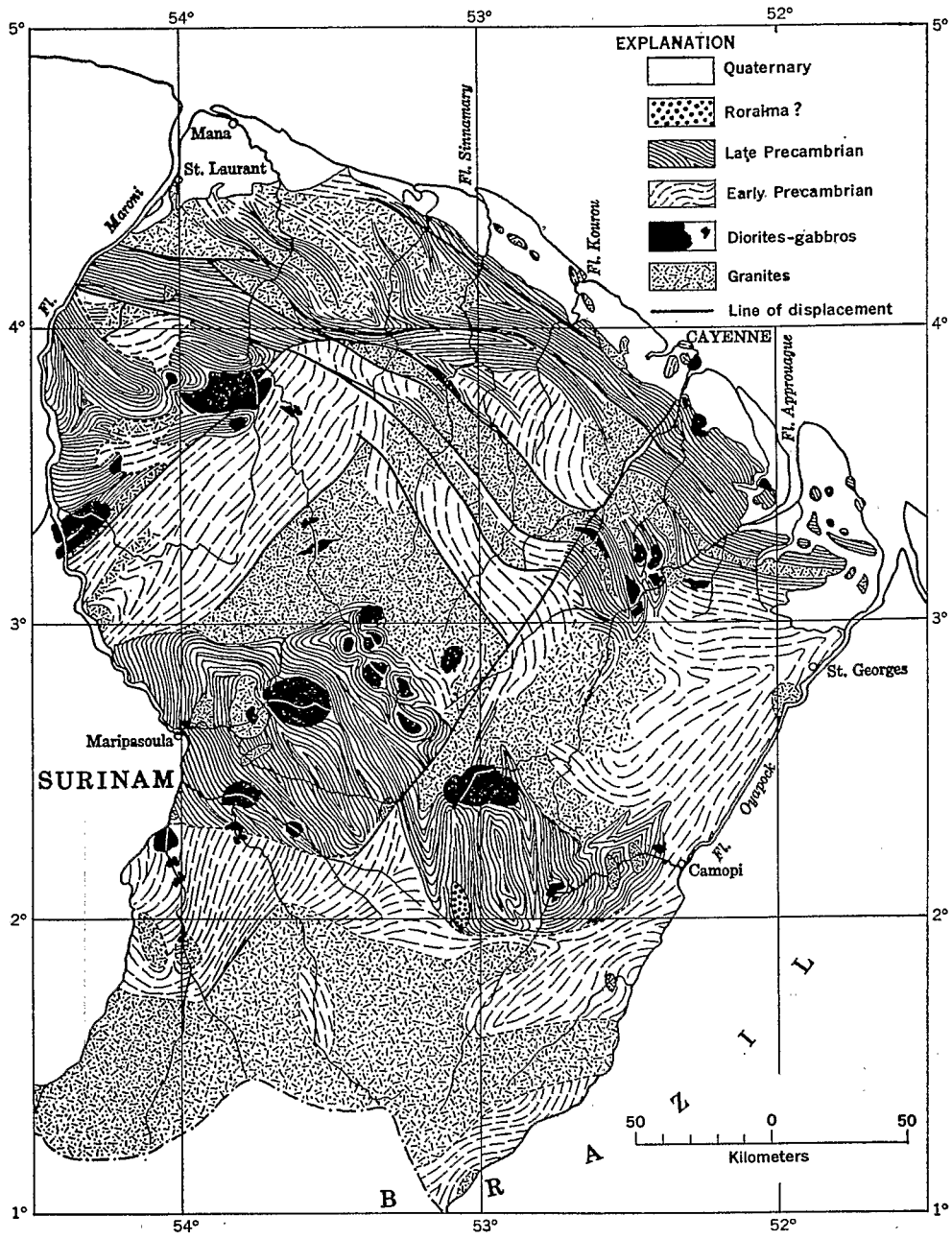

FIGURE 1.—*Geologic and structural sketch map of French Guiana*

are inclusions in the migmatitic granites of the Ile de Cayenne and of the Mana valley. These limestones are rich in calcic metamorphic minerals such as wernerite, sphene, diopside, etc.

The Ile de Cayenne system shows a diversity of directions of folding and schistosity. Most common are northeast-southwest and east-west strikes. The dips are usually subvertical (Pl. 1), but some are subhorizontal, especially along the east shore of the Ile de Cayenne.

The paragneisses shown by E. Aubert de la Rüe along the Oyapoc and at several places in southern French Guiana, as well as various rocks referred by him to the lower Precambrian, probably correspond to the Ile de Cayenne series.

Paramaca system (volcanic series).—This system is certainly separated from the preceding by an unconformity, though the contacts have never been seen. The rocks composing it in general show a much less intense metamorphism.

These terranes are clearly distinguishable on the aerial photographs. Their relief is rugged. They form massifs which stand out above the surrounding peneplain. They consist of chlorite schists, talc schists, mica schists, various other schists, detrital rocks, quartzites, and carbonatized rocks.

Thick lava flows form intercalations in these formations. In zones less affected by metamorphism one may recognize andesites, basalts, and rhyolites. These rocks are generally related to gabbro, diorite, and pyroxenite intrusives which appear to be old, deeply eroded volcanic necks.

The Paramaca system also contains ultrabasic rocks (peridotites) which have been strongly modified and transformed into serpentine with magnesite.

The eruptions appear to have occurred during a very long period of time, and, among the basic intrusions, one may distinguish several surges. The whole has been folded and cut by major granite intrusions of a calc-alkaline type, which have given rise to vast zones of migmatite.

The Paramaca terranes are present in almost all of French Guiana. They are especially well represented north and south of the wide granite zone which makes up the center of the country.

The strike of the folds in rocks of the Paramaca system ranges from north-northwest to north-northeast.

This system is known in all three Guianas. It is the same as the Balling series in Surinam and the Volcanic series in British Guiana (Table 1). The general facies, as well as the presence of lava flows, quartzites, and iron ore beds justifies thinking of a possible correlation with the Minas group of Brazil.

Bonidoro series.—This essentially detrital and slaty series was formed at the expense of the older series, as a result of erosion following uplift of the Guiana range. It contains rhyolitic flows and tuffs and is scarcely metamorphosed in the middle Mana valley.[2]

South of Cayenne the series includes silicified and ferruginous horizons. It has been distinguished as a formation only recently. It is cut by leucocratic granites

[2] These formations along the middle Mana River are named Ga-Kaba in our first work, but it has later seemed necessary to adopt another term, in conformity with the Surinam geologists.

TABLE 1.—*Correlation table for the Guianas*

	French Guiana	Surinam	British Guiana
Quaternary and Pliocene (?)	Demerara series Coswine series Basal subcontinental series	Demerara series Coropina series Zonderij series Nickerie series	Demerara series White sands
Mesozoic (?) or Paleozoic (?)	Roraima formation (?) dolerites	Roriama formation dolerites	Roraima formation dolerites
	Rhyolites	Rhyolites	Rhyolites
	Caribbean orogeny—Granites		
Upper Precambrian	Orapu System: Upper group, Lower group, Bonidoro series	Rosebel series Bonidoro series	Haimaraka shales (?)
	Guayanan orogeny—Granites		
Middle Precambrian	Paramaca system	Balling system: Paramakka series, Nassau series	Volcanic series
	Hylean orogeny—Granites		
Lower Precambrian	Ile de Cayenne system	?	Orthogneiss

with a sodic tendency. Around these granites the metamorphic aureole is narrow and of feeble intensity. A genetic relationship with the rhyolites is probable, considering the similar chemical composition of the two types of rock.

Orapu series.—This series, which represents the end of the Precambrian, begins with thick conglomerates of variable appearance and composition, with which micaceous quartzites are often associated. Sedimentation then became argillaceous, giving rise to the Orapu slates.

These formations cross all of French Guiana, parallel to the coast. In the east they end shortly before the Oyapoc is reached. In the west they pass the Maroni River and are well represented in Surinam.

Broadly speaking this is a vast synclinal zone, but certain structural peculiarities make one think sedimentation was not continuous. Lower conglomerates and quartzites are separated from the overlying strata by either an erosional or angular unconformity.

Actually these rocks, which bound the schist region south of the Ile de Cayenne continuously from the Cayenne River in the west to the high basin of the Counana in the east, appear only sporadically south of the synclinal zone, where they are separated by outcrops of the Bonidoro series.

Along the middle Orapu these conglomerates have glacial characteristics, with large, roughly tetrahedral boulders distributed at random in a conglomeratic matrix with schistose pebbles dominant. This facies is clearly distinguished from the lower part of the slaty formation, which contains zones of conglomeratic sandstone. These differences justify the division of the series into two parts.

The conglomerates are strongly developed in the eastern part of French Guiana, where they extend over great areas. In contrast, their importance seems to be some-

what less in the west. Still farther west, in Surinam, they are again strongly developed.

The upper part of the series is uniform. It includes argillaceous, generally well bedded slates which are gray to blackish when fresh, reddish and violet on alteration.

The whole Orapu series is cut by important granitic intrusions, most commonly granodiorite. Where these granodiorites cut the slates they are clearly intrusive and have produced pronounced metamorphism; in these places the Orapu and Bonidoro slates contain large crystals of staurolite and are changed into biotite and garnet schists. The quartzites contain cordierite, kyanite, and muscovite, in many places in great quantity.

From a tectonic point of view the Orapu system is folded and foliated following a northwest to west-northwest direction, as shown in Figure 1. One frequently notes a difference in the strike of the schistosity and the general direction of the synclinal zone. These folds have given rise to the Caribbean Range, now greatly reduced by erosion.

In resumé, one may distinguish three principal orogenies in the continental Guianan region:

(1) *The Hylean trend*,[3] which probably includes several cycles and the rocks of which are grouped in the Ile de Cayenne system.

The rocks of this system are of igneous or sedimentary origin, and most of them are affected by intense metamorphism (gabbro and granulite facies of P. Eskola). Study of the migmatites leads to the assumption that there were several periods of granite intrusion.

(2) *The Guayanan trend*, which is characterized by thick sequences of sediments and by thick interbedded lava flows. It includes numerous intrusions of diorite, gabbro, pyroxenite, etc. Metamorphism is less intense than in the Hylean trend and ranges from the amphibolite-albite-epidote facies to the hornblende gabbro facies. These terranes are grouped under the name Paramaca system.

(3) *Caribbean trend*, which takes in several cycles and is made up of slightly metamorphosed rocks which are, however, affected by contact metamorphism. The Bonidoro series, with its rhyolites, and the Orapu series are involved in this trend.

In the legend of the Geologic Map of South America the Ile de Cayenne system and its presumed southern equivalents are included in the Early Precambrian, the remainder being Late Precambrian. We have adopted this subdivision on our map (Fig. 1).

RORAIMA SYSTEM AND DOLERITES

The old sedimentary sequence of the Guianas ends with the Roraima series, which is several thousand meters thick and made up of conglomerates, sandstones, and other detrital rocks, as well as of dolerites in the form of small intrusive bodies, dikes, and interbedded flows.

This series rests on the presumed Precambrian and is separated from it by a great unconformity. It is generally unmetamorphosed and is little deformed. Absence

[3] After *Hylea* of von Humboldt.

of fossils does not permit dating these beds, and various authors assign different ages to them. Most commonly they are dated as Paleozoic or Mesozoic.

The Roraima series underlies vast areas in the Venezuelan and British Guianas. It forms a few limited areas of outcrop in Surinam but has not been identified with certainty in French Guiana. In the southern part of the country there are some flat-topped summits which might be buttes, erosional forms typical of this series (Aubert de la Rüe, 1953).

Dolerites and gabbros are, at least in part, contemporaneous with the Roraima series. They are abundant in all the Guianas and, in French Guiana, form small intrusions and numerous dikes which strike about north or north-northwest. In certain localities, especially on the north coast of the Ile de Cayenne, there are about 10 dikes per kilometer, and in places more.

On the basis of physical chemistry one may distinguish several types ranging from quartz dolerites to dolerites rich in iron or magnesium. Dolerite dikes cut others, indicating successive intrusions. These rocks are often accompanied by pegmatoids which represent the residual solutions of the same magma. The latter resemble those described by A. Lacroix in Madagascar. Under the microscope they show beautiful micropegmatite structures, and some contain riebeckite.

Certain dikes, clearly visible on the aerial photographs, are more than 50 km long. In places they contain patches of native copper. The rocks are fresh, though some are a little crushed.

QUATERNARY

A Quaternary mantle covers all the coastal part of French Guiana (Choubert, 1954a). It is generally thin—from a few meters to about 200 m. Of marine and fluviomarine origin, it may be subdivided into several series separated by intercalated continental periods. It begins with subcontinental detrital formations whose age is not known with certainty, but which might be Pliocene (?). The sediments are uninterruptedly argillaceous and sandy, and fossil zones are rare. In general the fauna consists of existing or recent species.

From bottom to top there may be distinguished:

(1) *The basal detrital series*, which corresponds to the Zonderij of the Dutch;

(2) *The Coswine series*, composed of sands and clays and correlated with the Coropina of Surinam;

(3) *The Demerara series*, a general name for all three Guianas. These are blue clays which turn brownish on exposure to the air, with lenticular intercalations of sand and old shore lines in the vicinity of the estuaries.

In Surinam these three series form superposed coastal plains whose altitude decreases from that of the oldest (Zonderij), which forms a nearly continuous band and represents the farthest advance of the Quaternary, to that of the most recent (blue clay) at the coast.

Along the shore a fourth coastal plain is being formed and consists of deposits transported by the equatorial current and cast up on the shore by the trade winds. Formation of this present-day deposit is extremely rapid in French Guiana, where in places the coast is being built out more than 100 m a year. It is due to the alluvial

material brought to the ocean by rivers, especially the Amazon. As a result, the sea is muddy over a width of several kilometers from the mouth of the Amazon to that of the Orinoco. The plain forming is covered with mangrove swamps. The rest of the Quaternary area is generally characterized by savannas which are clearly visible on the aerial photographs, where they contrast sharply with the forest-covered Precambrian.

This accumulation of mud gives rise to peculiar geomorphic phenomena. Most of the estuaries of Guianan rivers have a westerly direction on approaching the coastal zone; the lower sections, offset in this manner, in places are several kilometers long and blend with the old shore lines. The most recent are separated from the sea by mud bars. As they are extended they capture the rivers farther to the west. We have proposed calling this type of capture "coastal confluences due to sedimentary barriers" (Choubert, 1948).

In a general way the importance of the Quaternary deposits increases from east to west. Their thickness, which is a few tens of meters in French Guiana, exceeds 2000 m in the Berbice River Valley, British Guiana.

The coast of French Guiana, moreover, is affected by a positive epeirogenic movement; all the rivers are cutting into their alluvial deposits and many have already reached bedrock. Their ancient flood plains thus form the most recent terraces. In the interior of the country there are higher terraces, but their correlation with movements of the Quaternary sea has not yet been clearly established.

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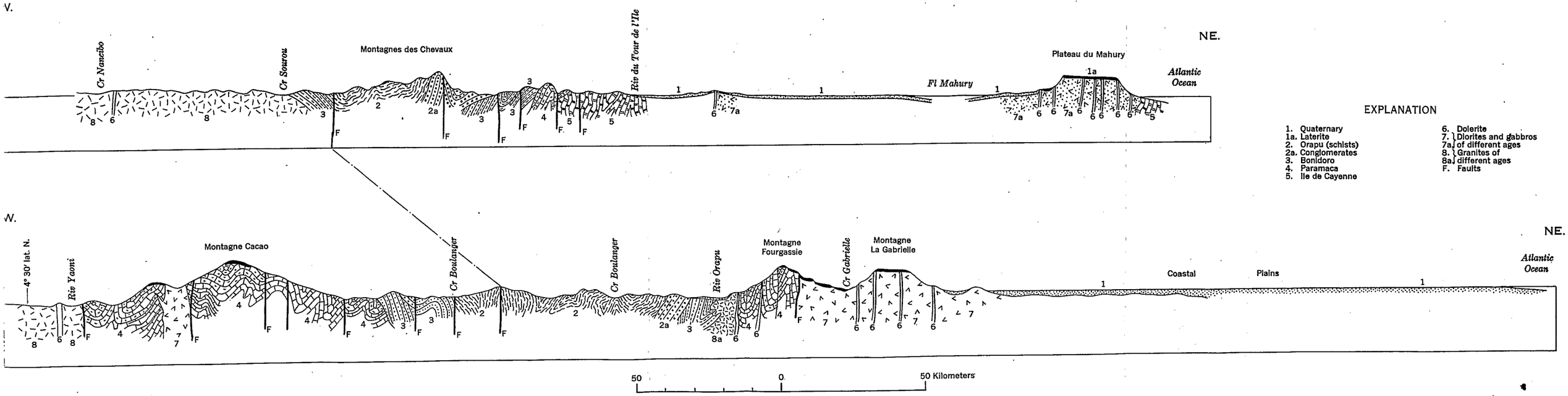

EXPLANATION

1. Quaternary
1a. Laterite
2. Orapu (schists)
2a. Conglomerates
3. Bonidoro
4. Paramaca
5. Ile de Cayenne
6. Dolerite
7. 7a. Diorites and gabbros of different ages
8. 8a. Granites of different ages
F. Faults

TWO PARALLEL GEOLOGIC SECTIONS, 18 KM APART, ACROSS NORTHERN FRENCH GUIANA

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