a structural terrace, should be tested if it is proved that the underlying rocks are petroliferous elsewhere.

The northwestern part of the plain is not so promising as the southeastern part. The lower part of the Thomonde formation is exposed on the Fond Bleu dome, and the thicker coarse detrital rocks of the same age on the plunging anticline between Maïssade and Pignon are probably entirely delta and flood-plain deposits.

Possible Oil in Other Regions.

The Artibonite Valley resembles the Central Plain in many features, as structurally it is a northwestward-plunging syncline, modified by secondary anticlinal and synclinal folds. It also is floored with the Miocene rocks of the Artibonite group. Figures 12 (p. 207) and 13 (p. 208) show that a secondary anticline flanks the major synclinal trough on both sides of the valley. Except in the upper part of the valley the Miocene rocks consist principally of marl and limestone, which do not contain the rich fauna of deposits of the same age in the Central Plain. The Miocene rocks of the Artibonite Valley are therefore not so promising, either as a possible source of oil or as reservoirs.

Miocene rocks probably floor the Cul-de-Sac Plain under the cover of alluvium, but they are so completely concealed that their structure is indeterminable from surface observations. Their lithology, as observed at their outcrop along the borders of the plain, does not warrant any exploration with the drill.

Reports of asphalt near Étang de Miragoâne have been repeated in several accounts of the mineral resources of the Republic. Although no attempt was made during this reconnaissance to find the deposits, the geology of the region indicates that the reports are not authentic.

ROAD MATERIAL.

Present State of Road Building.

As compared with the area of the Republic, the length of improved roads already built is very small, and most of them are not suited for heavy traffic. Roads that will bear heavy traffic are needed in the plains to facilitate agricultural development, and trunk lines connecting the larger cities and towns are desirable.

Although an unlimited amount of good material for road making is available, much of it is inconveniently situated, and a great deal of easily accessible but inferior material is therefore used.

Along the coast much of the soft coralliferous limestone of Quaternary age is used. It binds well but is too soft except for light traffic. Much gravel from stream beds and older gravel beds is used, especially in the Cul-de-Sac Plain. If properly graded and carefully laid it is reasonably satisfactory, although it also is rather soft. The impure

cherty limestone at Cap-Haïtien is used extensively on the streets of that city with good results. In the mountainous regions hard rock is generally available, but it is not much used because of the lack of machinery for crushing it and preparing the roadbed. Some of the stony residual soils of the mountain areas, when properly graded and dressed with a little gravel, make good roads for light traffic.

Tests of Samples of Road Material.

The Bureau of Public Roads of the United States Department of Agriculture tested six samples of material either used or available for use in road making in the Republic. Four of these samples were rock and were tested for use as courses in water-bound macadam. Two samples of residual chert and gravel were tested for use in surfacing roads. The cementing value of the rocks was not tested. The results of tests of the four samples of rock are given in the following table:[1]

Results of physical tests of some rocks available for road building.

Sample No.	Locality.	Kind of rock.	Specific gravity.	Percentage of water absorbed.	Per cent of wear.	French coefficient of wear.	Hardness.	Toughness.
1	Near Limbé	Amphibolite	3.01	0.60	5.8	6.9	18.7	22
2	Near Acul Samedi..	Quartz diorite	2.74	0.34	2.8	14.3	18.0	15
3	Cap-Haïtien	Chert (weathered).....	2.35	2.77	9.1	4.4	17.7	[a]
4	Cul-de-Sac Plain ...	Limestone (boulders)...	2.64	0.67	4.4	9.1	14.7	7

[a] Variable.

The amphibolite (sample 1) consists mainly of hornblende and magnetite. It is a dense dark-gray rock of unusually high specific gravity. It belongs to the early Mesozoic volcanic series but has been metamorphosed by a near-by intrusion of quartz diorite. The sample was collected in a road cut on the north slope of Plaisance Mountain, about 4 kilometers south of Limbé. The hardness and toughness are high, and probably the rock would bind fairly well. The percentage of wear is rather high; nevertheless, this rock is considered the best road-building rock tested.

The quartz diorite (sample 2) contains about 88 per cent of the essential minerals, plagioclase, quartz, and hornblende. The accessory minerals magnetite and biotite constitute about 3 per cent and the secondary minerals kaolin, chlorite, and limonite about 9 per cent of the rock. This rock is typical of the quartz diorite that covers large areas in the Massif du Nord, from Grande Rivière du Nord eastward

[1] For description of the methods of testing, see Jackson, F. H., jr., Methods for the determination of the physical properties of road-building material: U. S. Dept. Agr. Bull. 347, 1916.

to the Dominican border. The sample was collected from boulders in the bed of Rivière Marion near Acul Samedi. The hardness and toughness are high and the percentage of wear low, but rocks of this type do not bind well. The rock might be satisfactory in lower courses if used with a good binding material.

Sample 3 comes from the impure cherty limestone, probably of Cretaceous age, that crops out in small areas in the Morne du Cap. The sample was collected in a quarry near the Civil Prison at Cap-Haïtien. It is composed mainly of very fine angular fragments of quartz embedded in a cryptocrystalline siliceous matrix. A little secondary limonite and sericite are present. Near the surface the rock is much shattered and badly weathered. The percentage of wear is high, but the hardness is also high and the binding power is probably good. Material that is not too badly weathered should do fairly well for courses in macadam roads.

Sample 4 represents the harder Eocene and Oligocene limestone of the Republic. It was obtained from large boulders in a gravel pit about 3 kilometers west of Pont Beudet, on the Cul-du-Sac Plain. In hardness and toughness the limestone is inferior to the other rocks tested, but in its percentage of wear it compares favorably with them. Moreover, the binding power of limestones generally is excellent, and the binding power of this sample may be judged from that of sample B of the gravel, which was taken from the same pit. (See below.) The Bureau of Public Roads states that this rock "is not sufficiently durable to be used in water-bound macadam surface except where traffic will be light." However, the results of the physical test compare favorably with those of many limestones that are successfully used in the United States.

Two samples of material were tested for use as surfacing material. One is a finely divided and much-weathered residual chert from the same quarry from which rock sample No. 3 was obtained. The other is a gravel from the gravel pit at which rock sample No. 4 was collected. The results of the tests are as follows:

Results of tests of samples of residual chert and gravel.

Sample.	Locality.	Kind of material.	Principal constituents.	Loss by washing (silt and clay) (per cent).	Cementing value.
A	Cap-Haïtien	Crushed rock.	Angular fragments of weathered chert with considerable fine chert.	26.0	*
B	Cul-de-Sac Plain ..	Sand, clay, gravel.	Rounded fragments of limestone, quartz, basalt, and chert. Quartz sand and calcareous clay.	2.9	88

*Impossible to test.

Mechanical analyses of two samples of residual material.

	A	B
	Per cent.	*Per cent.*
Gravel (material retained on ¼-inch screen)	34	72
Sand (material passing ¼-inch screen)	66	28
Gravel (material retained on 1½-inch screen)	0	16
passing 1½-inch screen but retained on 1-inch screen)	11	29
1 ¾	10	14
¾ ½	27	21
½ ¼	52	20
Sand (material retained on 10-mesh screen)	23	23
passing 10-mesh screen but retained on 20-mesh screen)	15	12
20 30	7	10
30 50	5	14
50 100	4	13
100 200	5	8
200	41	15

Sample A represents the finer material that is abundant at the surface of weathered exposures of the impure cherty limestone. The Bureau of Public roads says that this material "should prove satisfactory as binder for broken rock in waterbound macadam road construction. Although the cementing value test could not be made, experience has shown that this type of material has good binding properties." As a matter of fact, it is used with good results as a top dressing on the streets of Cap-Haïtien.

Sample B is typical of the finer material obtained at several gravel pits in the Cul-de-Sac Plain and resembles many other gravel deposits in the Republic that are composed predominantly of limestone pebbles. The cementing value of this gravel is very good, and although rather soft it gives good results under light traffic. Fairly good roads can be constructed entirely of this gravel by using the coarser material for the lower layers or by crushing the large boulders and carefully grading the gravel. The highway from Croix-des-Missions to Pont Beudet was constructed entirely of this gravel, and although the traffic is rather heavy the road bed has not deteriorated rapidly. The highway from Port-au-Prince to Croix-des-Missions shows the results of using ungraded gravel, as the roadbed deteriorated rapidly when large cobbles near the surface became loose.

Summary of Available Material.

The value of road material depends not only on its physical properties but also on its accessibility and cost. The best rock in the Republic for use in courses in water-bound macadam roads are the extrusive igneous rocks, such as basalt, andesite, and dacite. The amphibolite tested (sample 1) is a somewhat metamorphosed rock of this type. Probably all the basalts, which comprise nearly all the igneous rocks of the Southern

Peninsula, would make good roads. Large areas of basaltic and andesitic rocks crop out in the Massif du Nord from Grande-Rivière westward to Port-de-Paix and in the Terre-Neuve region. Small exposures of basaltic and andesitic rocks also occur near the road between Dessalines and Gonaïves. Metamorphosed basaltic rocks also are known at accessible locations on the North Plain near the head of Acul Bay and at the southern border of the plain east of Le Trou. Other basaltic rocks crop out at the foot of the mountains near Thomazeau and Maneville.

The coarsely crystalline intrusive igneous rocks, such as quartz diorite and granodiorite, occur mainly in the Massif du Nord, from Grande-Rivière eastward to the Dominican border. These rocks are less desirable as road material and probably need not be used to any great extent.

The hard Eocene and Oligocene limestones will make good roads where traffic is not too heavy, and because of their very wide distribution they probably will be used extensively. They occur in practically every mountain range in the Republic.

Gravel is found in the plains and valleys where roads are especially needed. It is the cheapest and most accessible road material available, for machinery would be required to quarry and crush the igneous rocks and limestone. An extensive program of highway construction is entirely unwarranted at present, and highways constructed of gravel would be satisfactory in the more thickly populated plains. The gravels are very irregular in texture and composition, and careful grading is necessary to assure good results. The best gravel, composed mainly of fragments of igneous rocks, is found in extensive areas only on the North Plain.

The soft coralliferous limestones of the coast and of the Miocene formations are better than dirt but are inferior to any of the other rocks for road material.

BUILDING STONE.

Many of the walls, aqueducts, and other structures built during and since the colonial period consist of rubble masonry, made of rough field stones laid in thick mortar. Bricks were used liberally wherever the stones did not fit well, as in arches and at corners. Limestone boulders generally were used because they were most common. Occasionally, especially at Port-au-Prince and Cap-Haïtien, large coral heads from the living reefs take the place of boulders. Many of the colonial structures of this type were well built, and parts of them are still intact.

At Port-au-Prince considerable chalk from the hardened upper crust of the Quaternary conglomerate is used in buildings and for foundations. It is very easily quarried but too soft to shape well. The rough, irregular lumps are laid in thick lime mortar. The life of this material appears to be short, and failures of structures in which it has been used are rather common.