Possibly some of the brick clays, like those at l'Arcahaie, would be satisfactory for mixing with limestone to make cement.

In recent years the Republic of Haiti has imported about $100,000 worth of cement annually, and the importations are increasing, but a plant to furnish the domestic supply would not be warranted by such a volume of business. The location of cement plants is generally determined more by other factors, such as labor, transportation, nearness to markets, and fuel supply, than by the occurrence of suitable raw materials. There is now no suitable fuel supply for cement manufacture in the Republic, and unless oil should be found it probably will be impossible to establish a profitable cement industry.

CLAY FOR BRICKS.

The Republic produces nearly all the common building brick that it consumes. The largest brick factories are those near l'Arcahaie and near Cap-Haïtien, but there are smaller ones at other places. The plants near l'Arcahaie make the bricks used at Port-au-Prince and also ship them by boat to other parts of the country. So far as was learned, none of the factories make tile or terra cotta, nor any special kinds of brick, such as pressed brick, vitrified brick, or ornamental brick. The variety of products manufactured might therefore be somewhat increased.

A few brick factories were visited, particularly for the purpose of determining the kinds of raw materials used. These plants are described in the following pages. Samples of clays collected were tested at the ceramic station of the United States Bureau of Mines at Columbus, Ohio (G. A. Bole, superintendent), with the results given in the table on page 504.

One of the plants near l'Arcahaie, known as the Usine l'Étoile, was visited. It is said to be the largest of three plants at this locality, which is near the shore, about 5 kilometers southeast of l'Arcahaie. When this plant is running at full capacity it is said to produce from 15,000 to 20,000 bricks daily and to employ about 80 workmen. The bricks are shipped by rail to Port-au-Prince and St.-Marc and by water to other localities. They were selling in 1921 at $12 to $15 a thousand.

Alluvial clay is obtained from shallow pits about 200 meters from the shore. (See Pl. XXXVIII, *A*.) The clay is rather variegated in color, the mixture of red and white resulting generally in a brownish tinge. It consists mainly of reworked Miocene marl. Certain beds appear to contain much fine calcareous sand. Gypsum in small flakes occurs throughout the clay. Sand taken from the adjacent beach at low tide is mixed with the clay in the proportion of 1 part sand to 4 parts clay. The sand is very fine and seems to consist mostly of calcareous grains.

After molding, the bricks are dried from 4 to 10 days in large sheds (see Pl. XXXVIII, *B*) and are then burned in intermittent wood-fired kilns, the only type of kiln in use in the Republic. There are five of these

Results of tests of clays.

No.	Location.	Source.	Water of plasticity r cent).	Working quality.	Dry volume shrinkage (per cent).	Drying behavior.	Burning behavior.	Fire shrinkage.		Softening tempera- ture (cone No.).	Color in raw state.	Color after burning.	Remarks.
								Cone No.	Per cent.				
1...	Brick factory at l'Arcahaie.	Alluvial.	35.2	Good.	35.5	Fair.	Good at cones 07, 06, 05, 04.	07 06 05 04	3.75 3.43 1.73 2.70	02	Light brown.	Buff.	Good for common ware.
2...	Brick factory at l'Arcahaie.	Alluvial clay (No. 1) mixed with 20 per cent of beach sand.	....	Good.	27.0	Good.	Good at cone 03.	03	7.6	....	.....	Buff.	Makes good brick.
3...	Brick factory at Grande-Rivière du Nord.	Residual from basalt.	32.5	Good.	47.6	Fair.	Cracked badly at cone 04.	....	....	2	Brown.	Dark brown.	Poor.
4...	Grande-Rivière du Nord.	Residual.	28.7	Good.	20.5	Good.	Good at cones 5 and 10.	8 10	6.10 6.15	16	Red.	Brownish red.	Possibly good for building brick.
5...	Grande-Rivière du Nord.	Residual.	34.5	Fair.	17.3	Good.	Good at cones 7, 8 and 10.	7 8	13.2 14.5	14	Buff.	Grayish brown.	Good for common ware.
6...	Brick factory at La Gorge on Rivière du Môle.	Miocene marl.	38.1	Good.	....	Good.	Good at cone 03; starts to crack at cone 02; cracks badly at cone 1.	03 02	21.8 21.3	....	Gray.	Gray.	No good.
7...	Rivière Guayamouc opposite Hinche.	Miocene clay.	25.4	Good.	20.7	Good.	Good at cone 02; starts to fuse at cones 1 and 2.	02 1 2	24.2 21.1 21.8	4	Buff.	Grayish brown.	Good for common ware.
8...	Mont-Organisé.	Residual from quartz diorite.	45.9	Fair.	36.3	Good.	Showed fine cracks at cones 6, 7, 8 and 10.	6 7 8 10	20.3 22.1 23.0 24.7	13	Red.	Dark brownish red at cones 6, 7, 8. Steel-gray at cone 10.	No good.

kilns, with capacities ranging from 15,000 to 30,000 bricks each. When properly burned, the bricks are buff, presumably owing to the large amount of calcareous material in the clay. When insufficiently burned they are reddish, and when overburned they become green and brittle.

Tests of the clay (sample 1, in table on p. 504) show that it has a low fire shrinkage. It burned hard at a low temperature (cone 06). The addition of sand obtained on the beach near by makes the material dry better but gives it a higher fire shrinkage (see sample 2), indicating that the sand is highly calcareous and that its use could be discontinued. This is the most satisfactory clay tested.

The brick factory of M. LaRoche, near Cap-Haïtien, operates under its former name of G. LeConte & Cie., which is stamped on all bricks. It is on the North Plain about 3 kilometers south of Cap-Haïtien, between the Port-au-Prince road and Rivière Haut du Cap. It supplies all the bricks used in the vicinity of Cap-Haïtien and ships some by rail to Grande-Rivière du Nord. In March, 1921, twelve men were employed, and the weekly output was said to be about 5,000 bricks. The selling price was reported to be $20 a thousand.

Alluvial clay of a dirty red color is obtained from shallow pits near the plant. The clay is rather silty and is poorly assorted, containing small fragments of quartz and feldspar. Purer clay probably could be obtained east of Rivière Haut du Cap, farther away from the Morne du Cap. No sand is mixed with the clay.

The bricks are molded by hand, dried in covered sheds, and burned in intermittent wood-fired kilns. One kiln has two compartments which hold about 12,500 bricks each. One compartment is emptied and recharged while the other is burning. A larger kiln, holding 70,000 bricks, was shut down when the plant was visited.

As the alluvium of the North Plain is derived mainly from igneous rocks, the clay is not so calcareous as that at l'Arcahaie and also contains more iron oxide. As a result the bricks are deep red. A sample of clay obtained from the pits for testing was lost.

At Grande-Rivière du Nord there is a small plant owned by M. Alexis Paul, which is operated intermittently as orders are received. All work is done by hand. The single kiln holds 5,000 bricks.

Residual clay from the decay of basaltic volcanic rocks is obtained on the adjacent mountain slopes. The clay is deep red, and when wet is extremely sticky. In a pit near the plant it appeared to be about 2 meters in depth, but the upper part contained so much residual gravel that it was useless. The remainder also contained small fragments of quartz and unweathered feldspar. Three parts of this clay are mixed with one part of sand obtained from the beds of small streams or from the Grande Rivière du Nord. This sand is rich in quartz.

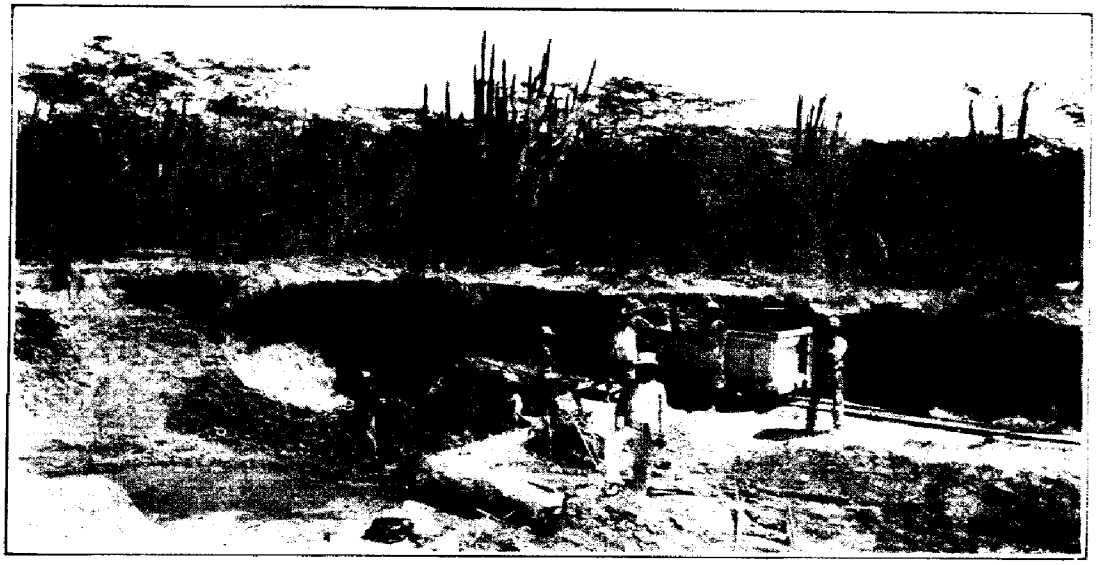
The burned bricks are deep red and resemble those produced by the plant near Cap-Haïtien. Tests were made of three samples of clay obtained at the factory and near by (Nos. 3, 4, and 5 in the table, p. 504). Sample 5 showed a rather high fire shrinkage. This shrinkage and the unsatisfactory behavior of sample 4 is avoided at the plants by adding siliceous sand. Sample 3 cracked badly at cone 04, but the other two samples made fairly satisfactory bricks, although a high temperature was necessary to burn them hard.

At La Gorge, about 3 kilometers south of Môle St.-Nicolas, a small plant had just begun to produce bricks in February, 1921. This plant was using Miocene marl resembling that for which an analysis is given on page 502 and sand from the bed of the Rivière du Môle, in the proportion of 8 parts of marl to 3 parts of sand. The sand appeared to be composed of about three-fourths calcareous particles and one-fourth fragments of volcanic rock. All work was being done by hand. The single kiln held about 5,000 bricks. When visited the plant had just finished its initial burning. Many of the bricks were cracked, but some looked fair. Tests (sample 6) show that the marl has a high fire shrinkage, and the test bricks began to crack at cone 02. The addition of sand from the bed of Rivière du Môle probably does not improve the material, as the sand is almost as calcareous as the marl.

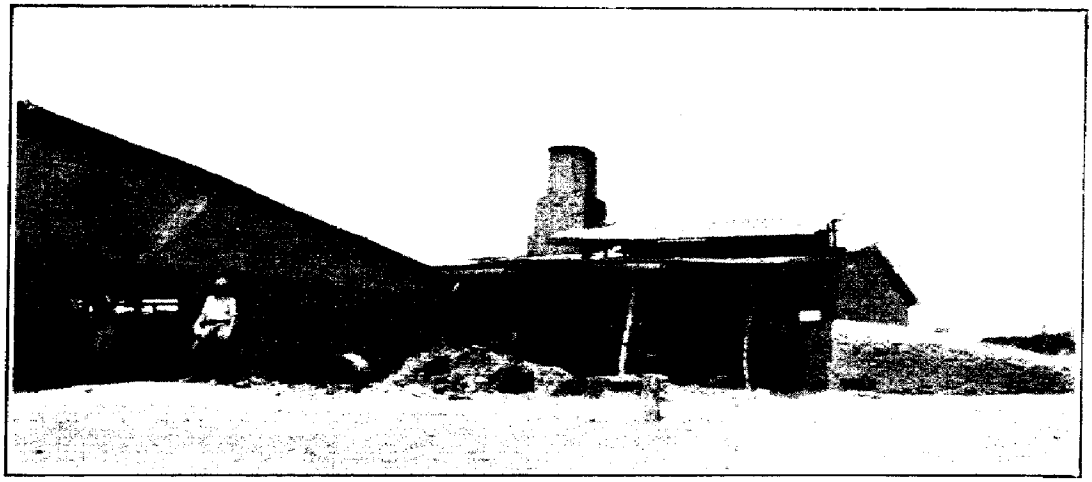
At Hinche, in the Central Plain, a temporary brickyard was making bricks for a prison building in 1921. Loam obtained on a high-level river terrace was mixed with sand from the bed of Rivière Guayamouc. The loam deposit probably is of Quaternary age. The material is sandy and is black from organic matter, but the bricks burned red. It is said that silty clay taken from the hill leading up to the military camp made unsatisfactory bricks, but the fault may have been in the handling of the material rather than in the material itself. Tests of a sample of Miocene clay obtained near Rivière Guayamouc, opposite Hinche (sample 7), show that it makes satisfactory bricks, although the fire shrinkage is high. It burned hard at a fairly low temperature.

A sample of clay residual from quartz diorite, obtained at Mont-Organisé (sample 8), has a high fire shrinkage. A high temperature (cone 6) was necessary to burn it hard, and the product has many cracks.

Each of the factories described uses a considerably different raw material. The plant near Môle St.-Nicolas uses a consolidated marine marl, presumably very high in calcium carbonate. The tests show that this material is unsatisfactory. The plants at l'Arcahaie satisfactorily use material of the same kind which has been reworked into alluvium and probably reduced in calcareous matter. The plant at Grande-Rivière du Nord uses a residual clay resulting from the decay of basaltic rocks, and the plant at Cap-Haïtien uses material of the same kind which has been assorted and redeposited as alluvium. One other type of clay that is common in the Republic, the residual red clay resulting from the weathering



A. CLAY PITS AT BRICK FACTORY NEAR L'ARCAHAIE.



B. DRYING SHED AND KILN AT BRICK FACTORY NEAR L'ARCAHAIE.

C. PITS FOR EVAPORATING SEA WATER TO OBTAIN SALT NEAR GRANDE SALINE.

of limestone, probably could also be used to make bricks. In general the alluvial clays are better assorted and occur in more extensive deposits than the residual clays and consequently can be worked more cheaply. Quartz sand suitable for addition to clay to reduce fire shrinkage and increase the tensile strength is found in abundance only along the streams flowing down into the North Plain. Calcareous sands have probably no value for this purpose.

SAND.

Sand is used in the Republic of Haiti mainly in lime mortar and in concrete. For these purposes sand should be graded—that is, it should consist of a mixture of grains of different sizes so that the smaller grains will fill the spaces between the larger ones. Very fine sand is not desirable, as it requires more cement or mortar and makes a weaker mixture. Sand should be reasonably free from clay and organic impurities, and particularly the surfaces of the grains should be clean, so that the mortar or cement will adhere to them readily. Good sand is scarce in most parts of the Republic, and as a result much dirty, inferior material is used. Sand is scarce because so large a part of the surface rocks are composed of pure limestone, which on weathering yields but little sand.

There are two principal kinds of sand in the Republic—calcareous sand and siliceous sand. Calcareous sand occurs to some extent along stream channels in limestone areas and is also found at some places in the Quaternary gravels. For instance, considerable sand could be screened from the gravel taken from the Cul-de-Sac Plain, of which a mechanical analysis is given on page 497. The soft coralliferous limestones of Quaternary age contain small bodies of calcareous sand at some places, and most of the recent beach sands are composed chiefly of calcareous material. As a rule all these deposits are small and irregular and contain a large amount of clayey impurities. To obtain clean sand they should be screened and perhaps also washed. An exception is the deposit of beach sand on the north coast about 4 kilometers north of Môle St.-Nicolas. This sand is composed of ground-up fragments of sea shells, reworked by the wind into dunes. It is exceedingly clean and does not contain much material more than 3 or 4 millimeters in diameter. The deposit, however, is not very large.

Calcareous sand is inferior in strength and durability to siliceous sand, but it can be used in mortar and concrete with fair results. It is of course useless for many purposes, such as for abrasives, for molding sand, or for glass making, for which purposes pure siliceous sands are required, and it is of little value for road surfacing, as it is too soft.

Siliceous sand, composed mainly of quartz, is found in large quantities only on the North Plain and along the streams in the adjacent part of the Massif du Nord that is underlain by igneous rocks. It is derived mainly from the weathering of quartz diorite. Two samples of sand from