Analyses of limestone.

Sample No.	Lime (CaO).	Magnesia (MgO).	Carbon dioxide (CO_2).	Silica (SiO_2).	Alumina (Al_2O_3) and ferric oxide (Fe_2O_3).	Total.
1	55.60	0.45	43.45	0.14	0.26	99.90
2	55.12	0.56	43.18	0.50	0.20	99.56

Sample 1 was obtained from the middle Eocene Plaisance limestone at the top of Mont Puilboreau between Ennery and Plaisance. Sample 2 was obtained from beach gravel about 3 kilometers southeast of Mont-Rouis, where the shore touches the base of the Chaîne des Mateux. It is composed of pebbles of hard Eocene limestone and possibly in part of Oligocene limestone. Of course not all the limestones of the country are so pure as these samples, but rock of equal purity is plentiful.

The amount of lime consumed in the Republic is probably equal to the output of a large modern factory. However, if such a plant were erected it could scarcely compete successfully with the inferior but cheap lime made by the present crude methods. If sugar refining, which requires lime of high purity and uniformity, should continue to increase a plant to supply this trade might possibly be successful. A factory located near Port-au-Prince doubtless could find satisfactory limestone on Morne Hôpital. Good limestone could also be obtained very near the railroad, about 3 kilometers southeast of Mont-Rouis, near the place where sample 2 was collected. Many other reasonably accessible localities could supply limestone of satisfactory quality.

MATERIAL FOR CEMENT.

The Republic of Haiti probably contains an abundance of raw materials suitable for the manufacture of Portland cement, although present economic conditions do not favor their utilization.

According to the United States Geological Survey,[1] "The ordinary Portland cement mixture, when made from normal and natural raw materials, contains about 75 per cent of lime carbonate ($CaCO_3$) and 20 per cent of silica (SiO_2), alumina (Al_2O_3), and iron oxide (Fe_2O_3) together, the remaining 5 per cent including magnesium carbonate, alkalies, sulphur, and other unavoidable but unnecessary constituents." The United States Geological Survey states further[2] that the amount of silica present should be from two to three and one-half times the combined

[1] Eckel, E. C., Burchard, E. F., and others, Portland cement materials and industry in the United States: U. S. Geol. Survey Bull. 522, p. 41, 1913.
[2] Idem, p. 65.

amount of alumina and iron oxide. Magnesia should not exceed 3 or 4 per cent.

Occasionally a natural cement rock, an impure limestone of very nearly the right composition, is found, but generally it is necessary to mix different materials in proportions that will give a product of satisfactory chemical composition. As a rule, the calcium carbonate is supplied by limestone or marl, and the silica, alumina, and iron oxide by clay or shale. Free silica in the form of sand is highly undesirable, and chert greatly increases the difficulty of grinding. Grinding is much cheaper if all the ingredients are soft.

Pure limestone that would supply calcium carbonate is widely distributed in the Republic. Two typical analyses are given on page 501. Suitable clay or argillite is probably nearly as common. Analyses of two samples are given in the following table:

Analyses of materials that are possibly suitable for cement.

Sample No.	Silica (SiO_2).	Alumina (Al_2O_3).	Iron oxide (Fe_2O_3).	Lime (CaO).	Magnesia (MgO).	Carbon dioxide (CO_2).	Water (H_2O).	Total.
1	25.42	8.32	1.93	30.33	2.27	23.75	6.38	98.40
2	51.30	16.88	4.77	8.06	3.16	5.09	8.32	97.58

Sample 1 was obtained from a ravine near the bridge about 5 kilometers northeast of St.-Marc, on the road to Gonaïves. It represents the marl of Miocene age that underlies the surrounding valley and resembles other Miocene marls found at many places in the Republic. Sample 2 was obtained in a road cut about a kilometer south of the bridge over Les Trois Rivières near Plaisance, and represents beds of considerable thickness in the argillite, presumably of lower Cretaceous age, that underlies the Plaisance Valley and crops out elsewhere in the Massif du Nord.

Microscopic examination indicates that the samples contain little if any free silica (sand). The ratio of silica to alumina and iron in the two samples is very nearly the same, approximately 2.5 to 1, and is within the limits prescribed on page 501. However, the first sample contains a great deal of calcium carbonate and the second very little. In order to obtain a mixture of the composition specified on page 501, pure limestone, like that for which analyses are given on page 501, would have to be added to the marl (sample 1) in the proportion of about 80 parts by weight to 100 parts of marl. About 250 parts by weight of limestone would need to be added to the argillite (sample 2) to produce a similar mixture. However, materials that are chemically well proportioned do not always produce a good cement, and the results can be determined only by trial.

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