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

this area were tested by the Bureau of Public Roads of the United States Department of Agriculture for use in making concrete, with results as follows:

*Mechanical analyses showing fineness of two samples of sand from the North Plain.*

| Fineness. | Sample 1. | Sample 2. |
|---|---|---|
| Percentage of material passing ¼-inch screen, retained on 10-mesh..... | 1 | 9 |
| Percentage of material passing 10-mesh screen, retained on 20-mesh... | 3 | 35 |
| Percentage of material passing 20-mesh screen, retained on 30-mesh... | 18 | 38 |
| Percentage of material passing 30-mesh screen, retained on 50-mesh... | 52 | 15 |
| Percentage of material passing 50-mesh screen, retained on 100-mesh... | 21 | 2 |
| Percentage of material passing 100-mesh screen, retained on 200-mesh... | 3 | 0 |
| Percentage of material passing 200-mesh screen..... | 2 | 1 |
| | 100 | 100 |
| Loss by washing (silt and clay) in original.....Per cent.... | 1.5 | 0.5 |

When the sand was tested in concrete the results were as follows:

*Tests of sand in concrete.*

| | Sample 1. | Sample 2. |
|---|---|---|
| Strength compared to standard Ottawa sand [a] at end of 7 days..Per cent.. | 64 | 84 |
| Strength compared to standard Ottawa sand at end of 28 days.....do.... | 76 | 91 |

[a] "Standard Ottawa sand," used by engineers in the United States as a standard of comparison in testing sands for concrete, is a "natural sand from Ottawa, Ill., screened to pass a No. 20 sieve and retained on a No. 30 sieve." See Am. Soc. Civil Eng. Proc., vol. 75, p. 682, 1912.

Sample 1 was obtained from a sand bar in the bed of the Grande Rivière du Nord, at the southern edge of the North Plain, about 5 kilometers north of the town of Grande-Rivière du Nord. Quartz is the most abundant constituent, but there are considerable quantities of fragments of feldspar and limestone and some organic matter.

Sample 2 came from sand bars in the bed of Rivière Marion, about 2 kilometers west of Acul Samedi. It consists chiefly of angular quartz grains and minor amounts of feldspar, hornblende, and magnetite.

The Bureau of Public Roads states that these sands "are not as well graded as is considered necessary for first-class concrete work. Sample No. 1 is much too fine in grading to give the requisite strength for any type of Portland cement concrete construction and should not be used for that purpose. Sample No. 2 is somewhat coarser and might be used in concrete not requiring high strength, or if intended for first-class concrete construction it might be used with an additional amount of cement."

Coarser, better-graded sand could probably be obtained by searching the bed of Grande Rivière, or also from gravel pits at other places on the North Plain. Coarser sand was noted particularly near Le Trou. The deposits are extensive, and by proper screening, washing, and mixing could supply large quantities of good building sand.

Black sand derived from the disintegration of dark basaltic rock occurs in small amounts along some of the streams and more rarely on the beaches of the Southern Peninsula. A sample was obtained on the beach near the mouth of the Grande Rivière de Jérémie, where this sand is particularly abundant. It consists principally of fragments of dark basalt, augite, and magnetite, with a little calcareous sand. The magnetite constitutes perhaps 10 per cent of the sand. The screen analysis of this sand is as follows:

*Mechanical analysis showing fineness of black sand from beach near Jérémie.*

| | | | |
|---|---|---|---|
| Percentage of material passing | ¼-inch screen, retained on | 20-mesh.. | 6 |
| Percentage of material passing | 20-mesh screen, retained on | 28-mesh.. | 4 |
| Percentage of material passing | 28-mesh screen, retained on | 35-mesh.. | 9 |
| Percentage of material passing | 35-mesh screen, retained on | 48-mesh.. | 24 |
| Percentage of material passing | 48-mesh screen, retained on | 100-mesh.. | 55 |
| Percentage of material passing | 100-mesh screen, retained on | 200-mesh.. | 2 |
| | | | 100 |

This sand has been used in concrete at Jérémie, but the results are not known. It can not be very good for the purpose, as it is more poorly graded and much finer than either of the samples for which tests are given on page 508. If coarser, better-graded sand of this kind could be obtained it should be better than calcareous sand, although somewhat inferior to the siliceous sand.

Deposits of sand suitable for special uses demanding high purity or refractoriness, such as for glass making, molding, or the filtration of water supplies, probably do not exist in commercial quantities in the Republic of Haiti.

## SALT.

Almost all the salt used in the Republic is obtained by evaporating sea water with the natural heat of the sun. This salt is highly esteemed, is cheap, and is consumed in large quantities.

Salt works are easily constructed at almost any place where there is at least a narrow strip of low land near the shore. Large works near Gonaïves, Baie de Henne, and Grande-Saline were hastily examined. At all these places the salt water is evaporated in large square or rectangular pits, generally from 30 to 50 meters long and broad and 1 to 2 meters deep. The earth excavated from the pits is thrown up around them as an embankment to protect them from surface drainage or from tidal