

overflow. Many pits are constructed close together over a considerable area.

At Gonaïves, where the shore is low and flat and the soil is rather impervious, the sea water is admitted directly through open ditches, which are closed while the water is evaporating. Near Baie de Henne, however, where the pits are in a salty lagoon that is separated from the sea by an emerged beach of calcareous sand or in places by reefs of cavernous, coralliferous limestone, seepage from the sea is so effective that ditches are unnecessary. However, as the salt is deposited it tends to seal out the salt water, and after each harvest many stakes are driven into the bottoms of the pits to permit the salt water to fill them again. As more salt is deposited these holes are again sealed, and so on. A similar method is used at Grande-Saline.

When evaporation is sufficiently advanced workmen enter the pits and harvest the salt by hand, placing it in baskets. Usually it is dumped temporarily beside the pits (see Pl. XXXVIII, *C*), but if it must be stored for some time it is placed under shelter. Harvests are most frequent in the dry season, as at that time evaporation is most rapid. It is said that at Gonaïves the salt is sometimes harvested at intervals of only 18 days. As a rule, the interval is longer and may be as much as three or four months.

The salt obtained in this way is coarsely crystalline, and some of it is stained brown by impurities, but no further purification is attempted.

GUANO.

The Republic of Haiti contains numerous deposits of cave guano similar in many respects to those of other countries.¹ In 1909 the Government granted to Mr. O. P. Tommins, of New York City, a concession for the exploitation of these deposits in the arrondissements of Fort-Liberté, Grande-Rivière du Nord, Vallière, and Cerca-la-Source, notably at Cerca-la-Source.² The State was to receive a royalty of one-third of the product, and the valuation for purposes of taxation was placed at \$1.50 per ton at the custom house, Cap-Haïtien.

The deposits occur in ordinary caves in the limestone of the mountain sides. They seem to be most common in the limestone areas of the Massif du Nord, though they doubtless occur in other parts of the Republic. The caves in the Massif du Nord are well above the level of the present streams and are now dry. The guano is formed chiefly of the excrement of bats, which inhabit certain caves in great numbers. A considerable deposit has accumulated even very recently in the abandoned workings of the old mines at Las Lomas, where bats are especially numerous.

¹ For general discussion and references see "Nitrates" and "Phosphate rock" by Clarke, F. W., *The data of geochemistry*, 4th ed.: U. S. Geol. Survey Bull. 695, pp. 248-253, 515-526, 1920.

² *Le Moniteur*, No. 46, p. 314, 1909.

Three caves containing deposits of guano were examined. One is about 6 kilometers southeast of Cerca-la-Source, near the Sources Chaudes de Los Pozos. (See p. 562.) Its outlet with reference to the springs is shown in Figure 35 (p. 563). There are two small openings on the hillside at an elevation about 35 meters higher than the springs. One opening has been enlarged to facilitate entrance. The openings lead downward for about 20 meters into a large chamber from which there are several radiating passages. Although there were but few bats in the cave, the air was warm and foul with the odor of ammonia. The floor of some of the passages contained patches of fresh guano and elsewhere consisted of clayey earth mixed with decomposed guano. In one of the radiating passages a hole 1.2 meters in depth penetrated entirely through the guano and clayey earth to the rock beneath. A sample of the decomposed guano mixed with clay was obtained from the floor of another part of the cave.

The two other caves examined were near St.-Michel de l'Atalaye and are more fully described in connection with fossil bones found in the cave earth which they contain (see p. 257). In the larger cave there were very few bats and little indication of guano on the floor of the cave, which was covered with red clayey earth mixed at places with loose fragments of limestone. Two pits were dug in this cave, the deeper one less than 2 meters in depth. Neither pit approached the bottom of the cave earth, which may be 10 meters in thickness. A sample of red earth was taken from the deeper pit at a depth of about 1.5 meters.

The second cave near St.-Michel de l'Atalaye is smaller. There were many bats in it, and the floor of the rear part of the cave was covered by a deposit of fresh guano several centimeters in thickness. A pit dug at one side of the cave reached the sloping bedrock at a depth of about 1.5 meters. The deposit probably is 5 or 10 meters thick in the middle of the cave. Most of the guano is badly mixed with boulders that have been washed in from the opening of the cave. No sample was taken.

Analyses of the two samples of cave earth by the Bureau of Soils of the United States Department of Agriculture are given in the following table:

Fertilizing constituents in cave earth from the Republic of Haiti.

Source and kind of material.	Nitrogen (N).	Phosphoric acid (P ₂ O ₅).	Phosphoric acid as Ca ₃ (PO ₄) ₂ .
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Decomposed guano and clay from cave near Cerca-la-Source	0.365	13.07	28.4
Red earth from cave near St. Michel-de-l'Atalaye	5.02	10.21	22.2

According to the Bureau of Soils, "The analyses of both of these materials show that they would be of value for fertilizer, one of them running especially high in nitrogen and the other in phosphoric acid."

The nitrogen in these deposits seems to be clearly derived from the bat guano, and doubtless most of the phosphate is from the same source, though a part of that in the sample from the cave near St.-Michel de l'Atalaye might be derived from bones, which were found in abundance in one part of the cave (see p. 258) although not in the excavation from which the sample was taken for analysis.

Although the guano in these caves would make good fertilizer, it is not likely that it can be exploited commercially under present conditions because the caves are so inaccessible that charges for transportation would be prohibitive, because all the deposits observed are so small that they would not supply any large quantity for export and it is doubtful whether very large deposits exist, and because the guano even in a single cave differs so much in quality from place to place through mixture with earth and stones that a product of sufficient uniformity for export would be difficult to obtain. Nevertheless, if the use of fertilizer in the Republic should become popular or necessary the deposits might be of considerable value for domestic use.