rising thermal waters appear to mark places favorable for the deposition of manganese-bearing jaspers, but an easily replaceable wall rock, such as limestone, is probably essential to the formation of large ore bodies.

RESIDUAL CONCENTRATIONS OF IRON AND MANGANESE.

By WILBUR S. BURBANK and JOHN S. BROWN.

GENERAL FEATURES.

Residual deposits of iron and less commonly of manganese are found in regions of humid climate where rather basic igneous rocks or impure limestone have long been weathered. During the reconnaissance some residual concretionary deposits of iron and manganese were seen in regions of imperfect drainage. Although no commercially valuable deposits of this kind are known in the Republic, there are numerous deposits of ferruginous clay that have attracted attention and are often reported as "iron ores." Red residual clayey soils are common at many places, both on limestone and igneous rock, and are especially widespread in areas of massive impure limestone, either around sink holes or covering level country. Some of this residual clay makes an excellent agricultural soil, and at a few places, as near Grande-Rivière du Nord, it is used for making building bricks. Where the residual material is colored bright red or yellow by admixture of iron oxide it is sometimes used as a temporary paint on mud walls.

Chemical analyses of concretionary masses of iron and manganese and of iron-rich soils that were collected during the reconnaissance show that the particular deposits sampled do not contain commercial quantities of either iron or manganese. Two ferruginous residual soils, one from basalt and one from limestone, contained about 17 per cent of iron. Concretionary deposits of iron and manganese analyzed contained 3 to 4 per cent of manganese and 15 to 20 per cent of iron. These samples probably represent some of the richer concentrations of these oxides, and the results of the analyses indicate that the deposits are of no value. Small bodies of iron ore of commercial grade may be found, but probably no valuable large bodies.

IRON AND MANGANESE ON THE NORTH PLAIN.

The deposits on the North Plain that were examined are on the surface of a flat, slightly dissected savanna that lies 4 or 5 kilometers northeast of Acul Samedi. The plain, which here stands 60 to 80 meters above sea level, is floored with gravel of Quaternary age. The narrow stream valleys are entrenched in the plain deposits to a depth of 5 or 6 meters. The sediments consist largely of gravel and sand derived from the quartz diorite and include some beds of finer silty material. The deposits are lenticular and crossbedded and vary greatly in composition. They are nearly horizontal, parallel to the surface of the plain.

Where the drainage has been inactive the relatively insoluble constituents of these sediments have been left at the surface and the soluble ones have sunk into the porous gravels with the rain water. A typical section down through the gravelly or sandy deposits shows at the surface nodular concretions of iron and manganese oxides partly encrusting pebbles, quartz grains, and other unweathered material, but here and there cementing the sand into a hard mass. Below such a mass at many places there is a layer of reddish to yellowish residual clay, very sticky when wet, containing pebbles, sand, and quartz grains. This layer grades down to less weathered or unweathered gravel.

The iron and manganese oxides form rounded concretionary masses, some of them 10 to 15 centimeters in diameter, most of which contain considerable residual sand and fine gravel. Some of the concretions contain a large proportion of yellowish clay, the included material depending on the nature of the ground in which the concretions were formed. The iron occurs largely as yellowish or brownish limonite. The manganese minerals are brown or black and probably consist of wad and pyrolusite mixed with iron oxides. The concretions form only a very thin veneer, which rarely extends more than a few centimeters below the surface. They are scattered over an area that is probably 6 to 8 kilometers wide, but they contain little iron and occur in quantities so small that they are of no economic value.

Analysis of iron and manganese oxide concretions collected northeast of Acul-Samedi.

[Ledoux & Co., New York, analysts.]

	Per cent.
Fe	15.60
Mn	3.20
SiO_2	60.17
P	.026

The source of the iron and manganese is evidently the hornblende of the quartz diorite. The residual soil on the quartz diorite bedrock is described on pages 297-299.

Iron and Manganese Near Paul.

Iron and manganese oxide concretions appear to be rather widely distributed in the areas of igneous rocks in the Montagnes Noires and were seen near Paul along the trail from St.-Michel de l'Atalaye to Dessalines. About 3 kilometers northeast of Paul, just southwest of the first limestone range that borders the Central Plain, is a large savanna, much of which is underlain by a coarse dacitic porphyry that contains much hornblende. This rock is decomposed by weathering into several products, among them oxides of iron and manganese, which are derived mainly from the ferromagnesian minerals of the rock, hornblende and mica. These oxides, like

those in the deposits near Acul Samedi, become concentrated in the residual soil and form concretionary masses or encrust lumps of gravel, clay, and unweathered material. The iron occurs as brown or yellow limonite, and the manganese probably as wad and pyrolusite.

The oxides are mostly concentrated at the surface, where there are some lumps measuring 10 to 15 centimeters in diameter. An analysis of one of these lumps shows that they are similar to those found at Acul Samedi:

Analysis of iron and manganese oxide concretions collected near Paul.

[Ledoux & Co., New York, analysts.]

	Per cent.
Fe	20.15
Mn	4.40
SiO_2	47.04
P	.176

The deposits are richer in small, flat areas that have not been actively eroded, for on steep slopes or along gullies the products of weathering are washed away. The amount of manganese found more than one-half or at most one meter below the surface is not sufficient to form more than stains in the soil.

The area covered by such patches of residual oxides in the savanna northwest of Paul includes, perhaps, several square kilometers. In the large valley in which the village of Paul is situated float of similar material was seen, but no deposits were found in place.

These deposits, like those on the North Plain, are of no economic value.

Iron in the Southern Peninsula.

By John S. Brown.

Iron ores are reported to occur at several places in the Southern Peninsula, particularly near Anse d'Hainault and in section Plymouth, between Jérémie and Baradères. At both places there is some basis for the reports.

Residual deposits on basaltic rocks near Anse d'Hainault.

About 2 kilometers south of Anse d'Hainault the trail to Tiburon crosses a ridge of basalt that is perhaps a kilometer wide. The basalt has at places weathered to a conspicuous bright red soil that evidently contains considerable iron. A good exposure was found on a sea cliff at the north side of the ridge beside the trail. For 2 or 3 meters below the surface the rock is completely oxidized to red soil. Below that depth traces of the basaltic rock showing pronounced pillow structure are increasingly prominent and the red color is spotted more and more with gray and nearly disappears at a depth of 10 meters. Spheroidal masses of basalt seen here weather in concentric layers that are alternately red and gray. The sample taken for analysis is probably considerably richer in iron

than the rock in most of the oxidized zone. An analysis by Ledoux & Co., New York, of the residual soil on basalt near Anse d'Hainault showed that it contains 17 per cent of iron.

A concentrated deposit of particularly rich red clay containing some hematite was found covering a few square meters on the south slopes of the hill. It was probably concentrated by leaching and by the sorting action of running water.

The area of less oxidized ferruginous soil includes possibly several square kilometers but contains no ore of commercial quality.

Other exposures of basalt that break down into similar red hematite-bearing earth were noted in sea cliffs between Chardonnières and Les Anglais and west of Les Anglais. More promising deposits may perhaps be found in some of the areas of basaltic rocks.

RESIDUAL DEPOSITS ON LIMESTONE BETWEEN JÉRÉMIE AND BARADÈRES.

The other type of deposit also is residual but is found in areas of massive upper Eocene limestone, particularly in the region between Jérémie and Baradères. The limestone breaks down first into a soil that is colored red by ferric oxide. An analysis by Ledoux & Co., New York, of this residual soil on limestone about 10 kilometers west of Baradères showed that it contains 16.80 per cent of iron.

Further action on this soil by percolating water produces here and there lumpy concretions of hard brown limonite or hematite. Most of the lumps are less than 2 centimeters in diameter but some are much larger. A few lumps about 10 centimeters long were seen. Running water frequently washes away the loose red soil and concentrates deposits of little limonite pebbles in the gullies. Such deposits are of no commercial value. It is barely possible that material concentrated as cave breccia in the numerous sink holes might be of better grade.

NONMETALS.

By JOHN S. BROWN and WENDELL P. WOODRING.

LIGNITE.

The Republic of Haiti contains probably the most extensive deposits of lignite in the West Indies proper. The largest potential lignite field is in the northwestern part of the Central Plain near Maïssade, but there are other deposits near Camp Perrin, in the arrondissement of Les Cayes. Beds of impure lignite and carbonaceous clay in the Asile Valley are mentioned on page 229. Beds of black chert in upper Eocene limestone (see p. 134) and pieces of carbonized wood in Miocene beds have led to reports of deposits of lignite. The Miocene deposits are the only ones in the Republic that were laid down under conditions favorable for the accumulation of vegetable débris. Miocene rocks in regions not explored during