A Ground-Water Reconnaissance of the Jacmel-Meyer Beach, Haiti

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INTRODUCTION

The Jacmel-Meyer bench lies on the south coast of the southern peninsula of Haiti in the Departement de l'Ouest. Jacmel, at the west end of the bench, is about 40 kilometers airline southwest of Port-au-Prince.

In the early part of January 1949, the writer in company with Mr. Rémy Lemoine made a reconnaissance study of the ground-water conditions of the bench. The object of the reconnaissance was to determine the availability of ground water for irrigation of the bench as well as for the public water supply of Jacmel. Irrigation is practiced on the bench, but the existing water supplies are insufficient to cover all irrigable lands. Jacmel is at present supplied with water from a pipe line that delivers the flow of several developed springs to the city by gravity. However, this supply is inadequate and probably at times is contaminated.

TOPOGRAPHY AND DRAINAGE

The Jacmel-Meyer bench is roughly triangular in outline. (See accompanying map) It is limited on the south by the Caribbean Sea and on the west by Jacmel Bay and the valley of the Rivière Gosseline. The mountains of the Massif de la Selle border it on the north. At the east end of the bench a spur of these mountains extends south almost to the sea. The bench is about 9 kilometers long from east to west. Near its western end it attains a maximum width of about 5 kilometers but narrows gradually to a width of only 500 meters at its eastern end.

Along its southern and western coastal margins the bench is bordered by cliffs that rise abruptly from the sea to elevations of 15 to 35 meters. Bluffs that rise 10 to 25 meters from the valley of the Rivière Gosseline mark the western limit of the bench. From the margins of the coastal cliffs and the bluffs near the Rivière Gosseline the surface of the bench slopes gradually upward to elevations of about 60 to 90 meters above sea level along the base of the mountains. The surface of the bench is generally smooth and little dissected except by ravines along the coastal margins and by the Rivière des Orangers and Rivière Meyer which follow narrow, shallow ravines cut to depths of 5 to 15 meters.

The principal streams that drain the bench are the Rivière des Orangers and the Rivière Meyer. These rise on the southern slopes of the mountains at elevations of 400 to 600 meters above sea level. In their higher watersheds each of these streams carries a small perennial flow fed by spring discharge. The spring-fed flow of the Rivière Meyer is all diverted for irrigation during the dry seasons. Some of the springs of the Rivière des Orangers are developed for the public water supply of Jacmel, but the rest of the spring-fed flow is diverted for irrigation. In their lower courses both streams are intermittent and dry during long periods in the seasons of low rainfall. Both streams may carry large flash floods at times during the rainy seasons. On such occasions the Rivière des Orangers may flood the lower parts of Jacmel.

PRECIPITATION

The average annual rainfall of the Jacmel-Meyer bench and of the adjacent area is comparatively abundant as judged by standards for the Temperate Zone. However, owing to the prevailing high temperatures characteristic of the tropics the evaporation rate is high. Moreover, as is true of much of Haiti the rainfall is markedly seasonal. Two well-defined rainy seasons occur during the year, but the soil moisture built up during these is rapidly depleted in the long hot dry seasons that follow. Consequently, irrigation is necessary to assure the growth of crops during these periods. As based on 42 years of record the mean monthly and annual rainfall at Jacmel is as follows:

Rainfall at Jacmel, in Millimeters

January.....	36.3	July.....	72.2
February.....	44.3	August.....	126.7
March.....	90.6	September....	139.7
April.....	133.0	October.....	156.9
May.....	206.7	November.....	77.9
June.....	123.7	December.....	26.5

Year.....1234.5

The rainfall at Jacmel is probably representative for most of the Jacmel-Meyer bench. However, the southern slopes of the Massif de la Selle just to the north of the bench may receive half again as much rainfall as Jacmel.

GEOLOGY AND WATER-BEARING CHARACTER OF THE ROCKS

The rocks of the Jacmel-Meyer bench and of the surrounding area range from Cretaceous to Recent geologic age. The oldest rocks of the area are chiefly dark gray and brown basalts with some interbedded sandstones, limy shales, and tuffs of probable late Cretaceous age. The areas of outcrop of these rocks observed during the present reconnaissance occur in the foothills of the Massif de la Selle and are indicated in the accompanying map. Other outcrops not observed may occur in the deep ravines to the east of the headwaters of the Rivière Meyer and elsewhere. The Upper Cretaceous rocks are generally dense and indurated and in most places are deeply disintegrated by weathering. Because of these characteristics they would probably yield little or no water to wells or springs. In the Jacmel region they form a relatively impervious basement beneath overlying younger rocks.

Resting unconformably on an irregular erosion surface cut in the Upper Cretaceous rocks are massive jointed gray and white limestones of late Eocene age. These rocks crop out extensively on the southern slopes of the Massif de la Selle where they form the principal surface rock. They dip southward at angles of 15 to 30 degrees and pass beneath younger sediments of the Jacmel-Meyer bench. The upper Eocene limestones are moderately soluble in water weakly charged with carbonic acid. Commonly, in surface outcrops the limestone is pitted and fretted by solution. Moreover, the joints and bedding planes of the rock are generally enlarged by the dissolution of percolating water which in many places has

also formed extensive tubular solution passages. Through these openings in the upper Eocene limestones there is evidently active circulation of ground water. Several springs of moderate to large flow emerge from such openings in upper Eocene limestones in the headwaters of the Rivière des Orangers and the Rivière Meyer. The springs rise in deep ravines or canyons from the limestones generally at or slightly above the contact with the underlying impervious Upper Cretaceous rocks.

Overlying upper Eocene rocks to the northwest of Jacmel are sediments of Pliocene age which crop out at the surface in a belt along the Rivière Gauche. This belt extends southeast to the Rivière Gosseline about 3 kilometers north of Jacmel. Near the mouth of the Rivière Gauche and along the Rivière Gosseline the Pliocene sediments consist principally of semi-consolidated conglomerates, sandstones, siltstones, and marls. In this vicinity the beds dip southwestward at angles of about 10 to 25 degrees. Similar Pliocene sediments probably extend beneath Jacmel and the western part of the Jacmel-Meyer bench but are largely covered by younger Pleistocene and Recent deposits. The finer grained facies of the Pliocene sediments such as the siltstones and marls have low permeability and little capacity to store or transmit water. However, some of the conglomerates and sandstones are moderately permeable and where present in the zone of saturation may produce good yields of water to wells. Apparently no wells have as yet been drilled into the Pliocene sediments in the Jacmel area, and no springs that issue from these sediments were observed during this reconnaissance.

The Jacmel-Meyer bench is directly underlain by marine and non-

marine sediments of probable Pleistocene age. These rest unconformably on older Pliocene, upper Eocene, and Upper Cretaceous rocks. Along the coastal margin of the Jacmel-Meyer bench the Pleistocene consists of white and yellowish, massive, cavernous corraline limestone that forms cliffs rising 15 to 35 meters above the sea. This rock directly underlies Jacmel as well as most of that part of the bench south of the Jacmel-Meyer road. North toward the inland margin of the bench and the base of the mountains the limestone appears to grade into stream-laid gravels, sand, and silt. These deposits are semi-consolidated and commonly near the surface are cemented by secondary calcium carbonate or capped by caliche. The Pleistocene deposits appear to dip gently south toward the sea generally at angles of less than 5 degrees. The cavernous coralline limestones are moderately to highly permeable and where present in the zone of saturation yield moderate to abundant supplies of water to wells. At Usine Madsen in Jacmel, well No. 1 (see accompanying map) obtains a good yield from saturated material in this type of rock. The stream-laid gravels and sands also appear to be moderately permeable and where saturated should yield good supplies of water to wells.

The youngest deposits of the region are Recent unconsolidated alluvial gravels and sands in the lowest parts of the valleys of the Rivière Gauche and Rivière Gosseline. These deposits doubtless carry a considerable ground-water underflow that could be readily tapped by shallow wells of moderate to large productivity. Recent alluvial deposits also thinly mantle Pleistocene sediments of parts of the Jacmel-Meyer bench especially along the channels of the Rivière des Orangers and the Rivière

Meyer. However, they are generally no more than a few meters thick and are probably above the zone of saturation.

GROUND WATER

General Features

The ultimate source of ground water in the rocks of the Jacmel-Meyer bench and of the surrounding area is rainfall. Most of this runs off in streams to the sea or returns to the atmosphere by evaporation and by transpiration of plants. However, a considerable part seeps underground where permeable rocks crop out at the surface. In this manner the principal aquifers of the region are replenished each year during rainy seasons. Such aquifers sustain the dry-season flows of the springs.

Owing to the diversity of the rock structures and of the rock types of the region, there is probably more than one system of ground-water circulation. One such system appears to exist in the upper Eocene limestones. Because of their high permeability and large areal extent on the south slope of the Massif de la Selle, these rocks receive a relatively large infiltration from rainfall. In the mountain area the ground-water derived from such infiltration appears to move chiefly through the basal part of the upper Eocene limestones. Where erosion has cut through these limestones to or near the underlying impervious Upper Cretaceous rocks, some of this water is returned to the surface in springs such as those of the Rivière des Orangers and the Rivière Meyer. However, a considerable quantity of the ground-water probably moves down dip and southward through the undissected limestones passing

beneath the Jacmel-Meyer bench where the water may leak upward into permeable Pliocene or Pleistocene sediments.

Where they crop out at the surface the Pliocene and Pleistocene sediments also receive water by infiltration from rainfall or from streams. The water thus received moves underground through the permeable strata and discharges at the edge of the sea or in submarine springs.

Over most of the area of the Jacmel-Meyer bench the regional water table may lie at considerable depth below the surface. South of the Jacmel-Meyer road it is probably generally more than 20 meters below the surface except immediately along the coast. However, the peizometric surfaces of deep aquifers may be considerably above the regional water table of the bench.

The ground-water underflow in the Recent alluvium of the valleys of the Rivières Gosseline and Gauche and the Grande Rivière de Jacmel is derived essentially from the infiltration of these streams. In the lower parts of these valleys the water table is probably within a few meters of the surface.

Well and Springs

During the present reconnaissance all of the existing wells and most of the important springs of area were visited. Only one operating well was observed during the reconnaissance. Apparently the inhabitants of the bench have made little or no attempt to develop water from wells even for domestic or stock use. Springs are used almost exclusively for water supplies.

Well No. 1 (see map) at the Usine Madsen in Jacmel is located only about 50 meters from the shore line and 3 meters above sea level. The well is 3 meters in diameter and is dug, uncurbed to a depth of 3.2 meters in cavernous Pleistocene coralline limestone. The static water level is 2.6 meters below the surface or only 0.4 meter above sea level. The well is equipped with a piston pump and yields about 19 liters per second with a drawdown of only about 0.10 meter. The water temperature is 26 degrees Centigrade, and the water is of good quality. The well was dug in 1944 and has been in more or less continual use since then with no evidence of salt-water contamination from the sea.

Well No. 2, reportedly dug in French colonial times, is now caved or filled and dry at a depth of 5 meters. The well is evidently dug in permeable material because it is now used as a seepage sump for a surface drainage canal. The well located on the Jacmel-Meyer bench is approximately 40 meters above sea level.

Well No. 3 was also dug in the French colonial period and is thus more than 150 years old. The well is 3 meters in diameter and curbed with stone. It was dry at a measured depth of 18.7 meters when visited but may be caved or filled in the bottom. The well is about 42 meters above sea level and is located about 300 meters west-northwest of well No. 2.

Two groups of perennial springs were visited during the reconnaissance; those of the Rivière des Orangers and those of the Rivière Meyer and its tributaries.

Springs No. 1 - 5 or Sources Orangers rise along the channel of the Rivière des Orangers about 4-1/2 kilometers northeast of Jacmel. The springs all issue from cavernous or jointed upper Eocene limestone. Impervious Upper Cretaceous basalt crops out a short distance away on the north slope of the canyon of the Rivière des Orangers suggesting that ground-water in the upper Eocene limestone is forced to the surface at or near the contact with the older rocks. There are five principal spring heads in the Orangers group all of which are located within about 200 meters of one another. Each spring head is developed and covered with a concrete box, and the flow of each is led into a covered masonry canal which empties into a small concrete collecting tank. A 12-inch lock joint pipe line delivers the water from this point to Jacmel by gravity. Because the system is closed and all of the spring heads are completely covered, the total amount of water delivered to Jacmel could not be estimated.

A number of smaller undeveloped springs issue from the upper Eocene rocks in the same general vicinity as Sources Orangers. The aggregate dry-season flow of these may be about 20 to 30 liters per second all of which is diverted for the irrigation of lands along the Rivière des Orangers.

Three springs of moderate to large size supply most of the dry season flow of the Rivière Meyer. These are: Source Barnave, Source Neuve and Vieille Source. Source Barnave (No. 6) rises about 10 meters from the channel of the Rivière Meyer in a small ravine. The spring emerges from a solution cavern 1 to 1-1/2 meters in diameter in massive

upper Eocene limestone at the contact with impervious Upper Cretaceous basalt. The spring discharge was estimated at 60 liters per second. The temperature of the water is 23 degrees Centigrade.

Source Neuve (No. 7) also issues from a solution passage 50 centimeters to 1 meter in diameter in upper Eocene limestone apparently not much above the contact with the Upper Cretaceous rocks. The spring is located in the bottom of a deep ravine near the head of a tributary of the Rivière Meyer. The spring discharge was estimated at 70 liters per second. The water has a temperature of 22.5 degrees Centigrade.

Vieille Source (No. 8) is located in ravine tributary to that of Source Neuve. The spring emerges from a bedding plane and a joint in massive upper Eocene limestone directly avove weathered impervious Upper Cretaceous basaltic sandstone. The discharge of the spring was estimated at 3 liters per second. The temperature of the water is 25 degrees Centigrade.

All of the springs of the Rivière Meyer are reported to increase in flow during the rainy seasons. The flow is diverted from the channel of the river for the irrigation of lands on the Jacmel-Meyer bench near Meyer.

Two other springs; Source Diamant and Source La Rousée, are reported to rise in the deep ravine next east of the headwaters of the Rivière Meyer. These are used for the irrigation of lands in the eastern part of the bench.

CONCLUSIONS

Additional Sources of Water for Jacmel

The present water supply of Jacmel obtained from the Sources Orangers is inadequate for the needs of the city especially during the dry seasons when the discharge of the springs is low. In the rainy seasons the supply may be contaminated from time to time and may carry considerable sediment. It is reported that many residents of Jacmel obtain drinking water from well No. 1 during these periods.

Additional water supplies could be obtained by one or more wells drilled in or near the city. One favorable locality for drilling such a well would be near the eastern end of the city at the entrance of the Jacmel-Meyer road. In this vicinity it is believed that one or more productive water-bearing strata could be tapped by drilling to depths of 60 to 80 meters in Pleistocene or Pliocene sediments. In the lower parts of the city such strata could probably be tapped at shallower depths.

In the valley of the Grande Rivière de Jacmel just west of the city relatively abundant water supplies could be obtained by wells less than 20 meters deep in unconsolidated Recent alluvium. However, from such wells it would be necessary to lift water 20 to 30 meters by pumping to supply the higher parts of the city.

One well with a pumping installation would give a more than adequate supplemental supply to that of the present gravity system from Sources Orangers.

Irrigation Supplies for the Jacmel-Meyer Bench

During the dry season irrigation of parts of the Jacmel-Meyer bench is carried on by diversion of the flows of springs of the Rivière des Orangers, and the Rivière Meyer, and of the Sources Diamant and La Rousée. The available flow is adequate to cover only small parts of the irrigable area. With the present primitive systems of irrigation considerable water is wasted or seeps away in unlined ditches before it can be applied to the land. Much of the water loss could be recovered by improving ditches as well as by improved irrigation practices.

The geological studies made during the present reconnaissance indicate that water-bearing strata sufficiently productive for irrigation should be present beneath the Jacmel-Meyer bench. It is believed that one or more test wells to explore these strata would be justified. Suggested localities for such drilling are 2, 4 and 6 kilometers east of Jacmel along the Jacmel-Meyer road. The wells should be drilled to depths of 80 to 100 meters for adequate exploration. If the results of this drilling prove favorable additional wells can then be put down in other parts of the bench.

Port-au-Prince, Haiti
January 13, 1949

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