THE GEOLOGY OF CUBAN PETROLEUM DEPOSITS.

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I. INTRODUCTION.

The earliest known discovery and use by white men in the New World of any member of the petroleum family is probably that made by Sebastian Ocampo in the Bay of Havana, Cuba, in 1508. Ocampo found on the waters of the bay a "liquid bitumen" with which he careened his ships and as a result of this circumstance called the bay "Puerto de Carenas", a name which it bore until 1519, when the city of Havana was moved from its original foundation on the south shores of the island to its present site and the name of the bay changed in conformity.

Oviedo, in 1535, mentions a spring of "pitch" near the coast in the province of Puerto Príncipe and another on the shores of Havana Bay. The asphalts, whose occurrence in Cuba is widespread, were probably well known during colonial times and petroleum itself was not unknown during that time, since Humboldt, who visited the island during the early part of the last century, mentions the occurrence of petroleum springs in the serpentines of Cerro de Guanaboca (sic.) and the reported occurrence of petroleum springs in the eastern part of the island. The baths of Santa Rita in Guanabacoa, famous during the colonial epoch, consist of springs of medicinal waters coming from crevices in the serpentinite. The most medicinal of these springs seems to be the one accompanied by exudations of a petroleum of fairly good quality.

La Sagra published, in 1828, an extended account of the asphalt deposits near Havana. Navarro published, in 1829, an account of various bituminous deposits, and in 1837 R. C. Taylor

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1The references in this paragraph are taken from T. Wayland Vaughan's "Bitumen in Cuba," p. 344, Eng. & Min. Jour., Mar. 8, 1902.
described certain asphalt deposits near Havana as coal. In 1857, Moisant published a "Memoria sobre los Productos Bitumenosos".1

The various asphalt deposits were worked extensively during the latter half of the last century, but, with the increase in production of asphaltic residuums by oil refineries during the present century, the mines have been abandoned until not a single one is being extensively worked at present, and Cuba imports rather than exports asphalt.

During 1880 an enterprising Spaniard, one Manuel Cueto, who had observed gas escapes in the Motembo vicinity, commenced drilling a well at that place, and on August 18, 1881, he succeeded in striking a deposit of natural naphtha.

From 1890-96, Alvarez and associates drilled several wells in the Lagunillas district west of Cardenas and succeeded in developing a well which is said to have produced 100,000 gallons of oil.

In 1901, a report on a geological reconnaissance of Cuba was made by Hayes, Vaughan and Spencer. The various mineral resources of the island, including asphalt and petroleum occurrences, were visited, previous literature reviewed insofar as possible, and the occurrences described.2 E. Peckham in the same year described various oil and asphalt occurrences in the vicinity of Cardenas.3

On December 5, 1913, a considerable flow of gas was encountered in a well being drilled for water on the grounds of the Tropical Brewing Company at Puentes Grandes, a western suburb of Havana.

During the latter part of 1915 the discovery well of the Union Oil Company, at Bacuranao, was brought in.

Recent complete reviews of oil operations in the island have

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been made by P. K. Gillespie and an anonymous writer who is well acquainted with his subject.

Wells resulting in appreciable flows of oil or gas have been drilled at five points on the island, in order of their discovery as follows: Montembo on boundary between Matanzas and Santa Clara, the Alvarez or Felicidad properties some 6-7 miles west of Cardenas, the Shaler Williams property at Guayabal, some 25 miles west of Havana; at Puentes Grandes, a western suburb of Havana, and at Bacuranao, near Minas, some 10 miles east of Havana.

Small amounts of gas are produced from the Montembo and Shaler Williams wells and approximately 130 barrels per day of oil of good quality is being produced at the Bacuranao properties. This constitutes the commercial production of Cuba at the present time.

A number of unsuccessful wells have been drilled at various points on the island. These operations will be reviewed in greater detail at another place in this paper. Interest in the oil possibilities of the island seems to be greater at present than at any previous time and several of the larger American companies are either investigating properties or carrying on actual operations.

Oil rights pertain to the Government, as in most Spanish-American countries, and are secured by denunciations or filing on claims according to regulations set forth in the Mining Code. Denunciation may be made by any person or legal corporation, native or foreign, and subsoil titles are perpetual and transferrable quite the same as are surface titles. The cost of completing denunciation, including fees, taxes, official survey, etc., in blocks of 1,000 hectares, is approximately $3.75 per hectare (2.471 acres) and the time required to complete title, according to past practice,
is about 12 to 14 months. The greater part of the province of Havana, where excitement centers at the present time, is already under denouncement.

The author visited oil prospects on this island in 1913 and 1914, and in 1915 spent several months mapping the geology of certain areas in Havana and Pinar del Rio provinces and visiting various oil indications. Acknowledgment is due and is gratefully rendered to Messrs. E. B. Hopkins, Ben C. Belt, Victor E. Gothe, and numerous others for information furnished. The author further acknowledges with thanks, the permission of J. B. Body, Esq., to make public certain information contained in the present paper.

II. GEOLOGY.

Generally the geology of Western Cuba is well exposed, but parts of it are so complicated that its exact expression would require the most detailed mapping. For the purpose of this brief paper, however, the main structural and stratigraphic features may be described as follows:

There are five great groups of rocks which make up the eastern half of the island and which are, for the most part, structural, if not stratigraphic, units. The oldest rocks are apparently the schists, slates, limestones, granites, etc., which have been termed the basal complex. They are of unknown age, possibly including Paleozoic rocks, and with them, for convenience in maintaining the structural grouping, are included the serpentines which are probably of Cretaceous age. The second group consists of an enormous thickness of Jurassic limestones and the third group of various Cretaceous formations consists of marls, shales, sandstone, grits, conglomerates, arkoses, and limestones, generally severely faulted and folded and greatly metamorphosed in certain localities.

The preceding groups are generally closely folded and are

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6The various mining laws have recently been compiled and published under the title, "Disposiciones Vigentes para la Adquisicion de la Propiedad Minera y la Explotacion de sus Riquezas", Habana, Rambla Bouza y Cia., 1915. This edition is official.

overlain unconformably by the third group consisting of various Tertiary formations, for the most part limestones, showing comparatively low dips wherever observed. The fourth group consists of igneous rocks younger than the serpentines and perhaps including Tertiary intrusives. The fifth group includes coral limestones of Quaternary to recent age, terrace gravels, soils, beach sands, and alluvial deposits of recent age. They are of little or no importance in consideration of the petroleum geology but are included to complete the section.

**Stratigraphy.**

*Basal Complex or Protaxis of the Island.*

The oldest rocks in the island, and the basement upon which the succeeding geological formations were laid down, consists of highly metamorphosed rocks; schists, slates, limestones, and marbles. They outcrop in a large area in the southern part of the province of Santa Clara and the formation is reported to include granites near the south end of the harbor of Santiago de Cuba, near the eastern end of the island, and south of Santa Clara. The Santa Clara granite is apparently the source of the 300 feet of granite arkose encountered in Menendez Well No. 1 of the Cuban Oil Company.

Outcrops of this formation are not known west of the longitude of Cienfuegos, but small patches are doubtless included with the serpentines and more recent igneous rocks which outcrop over wide areas to the westward.

Into the older rocks, as well as the Cretaceous and Jurassic rocks, have been intruded, at several different periods, various igneous rocks, for the most part basic, which have subsequently been largely altered into serpentine.

The serpentines outcrop in every province of the island, the westernmost exposures known to the author being southwest of San Cayetano in the province of Pinar del Rio. Other serpentine masses outcrop along the axis of the island, on the northern flank of the Sierras Rosario and Organos in Pinar del Rio; west of Bahia Honda, where the Moralillo well of the Cuban Petroleum Company, Ltd., is reported to have encountered serpentine at 30'

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feet and continued in it to 1,811 feet, at which point the well was abandoned; near Martin Mesa and Boyer, north of Guanajay; at Puentes Grandes, west of Havana, where it was encountered at depths of about 60 feet in wells drilled on the grounds of La Tropical Brewing Company; in a large area extending from the east side of Havana Bay at Regla to a point about midway between Campo Florida and Jaruco; intermittently along this same line to Matanzas; at a point south of Colisco; in the Tetas de Camarioca, west of Cardenas; at Sabanilla de la Palma; Motembo, and over wide areas in Santa Claus, Camaguey, near Holguin, and eastward.

The various wells of the Union Oil Company at Bacuranoa were drilled into serpentine and a nearby well, that of A. C. Landes, et al., was drilled to a depth of 1,232 feet, reporting serpentine throughout. The various wells drilled by the Cuban Oil Company, west of Cardenas, encountered serpentine at depths of 790, 1,040 and 1,835 feet respectively, and the wells of Manuel Cueto and the Cuban American Oil Company, at Motembo, were drilled in a serpentine area which had been subjected to later intrusions. Wells were also drilled in serpentine to depths of 1,392 and 743 feet respectively, by the Cuban Petroleum Company, Ltd., at Anton Díaz, some four miles west of Santa Clara.

It should be noted that all oil which has yet been produced in Cuba, with the exception of the Shaler Williams well, has come from "sands" at the contact between the serpentine and the overlying sedimentary rock or from the serpentine.

It is also worthy of attention that most of the asphalt deposits and oil seepages occur in areas of serpentine. Along the contact of the serpentine and sedimentary outcrops, but well within the serpentine area, one often finds lenses or patches of limestones impregnated with oil or oil residue. This limestone is similar to the Cretaceous and Jurassic limestones and was evidently caught up at the time of intrusion by the igneous rock from which the serpentine was derived. Since the arkose and conglomerates of the basal Cretaceous in Santa Clara contain serpentine pebbles, there would seem to be serpentines of several distinct ages.

*This was shown to me at the Pelecidad denouncements near Cardenas by the late Dr. C. Willard Hayes.*
The serpentines have been intruded in turn by various igneous rocks. A dyke of diorite (?) cutting the serpentines in the outcrop east of Havana is well exposed by a quarry between Regla and Guanabacoa. Along the walls of the dyke and through crevices in it considerable oil seeps to the surface.

**Jurassic.**

*Vinales Limestones.*

The axial portion of the Sierra Rosario and Sierra Organos, in the province of Pinar del Rio, is a thick massive limestone of Jurassic age*. This limestone is hard, blue, and cut by a fine network of thin calcite veins. It is quite soluble and cavernous and under proper conditions would probably form an excellent reservoir for oil.

From a rapid examination of the section between Pinar del Rio and La Esperanza, it is estimated that at least 2,500 feet of limestone are exposed and the base of the formation is not seen.

This formation is believed to have been encountered in the Menendez well of the Cuban Oil Company, near Itabo, Matanzas province, which entered it at a depth of 350 feet and was still in it at 2385 feet when the well was abandoned. It has been suggested that the great thickness of limestone shown in this well is the result of drilling into a steeply dipping Cretaceous limestone such as outcrops in the vicinity of Coralilla, to the southeast of the property. The author does not believe such to have been the case. No fossils were found but the formation was lithologically identical with the Vinales limestone from known outcrops, the drilling of the well was accompanied by no crooked hole tendencies such as is usually the case when a well is being drilled in steeply dipping formations, and lastly the overlying granitic arkose was probably basal Cretaceous, thus fixing the upper limit of the possible age of the formation.

No occurrences of the Vinales limestone east of the Mendez well are known to the author though it may be involved in the complex in the northern part of Santa Clara province between Santa Clara and Camajuani.

CRETACEOUS

Formations believed to be of Cretaceous age possess an extensive development in this Island. The only available fossil determinations are from the province of Santa Clara and from near Santiago de los Baños, province of Pinar del Río. The last named occurrence is in a formation believed by the author to belong to the Lucero beds. The various formations believed to belong to the Cretaceous will be described as the Cayetano formation and its possible stratigraphic equivalent, the Camajuani; the Layano marls, and the Lucero beds.

CAYETANO FORMATION

The Cayetano formation is a name suggested for the reddish argillaceous schists, phyllites, and shales with occasional sandstones and limestones which overlies the Vinales limestones on the north and south flanks of the mountain range between Pinar del Río and La Esperanza. The formation along the road connecting these two places is excellently exposed and consists of ridges of folded reddish schistose or slaty shales in its upper portion and very closely folded, crumpled, and faulted schists, sandstones, and limestones near its base. All of this formation is of red color with the exception of occasional beds of purple and blue shales and a heavy bed of gray limestone, which occurs several hundred feet above the base.

The heavy limestone outcrops near Sumidero, north of Pinar del Río, and may be part of the Vinales limestone brought up by faulting rather than a part of the Cayetano formation.

A company formed by Mariano Medina, and financed by ex-president Jose Miguel Gomez, drilled a well starting in this formation at La Esperanza, on the north coast of the Island. This well is variously reported to have reached depths of 1100-1400 feet.

and, from the apparent general structure, one would have expected it to encounter only rocks of the Cayetano formation throughout. At the time of the author's visit in 1915, however, the well was only 830 feet deep and had encountered but little limestone, probably the Vinales, from a very shallow depth downward.

**Camajuani Formation.**

Cretaceous formations consisting of a basal bed of arkose and of a fossiliferous hard grayish limestone immediately above, followed by various limestones and shales, outcrop over a wide area in the northern part of Santa Clara province. The age of this formation has been determined as Cretaceous by Vaughan who found such typically Cretaceous fossils as Barrettia, Requienia, etc.

The basal arkose is composed very largely of material derived from the serpentine and granite. The 300 feet of granitic arkose found in Menendez Well No. 1 of the Cuban Oil Company is apparently the basal arkose of the Cretaceous in this area.

**Luyano Marls.**

At Luyano in the vicinity of Havana and near Mariel, as well as at other places, a series of white marls, shales, limestones and grits outcrop. Though one cannot be quite sure of stratigraphic position and relations where the rocks are so severely folded as in the areas of Cretaceous outcrop, this formation is believed to be the equivalent in part of the upper Cayetano or overlying the Cayetano, and to be in turn overlain by the Lucero beds.

The white marls or chalks are the predominating feature of the Luyano though grits in beds of 25 to 30 feet thick and some thinner conglomerates have been observed. The thickness of the formation is not known, only some 150 to 200 feet having been observed continuously because of the severe folding and frequent faulting, but the formation is probably much thicker. The gas producing rock in the well at Puentes Grandes is probably of this formation.

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"U. S. Geol. Survey, Prof. Paper No. 71, p. 643."
Lucero Beds.

Apparently overlying the Luyano marls conformably is a series of alternating thin bedded shales and sandstones containing occasional thick beds of sandstone, conglomerates, grits and occasional limestones. This formation is well exposed at various points over a wide area but may be seen as well at kilometer 8 on the Guines Branch of the Havana Central Railroad as at any other point. The formation is here typically thin bedded, folded and faulted and has the characteristic yellow and tan colors due to weathering. On a rough estimate, some 250 to 300 feet of strata are exposed though the formation is doubtless much thicker.

At its various outcrops, where the serpentine comes in contact with sedimentary rocks, the contact formation is usually Lucero beds. It is often metamorphosed, a condition that is particularly noticeable in the outcrops between Guanajay, Bahia Honda, and westward. It contains some conglomerate, including serpentine and limestone pebbles. In most places the outcrop forms a more or less narrow belt around the edge of serpentine outcrops indicating that the igneous rock, from which the serpentine was derived, was generally intruded into this formation.

The Lucero beds have been encountered by most of the wells drilled in the Island except those starting in the serpentine. The oil produced in the Shaler Williams well may come from this formation. A well was drilled by the Havana Oil Company to a depth of 1850 feet at a point about 8 miles south of Mariel Bay and started in this formation. The author has not been able to consult the record of formations penetrated by this well, but noticed some serpentine among various materials in the slush pit. The well encountered some gas and oil and considerable quantities of salt water.

Bejucal Limestone.

In the central part of Havana province at Bejucal and eastward, a thick series of limestone interbedded with calcareous shale and marl out crops.

The middle and lower parts of the formation contain considerable beds of shale, a condition which is of very great importance since it affords one of the most satisfactory cap rocks
to be found in the Cuban section and suggests a possibility of
the existence of conditions favorable to oil accumulation.

The age of this formation is not known since no fossils have
yet been encountered but, as it is believed to be younger than the
Yumuri limestone, an Eocene age is tentatively ascribed to it.

The thickness of the formation is not known but it is be­
lieved to be 3,000 to 3,500 feet. Two wells are being drilled by
the Antillian Corporation at points 11 1/2 miles south of Havana
and 26 miles southeast of Havana. These wells, according to
last report were 3000 and 2825 feet deep respectively, and are
believed to have been drilling in the Bejucal limestone throughout
their entire depth.

The formation overlies the older formations unconformably
and is in turn overlain unconformably by the Yumuri limestone.

The formation is well exposed and structure can be worked
out in it without great difficulty. The dips are usually low
though a dip greater than 30° was found at one place.

YUMURI LIMESTONE.

The Yumuri limestone consists of an extremely porous,
cavernous limestone which rests unconformably on the younger
formations and outcrops generally in a cape around the coast
of the Island where it has been examined by the author. The
north south section across the Island at a point a few miles east
of Cardenas shows only outcrops of this and younger formations.

The formation is altogether limestone and is so extremely
porous and cavernous that one can hardly conceive that it would,
no matter how thick, form an effective cover or cap rock for
containing oil. It might act as an excellent reservoir if it were
properly covered, but such condition does not exist. It is diffi­
cult to exaggerate the porosity of this formation. Drill cuttings
from a depth of 1000 or 1000 feet in one of the Felicidad wells
were found to be stained with red soil which had been brought
down by percolating waters. It is entirely too porous to act as a
cap rock, cannot serve as a reservoir rock for lack of cap, is uncon­
formable over the underlying formations to such an extent that
its structure is not the least index to the structure of the underlying formations and consequently serves only to mask formations which might be oil bearing.

The thickness of this formation is not known. It is excellently exposed in the gorge of the Yumuri River at Matanzas where it rests unconformably upon the Lucero beds. Some 750 to 800 feet of the formation were measured at this place. The greatest known thickness, some 1670 feet, was encountered in the Dos Toros well of the Cuban Oil Company a few miles Northwest of Cardenas.

The formation contains the famous Belmar caves near Matanzas. Because of the great range of temperature and excessive humidity, it weathers into very sharp points and ridges called, by the natives "dientes de perro" or dog teeth. It also weathers into a deep residual soil and often forms immense flat monotonous plains or savannas, miles in extent, which are so remarked a feature of Cuban topography.

Vaughan found characteristic upper Oligocene fossils in this formation at its type locality, the Canyon of the Yumuri near Matanzas, and considers it to be of Upper Oligocene age. Upper Oligocene fossils were also collected at Consolation del Sur near Pinar del Rio.

**Quaternary**

There are formations of coral reef rock younger than any of the formations described, at various places in the Island; also a wide spread occurrence of terrace gravels in the southern part of the province of Pinar del Rio and generally along the south side of the Island, and alluvial deposits of recent age, but these are of no concern to the present report.

**Igneous Rocks.**

Igneous rocks, aside from serpentines and granites already mentioned in connection with the basal complex, are of fairly

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"For more complete description of the younger rocks, see R. T. Hill's Notes on Geology of the Island of Cuba, Bull. of the Mus. of Com. Zool., Harvard Coll., Vol. XVI, No 15."
common occurrence in the Island and probably range up to post-Cretaceous age. Syenites have been reported from just south of Campo Floridó and at various places in the eastern part of the Island, and various igneous rocks are exposed in the western part of Havana province near Madruga. Some obsidian was encountered in wells drilled at Motembo and diorite outcrops in the quarry already mentioned near Regla and at San Diego Valesquez.

Dykes are reported from Santa Clara and various points to the eastward. R. T. Hill\(^a\) reports a dyke near Viento, south of Havana.

**STRUCTURE**

The general structure of the Island is broadly anticlinal, the structural axis being parallel to the major geographical axis though somewhat nearer to the north than to the south coast. The flanks of this anticline or anticlinorium are not of equal extent, the slopes being broader and the dips gentler and more uniform on the north than the south side.

This general structure just described is the result of late Tertiary or post-Tertiary folding. The pre-Tertiary rocks are closely folded, standing on edge and even overturned in many places, and very much faulted indicating most violent movement before the younger Tertiary rocks were deposited. Traversing along the main road from Guanajay to Bahía Honda, for instance, one finds the Lucero beds folded into a series of very close east-west striking synclines and anticlines. Pre-Tertiary movements were so severe and complex that their full interpretation can come only after some extremely detailed mapping of Cretaceous rocks.

A section across the Sierra Organos between Pinar del Rio and Esperanza shows an anticlinorium, the axial or main mountain mass consisting of an east-west striking anticline of the more resistant Jurassic limestone, flanked by the closely folded and faulted softer Cayetano beds. The structure is further complicated by folding or faulting as witness the very shallow depth to the limestone in the wells drilled at Esperanza.

\(^{a}\)Op. cit. page 287.
Further east, a hurried section across the Sierra Rosario between Bahía Honda and San Cristóbal shows folding apparently modified by step or block faulting so that the prevailing dip is northward in the main mountain mass and southward in the northern coastal plain.

A north-south section through Guanajay shows an anticline, between the town and the north coast of the Island, from which the Tertiary limestones dip gently away to the north and south. The steeply folded and faulted Cretaceous formations and small patches of serpentine are exposed along its crest.

This anticline plunges eastward, the Cretaceous exposures ending near Central Santa Luísa but reappearing again in a small closed dome at the El Cano.

Eastward, the Cretaceous reappears in the valley of the Almendares River near Havana and is exposed in a wide area whose southern boundary follows generally the curious circular course of the Almendares River as it swings in from Cotorro to the westward. This broad exposure must be the result of post-Tertiary doming or folding. The anticline continues eastward to Matanzas, the serpentine outcropping intermittently along its axis, flanked on both sides by the Cretaceous formations, and these in turn flanked by the north and south dipping Tertiaries.

South of this Havana-Matanzas anticline or anticlinorium is another roughly parallel anticline or anticlinorium generally termed the Bejucal-Guines anticline. Only the Tertiary rocks outcrop along its axis. It is being prospected at present by the wells of the Antillian Corporation.

Cretaceous rocks and serpentine are again brought to the surface by folds at Madruga, south of Matanzas near Jovellanos, and at the Tetas de Camarioca west of Cardenas.

As has been previously noted, a north-south traverse across the Island a few miles east of Cardenas, shows only rocks of Tertiary and younger age.

In the extreme eastern part of Matanzas province and in the province of Santa Clara and eastward, the structure becomes again more complex and it is not well enough known to the author to justify any attempt at description.
The author cannot see at the present time that structure, generally regarded as desirable in oil field practice, presents any very reliable criterion for well locations in this region. Structure in the Vinales limestone outcrop leaves one with no known caprock impervious enough to retain the oil, no knowledge of the thickness of the limestone beyond 2000 feet, and no information as to the underlying formation. An exploratory well in this formation might furnish a key for the solution of the Cuban problem. The Cretaceous formations have been too violently disturbed in most places visited by the author to suggest possibilities for the accumulation of more than small pockets of oil unless covered by a suitable cap rock such as the lower part of the overlying Bejucal formation. Certain of the Cretaceous beds, when overlain by the more or less impervious Bejucal formation, present stratigraphic conditions favorable to the accumulation of petroleum and may present suitable structural conditions no matter what the apparent structure of the Bejucal formation may be.

This condition the author conceives to be true because the Cretaceous, where it outcrops, is generally dipping at a high angle and is structurally unconformable to the overlying and generally gently dipping Bejucal limestone. Manifestly, the sealing of vertical standing or steeply dipping sands by overlying impervious beds forms a suitable reservoir for oil accumulation, no matter what the structure of the overlying beds may be. Such accumulations are likely, however, to be of very limited lateral extent and hard to find with the drill.

The author does not wish to be understood as believing that oil cannot be found in an anticline in the Bejucal formation. In fact he even recognizes that the anticline might have a slight tendency toward accumulation, especially if the buried steeply dipping sand strikes at right angles to the strike of the structure, but it is his belief, that unless an oil sand should be found in the lower part of the Bejucal or unless the unconformity between the Bejucal and underlying Cretaceous should be found to be much less than he now believes to exist, areas of level lying Bejucal rocks will be equally attractive for prospective purposes to those presenting structural features such as are generally regarded as favorable to oil accumulation in other fields.
On the other hand, structure in the Bejucal formation may be only the most recent and faint expression of continuous folding which has been going on in the underlying formation.  

III. Petroleum and Asphalt Occurrences.

Surface evidences of the existence of the natural hydrocarbons in the subsoil of Cuba are of wide occurrence. Every gradation of the series from hard glistening asphalt, through the malthas, heavy and light oils, and natural naphthas to natural gas have been found. Seepages of oil and gas or asphalts have been reported from every province of the Island. They are known to extend from near Querto Padre in Oriente province to Esperanza in Pinar del Rio province, a distance of some 475 miles, though they are of most common occurrence between Esperanza and the eastern boundary of Santa Clara province in a zone 5-30 miles wide and some 300 miles long and lying near the north coast of the Island.

Detailed description of the occurrences by provinces from east to west is as follows:

Oriente Province.

The only asphalt or oil occurrence known in this province (formerly called Santiago de Cuba) is the Farola seepage which lies about two miles SWS of the Ingenio San Manuel, and about a quarter mile south of La Farola cross-road store and just off the road. The seepages of light maltha or heavy oil are in the serpentine and have been mined to some extent. According to a native guide, more than a hundred casks of this oil have been mined and used for lubricants at the nearby San Manuel sugar mill. This report is probably exaggerated as to amount and mistaken as to use since the oil very apparently is heavy and of asphalt base.

Such conditions would be very similar to that found in the Healdton, Oklahoma, field, but it is not known whether the lower Bejucal contains any beds capable of forming an oil reservoir such as those of the Permian and Pennsylvanian of Southern Oklahoma, which overly the Ordivican unconformably. See Sidney Powers' Healdton paper, Econ. Geol., Vol. XII, pp. 594-606, 1917, especially the section on page 597.
There are also vague reports of oil seepages in the valley of the Cauto River, and of bitumens near Tunas, Manzanillo, and in the barrio of Guisa.

**Camagüey Province.**

The only known occurrences of the natural bitumens in this province, formerly known as Puerto Principio, consist of a seepage of heavy oil (10° Be.) said to produce as much as a barrel per day which is found a short distance east of the Jatibonica River (western boundary of the province) in the jurisdiction of Moron, and a vein of asphalt which outcrops in the eastern or Camaguey bank of the same stream. These deposits belong to the same group as the Jatibonica asphalt mine.

The seepage of oil or maltha is known by the name of 'Mal Nombre' and occurs in a region of serpentines and metamorphosed rocks.

**Santa Clara Province.**

Deposits of asphalt and oil and gas seepages are of fairly common occurrence in this province.

The Jatibonica asphalt mine, some 8 miles southeast of Mayajigua, is reported to be a deposit of hard grahamite, of brilliant luster, having a strong odor of petroleum and associated with maltha or heavy oil. Belt\(^7\) who visited the deposit in 1914, states that the vein occurs in serpentine some 200 yards south of its contact with schists and metamorphosed limestone. There are reports of other asphalt deposits in this vicinity including outcrops of two asphalt veins in the Santa Clara bank of the Jatibonica River.

Greit\(^8\) states that a pocket of 14° Be. oil was encountered at a depth of 230 feet in copper mining operations in this general region.

Stains or patches of maltha have also been reported as occurring on the conglomeratic Tertiary limestone overlying rocks.

\(^7\)This and following statements ascribed to Belt are from a private report.

\(^8\)This and following statements on Greit's authority are from a private report.
of the Camajuani formation at a point some 1½ miles northeast of Camajuani. The author was unable to find this locality but was shown abandoned workings, said to have been asphalt mines, in the metamorphosed limestone on the east bank of the Camajuani River some 1½ miles southwest of town. Hayes, et al. report various deposits in this vicinity of liquid asphalt.

The Eloisa asphalt mine lies a half mile south of the Santa Clara-Camajuani automobile road between kilometers 12 and 13 from Santa Clara near a ridge known locally as Loma de la Cruz.

The asphalt here, which is lusterless, melts easily in match flame, and has an odor of petroleum even when not heated. It occurs as veins and sheets in serpentine country rock which outcrops over a wide area.

Asphalt from this one was formerly used as gas enricher in Santa Clara but the mine has not been operated for some years and at the time of the author's visit in 1915, the workings were filled with water. Some 300 or 400 tons of asphalt had been mined and was then above ground.

The shaft is said to have been sunk to a depth of 35 metres and tunnels driven in several directions to distances of 100 metres. The vein is said to be 3 metres thick.

Hayes, et al., also report maltha from near a plantation called El Indio, about 15 miles northwest of Santa Clara in the direction of Sagua la Grande; a deposit of hard asphalt three miles from Rancuuelo and 12 yards from the Sagua River; and two undeveloped deposits on the Sugar plantation San Antonio, about 30 miles from Sagua la Grande.

Asphalt is also reported as occurring in the northeast part of this province at "La America," some 4 miles east of La Teja, province of Matanzas, and in a well drilled by railroad interests at Santa Clara city.

Seepages are reported in an east-west striking closely folded limestone basin, which is some 4 or 5 miles wide and lies between

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partially serpentinized igneous rocks near Placetas in this province. Oil seepages occur in the limestone and also at a point several hundred feet into the serpentine, beyond the contact on the south side of the basin.

Natural gas and a unique natural naptha\(^\text{21}\) have been found in wells drilled at Motembo in the northwestern part of the province and gas escapes are of common occurrence in that vicinity. There are also vague reports of oil springs in the Peninsula de Zapata region.

Dr. Stokes\(^\text{22}\) has described an oil from a spring near Santa Clara, known as Sandalwood spring. The oil is a peculiar oil with an odor resembling cedar wood.

Hayes, et al\(^\text{23}\), note a reported occurrence of one of light petroleum at a place 3 or 4 miles west of Santa Clara city but state that a filled up well was the only thing in evidence at the time of their visit. This locality may be the same as that at Anton Diaz where wells were drilled by the Cuban Petroleum Company, Ltd. Gas was seen bubbling through the waters with which the cellars of the old wells were filled at the time of the author's visit.

**MATANZAS PROVINCE.**

Asphalt is reported to occur near the ruins of Ingenio Santa Isabel in the northeastern part of this province. Some oil is also reported to have been encountered here in shallow wells dug in 1884-1889. Some two miles north of this place are the Menendez sulphurous water baths. The temperature of the waters is said to vary, becoming as high as 104° F. at times. About a half mile south of the Santa Isabel ruins is Menendez well No. 1 of the Cuban Oil Company, where the Vinales limestone from 1,115 to 2,385 feet was found to be impregnated with the asphaltic residue of what was probably a former oil deposit.

\(^{21}\)This naptha has been described in greatest detail by Clifford Richardson, Am. Jour. Sci., 4th Ser., Vol. XXIX, pp. 439-446.

\(^{22}\)U. S. Geol. Surv., Bull. 78, pp. 98-104, 1891.

Asphalt and limestone have been mined from a number of pits in the Yumuri limestone at a point about 1 mile east and 1¼ miles south of the mouth of the Rio Palma, some 5-6 miles west of the Menendez well. The material mined from this place is said to have been used in paving operations in Cardenas, Matanzas, and Havana.

An oil seepage is also reported to occur just off the mouth of the Rio Palma and another is noted on an old map as occurring near the southern end of the Canal del Pargo between Cay Laborde and Cay General, some 15 miles from the mouth of the Rio Palma.

Asphalt is mined at Sabanilla de la Palma near the railroad and 2½-3 miles west of Hato Nuevo. A shaft some 90 feet deep has been sunk in the serpentine at this place and two short tunnels have been driven. This mine is said to yield some two-thirds barrels of maltha per day. The plant is equipped with a small refinery but is not operated at present. There are a number of seepages in the serpentine at this place and others in the Yumuri limestone about 1 to 2 miles to westward.

Three maltha springs are also reported to occur some 2-2½ miles south of Hato Nuevo between Livano and Gamutas. Peckham also describes a large asphalt pit near Santa Catalina, some 2-3 miles from the Sabanillas seepages.

Gas seeps through the Yumuri limestone in the bottom of a 30 foot well some 4 miles SW of Macagua. The denounced is called San Francisco and was at one time quite extensively advertised by its owner. The author was also shown a flask of crude oil of good quality said to have come from a seepage in the vicinity of Macagua.

Greit states that some 14 tons of asphalt were mined from a deposit in the Yumuri limestone at La Paz denounced just south of Perico in 1899.

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25 See Diario de la Marina, June 16, 1915.
26 By Ing. Guillermo Alonso.
The asphalt deposits of Cardenas bay have long been famous. The largest deposit is said to be that of the Constancia denouncement, just off Diana Cay some 7 miles NEN from Cardenas. More than 20,000 tons are said to have been mined from this deposit before 1895. Another deposit lies in the western part of Cardenas bay and another important deposit is northeast of Cupey Cays.

Asphalt outcrops have also been reported at Cayo Cruz del Padre, Zalindo, Macho, and General Bustillo but these reports may refer, in part at least, to patches of asphalt thrown up by the sea rather than true deposits.

The owner of Progreso, 3½-4 miles southeast of Cardenas, states that several wells drilled for water near that place have encountered shows of asphalt.

Asphalt is reported near Tosca station between Coliseo and Jovellanos, an oil seepage at the baths of San Miguel southeast of Sumidero, near Coliseo, and hard asphalt on the lands of the old Ingenio Jinsey, evidently near the same place.

A small seepage is found at Felecia, a short distance SES of Cantel and 9 miles W by S from Cardenas, where oil and water seep out near the serpentine contact. It is here that the Alvarez and Cuban Oil Company wells were drilled.

A few miles NW of these seepages are a number of heavy oil seepages along the sedimentary-serpentine outcrop. These are on the San Juan denouncement.

Oil seepages are also reported at Finca Blanca and Aranguron in the barrio of Camraioca.

There is also a seepage about a mile north of Recreo and 10 miles west of Matanzas. The oil comes out with water from a spring at a contact of a thin detrial conglomerate and serpentine, and the place is known locally as “La Mina de Chapopote.”

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²See Cardenas and Santa Clara Bays chart of U. S. N. Hydrographic Bureau.
Greit states that asphalt denouncements have been made in the Barrios of Bacunayagua and Canasi; that asphalt was found in a water well 70 feet deep at a farm of the American Red Cross Society near Ceiba Mocha, and that asphalt was also reported from the west side of Pan de Matanzas but that he was unable to verify the report.

HAVANA PROVINCE.

A maltha seepage is reported in the serpentine about $\frac{1}{2}$ mile west of Madruga on the Havana-Matanzas road and an asphalt vein is reported near the same place, as well as a maltha seepage $1\frac{1}{2}$ miles east of Madruga.

There are also said to be a 3 foot vein of hard asphalt striking ENE by WSW on Rosario plantation near Aguacate and various occurrences of hard and soft asphalts in the municipality of Jaruco and hard asphalt deposits near Bainoa and Jiboca.

Hayes, et al note that viscous asphalt was seen exuding along the joint planes in syenite rock which was being quarried at a point about $1\frac{1}{2}$ miles southeast of Campo Florido at the time of their visit. The old asphalt mines of Jesus del Potosi and Santa Rosa, in the same general region, are at present abandoned and "caved in." Belt visited the locality in 1914 and states that the entire region is serpentine and syenite with occasional small patches of highly metamorphosed Cretaceous sediments.

There are a number of active oil seepages in the serpentine about 100 yards from the contact with the sedimentaries near Bacuranao where oil is being produced at present.

Oil of good quality was found in fairly large amounts (several litres per day) oozing from along the walls of a diorite dyke in serpentine and from joint planes and cracks in the igneous rock itself at a quarry just off the main road between Regla and Guanabacoa. Oil also oozes out with mineral waters from springs in the serpentine at the Santa Rita baths in Guanabacoa.

Gas is found in wells at Puentes Grandes and asphalt, both hard and soft, has been mined at Finca de las Minas, near

kilometer 12, on the Havana-Guines road. This general region is apparently one of Cretaceous sediments.

Oil is often found in quarrying the Yumuri limestone near Jamaica.

Greit notes that a number of outcrops of hard asphalt are found to the north of Tetas de Managua and near San Antonio de Barreta.

There are a group of asphalt mines some 4-5 miles ESE of Bejucal which were formerly producing properties of importance. These deposits consist of veins of asphalt in the Bejucal limestone near the west end of the Bejucal-Guines anticline.

Small amounts of gas have been encountered in both of the deep wells now being drilled along the Bejucal-Guines anticline by the Antillian Corporation.

There is an abandoned asphalt pit in the eastern edge of the village of Punta Brava. It is some 600-800 feet north of the Havana-Guanajay automobile road and is in the Yumuri limestone just west of the Tertiary-Cretaceous contact on the Cano dome.

Gas and oil have been encountered in the Shaler Williams well, drilled at Guayabal.

A considerable seepage of petroleum is found in Cretaceous sediments which are exposed along the axis of the post-Tertiary anticline near the ranch of Coroneles. About two miles west of this place, on the Finca San Pedro, is a spring of cold sulphurous water which carries drops of oil with it. This seepage is in serpentine and also near the anticlinal axis. Hard asphalt veins outcrop in the bank of the Rio Banes a short distance north of Banes. These deposits are in a region which was formerly a part of the province of Pinar del Rio.

Hard asphalt is reported to outcrop to the northeast of the Sierra Canada and at the base of Cerro Natividad, in the Isle of Pines, as well as along the line of keys, Islas de Mangles, north of the Island including Cayo la Torre and Cayo Alacran.
PINAR DEL RIO PROVINCE.

Patches of asphalt or maltha are said to have been found on the rough exposed surface of the reef at Mariel and there is said to be a deposit of hard asphaltum one mile south of Mariel Bay on the Canas plantation. Some 3 miles SSW of the bay is a seepage of liquid petroleum near which a deep well encountering small amounts of oil and gas and some water was drilled.

About a mile north of this well is a deposit of hard asphalt which has been worked extensively during the past. The workings were abandoned and full of water at the time of the author's visit but Belt visited the mine in 1914 and reports that the asphalt occurs as a vein some two metres thick between vertical beds of sandstone and shale.

Southeast of Rosario, near Gayajabos are abandoned works where hard asphalt was formerly mined.

A submarine seepage just off shore at Herradura is reported by fishermen and the author is of the opinion that it actually exists since patches of maltha are found along the beach.

There is an important and almost unworked asphalt deposit about one mile NNW of Cacarajicira and 8-9 miles SW of Bahia Honda. Here are two veins striking approximately N20°W in the closely folded Cretaceous rocks. The westernmost vein is some 8-10 inches thick at the top and 30 inches wide six feet lower down, the lowest point seen.

Just east of Martillo, which is south of Bahia Honda, is a mine of what is generally regarded as asphalt but may be bituminous shale or slate and some three miles to the east is another mine of the same sort. A short distance NE of this latter mine is an old maltha pit.

About 100 yards offshore at Moralillo, due north from Coralillo, is a seepage on the floor of the sea. The author visited this locality in a rowboat on a calm day and was able to observe globules of oil constantly rising to the surface through the water and to collect oil in a gourd. The oil appeared to be of about 15-20° Be. in gravity. The Cuban Petroleum Company drilled a well near this place.

Two wells are said to have been drilled in the valley of Rio Blanco some two miles from the Sierra Organos and four miles from the sea. Oil of 36° Be. gravity is said to have been encountered.

The well at Esperanza reported numerous gas shows below 400 feet. Asphalt and oil seepages of minute size are said to be of common occurrence in this region, in fact water from many of the shallow wells at Esperanza is said to be tainted with oil.

Belt reports a seepage in the shallows of the beach where maltha rises to the surface at a point five miles northeast of Esperanza.

Greit reports additional information regarding this province as follows: 8 feet of asphalt in a well drilled four miles north of Artemisa; asphalt at Loma de Chapopote, San Claudia, and Ana Teresa denouncements around the bay of Cabanas; 17 feet of asphalt at a depth of 30 feet at San Cristobal; maltha at Brujito, barrio of Minas; outcroppings of grahamite near San Joaquin about one mile west of Rio Santa Cruz and at the foot of Sierra Pinal del Rangel in the barrio of Santa Cruz, both Santa Cruz and Minas being in the municipality of San Cristobal; asphalt at 70 feet in a well at Pinar del Rio; asphalt at 100 feet in a well some seven miles north of Consolacion del Sur; asphalt outcrops near San Cayetano; an outcrop of oil impregnated sandstone at the base of a hill north of Ovas and another on the east side of the Sierra del Infierno near Isabelita.

A seepage of oil from a fissure in serpentine is reported at “Pacheco” denouncement in the municipality of Candelaria. This seepage is found in an EW striking valley in the Sierra Organos.

IV. DRILLING OPERATIONS.

The author has no information regarding wells drilled in Oriente or Camaguey, the two easternmost provinces of the Island. Information regarding drilling operations has been given generally in the preceding part of this paper so that the present chapter will be used in order to make a brief resume.

SANTA CLARA PROVINCE.

Santa Clara: A well was drilled by the railroad at this place. It is variously reported as 700-2500 feet deep and to have passed through 7 feet of asphalt.
Motembo: Manuel Cueto and associates.
San Juan No. 1. In southwest corner of San Juan de­
nouncement at Motembo. Drilled to depth of 950 feet with
shows of naphtha at depths of 295 feet and 764 feet respectively.

San Juan No. 2. Some 100 feet south of No. 1. Drilled to
depth of 950 feet with naphtha at 590 feet.

San Juan No. 3. Some 70 feet west of No. 1. Drilled to
depth of 800 feet with naphtha at same depths as in No. 1. Drilled
to depth of 80 feet with diamond drill and completed with per­
cussion drill.

According to graphic logs by M. Ceuto, from which the
above information was taken, the three wells had the same logs
consisting of:

0- 58 feet—Fine grained somewhat ferruginous diorite with
a great quantity of black and dark smoky resinite
which constitutes almost one-fourth of all of the
rock.

58- 85 feet—Diorite with less hornblende and resinite.

85-106 feet—Feldspar without hornblende, apparently ferru­
ginous and somewhat decomposed. Abounding in
dark red resinite.

106-142 feet—Ferruginous feldspar with a great quantity of
resinite of white, smoky, black and dark red colors.

142-166 feet—Feldspathic serpentine somewhat ferruginous with
black, green, grayish green and bluish resinite.

166-173 feet—White feldspar, very pure, almost kaolinized.
Contains black resinite and some chlorite in its
lower half.

173-200 feet—Serpentine, dark green with feldspar, somewhat
decomposed and black and smoky resinite.

200-690 feet—Greasy (esteatitoso) serpentine of light bluish­
green color.

690-720 feet—Feldspathic serpentine and diallage of dark green
color.
720-800 feet—Greasy serpentine of light bluish-green color.

800-903 feet—Feldspatic serpentine and diallage of dark green color.

903-950 feet—Greasy serpentine of light bluish-green color.

The resinite or resnite of the section is apparently volcanic glass or obsidian. The author has seen various bits of obsidian from the well cuttings at Motembo and Vaughan\(^a\) notes that a portion of a well core consists very largely of volcanic glass and other volcanic material.

**CURAN-AMERICAN OIL COMPANY.**

In 1906, a company controlled by the same interests as the Cuban-American Sugar Company started drilling in this region, the first well being about 1,350 feet west of San Juan No. 1. Considerable difficulty was encountered and drilling was stopped on January 1, 1911, with the completion of the third well.

Results encountered in the wells were as follows:

No. 1—Abandoned at a depth of 420 feet (may have reached 700 feet but no record kept beyond 420 feet). The graphic log shows a bed of gravel at 70 feet; igneous rock at 89 feet; "sharp white gray sand" (?) at 104 feet; "black lime" (?) at 118 feet to 175 feet; "white marble" (?) at 180 feet; volcanic dyke and traces of serpentine at 208 feet; "black shale and shelly" (?) at 216 feet; "limestone" (?) and serpentine at 219 feet; and soft "blue slate" (probably serpentine) to 420 feet. At 280 feet the well was showing gas.

No. 2—Abandoned at 700 feet. Log a mixture of materials similar to those set forth in the log of No. 1. "Hard black lime" (?) from 608 to 616 feet and naphtha shows at 425 and 580 feet.

No. 3—Completed as a naphtha producer at a depth of 1,905 feet. Log also a bad mixture, with considerable "slate" reported in upper part of well. Oil and gas shows were as follows: Four hundred and ninety-two feet, gas show; 680 feet, half pint naphtha; 1,016 feet, gas for domestic uses; 1,320 feet, more gas;

\(^a\)Hayes, et al., op. cit., p. 99.
1,420 feet, gas; 1,560 feet, tested an average of about 90 gallons per day of pure naphtha, salt water coming in later.

At the time of the author's visit in 1915, enough gas was being secured from one of the old Cueto wells for cooking purposes and the Cuban-American Well No. 3 was said to be making about 10 gallons of naphtha every other day.

This is an area of serpentine outcrop, the serpentine apparently having been subjected to more recent intrusion. The naphtha may be the result of natural distillation of a heavier oil by the intrusion of the volcanic rocks into the serpentine.\(^\text{32}\)

ANTON DIAZ.

Cuban Petroleum Company, Ltd.
La (Florita) Fe No. 1.
Started February 26, 1903, and completed April 27, 1904.

\textit{Log.}

\begin{itemize}
  \item 0-35 feet—Alluvium.
  \item 35-1,392 feet—Serpentine.
\end{itemize}

San Felipe No. 2.
Started August 15, 1904, and completed April 22, 1905.

\textit{Log.}

\begin{itemize}
  \item 0-743 feet (?)—Serpentine, some gas shows.
\end{itemize}

These wells were drilled in the lands of the estate of Felipe Silva, barrio Esperanza, near Santa Clara\(^\text{32}\).

PROVINCE OF MATANZAS.

MENENDEZ.

Cuban Oil Company.

Menendez Well No. 1: This well was completed to a depth of 2,385 feet in 1915. Log is as follows:

\(^{32}\)There was a great potash excitement at Motembo during the latter part of 1916. The expert of the Cuban Government pronounced the supposed deposit valueless. See New York Times of Sept. 22, 23, 24, 25, 27, 30, Oct. 8 and 20, 1916.

\(^{32}\)These wells have often been reported as near Esperanza, in Pinar del Rio, several hundred miles to the westward. Information from official log book and by courtesy of Mr. Beit, manager of Cuban Petroleum Co., Ltd.
0-60 feet—Travertine, remnants of recent limestone, and loose conglomerate of quartz, mica, and various other igneous material.

300-350 feet—Granitic arkose, including bits of serpentine.

350-2,385 feet—Vinales limestone.

The limestone was found to be impregnated with an asphaltic residue from 1,115 feet downward.

**FELECIA CLAIMS.**

**ALVAREZ AND ASSOCIATES.**

Well No. 1, 78 feet—black thick oil and water.
Well No. 2, 78 feet—water and traces of oil.
Well No. 3, 500 feet—dry.
Well No. 4, 500 feet—produced 100,000 (?) gallons of oil.
Well No. 5, 180 feet—dry.

**CUBAN OIL COMPANY.**

Felecia No. 1—

*Log.*

0-650 feet—Yumuri limestone.
650-790 feet—Lucero beds (?).
790-970 feet—Serpentine.

Antigua Felecidad No. 1—

0-990 feet—Yumuri limestone.
990-1,040 feet—Lucero beds (?).
1,040-1,044 feet—Lucero beds and serpentine.

Dos Toros No. 1—

0-1,670 feet—Yumuri limestone.
1,670-1,835 feet—Lucero beds (?).
1,835-1,850 feet—Lucero beds and serpentine.

These wells were drilled at a seepage near Cantel, west of Cardenas, and were dry holes. The Dos Toros well is some distance east of the other wells and nearer Cardenas.

**SABANILLAS.**

The Cardenas-Sabanillas Petroleum Company is reported to have a derrick up near the Sabanillas seepages. 34

**MATANZAS.**

34Oil Trade Journal, June, 1917, p. 58.
Rig and tools for a location to be drilled in the Yumuri valley near Matanzas have been reported.

HAVANA PROVINCE.

MINAS DISTRICT.

Union Oil Company—

Well No. 1—Oil at 540 feet and salt water at 690 feet. Well reported to have produced 1½ barrels per day of oil.

Well No. 2—Some 90 feet west of No. 1. Abandoned at 350 feet.

Well No. 3—Some 90 feet north of No. 2. Hole plugged at 370 feet.

Well No. 4—Some 160 feet west of No. 3. Reported to have passed through oil at 353 feet and 548 feet. Completed at 575 feet. Had produced a total of some 1,900 barrels of oil from August 15, 1916, to March 15, 1917, and was reported to be pumping 12 barrels per day at the end of January this year.

Well No. 5—Some 400 feet east of Well No. 4. Brought in February 15, 1917, at a depth of 1065 feet. Oil sand reported from 920 feet to 1,000 feet. On May 3, 1917, the well was shot and is reported to have resulted in a production of 200 barrels per day. According to recent reports it is producing some 60 barrels per day at present.

Well No. 6—Abandoned as a dry hole at 1,995 feet.

Well No. 7—Drilling suspended at 700 feet. This well had a showing of salt water and oil at 550 feet.

Well No. 8—Reported to have been drilled in during the month of February, 1918, and to be good for 100 barrels per day at a depth of 1,019 feet.

Cuban Petroleum Company—

Well No. 1—Some 250 feet NE of Union Oil Company No. 4. Completed March 14, 1917, pumping 150 barrels per day.

Oil, Paint, and Drug Reporter, Feb. 11, 1918, p. 51.

Oil, Paint, and Drug Reporter, Feb. 11, 1918, p. 51.
from a depth of 865 feet. Well said to be pumping 10 barrels per day at present.

Well No. 2—Reported abandoned dry hole at a depth of 1,095 feet. This well is reported to be about 1 mile west of the proven area.

Chretiland Petroleum Company—
Well No. 1—Some 16 miles east of Havana and 5 miles from north coast. Dry hole at 1,232 feet, having been drilled in serpentine throughout.

Well No. 2—One mile east of No. 1 and 2 miles south of the Union Oil Company wells. Reported shut down at a depth of 1,030 feet.

Republic Oil Company—
Well No. 1—Well reported to be producing 12 barrels per day from depth of 917 feet and drilling at 1,125 feet.

Cuban Standard Oil Company—
Well No. 1—Drilling suspended at 410 feet.

Gulf Petroleum Company—
Well No. 1—Drilling at 870 feet.

United States Oil Company—
Well No. 1—Drilling at 1,230 feet.

Cuba International Oil Company—
Well No. 1—Drilling at 125 feet.

Benedum and Trees—
Well No. 1—Rig up.

Cuba American Oil Company—
Well No. 1—Drilling at 400 feet.

Guanabacoa Oil Company—
Well No. 1—Rig up.

The oil produced from this district is said to be 26° Be. in gravity and to yield 13% of distillate of 0.7345 sp. gr. up to 150° C., and 31% of distillate of 0.8102 sp. gr. from 150° C. to 300° C.

The deposit as proved to date is very small and the oil is said to come from a "sand" near the serpentine contact on the north side of the Guanabacoa serpentine mass, a short distance from the contact with the sedimentaries. *

*Logs of Union Oil Company wells Nos. 2, 4 and 5 are given in the Oil, Paint, and Drug Reporter of July 9, 1917, but as to the formation classifications, they are of doubtful value.
GUINES.
Antillian Corporation—

Well No. 1—Some four miles northwest of Guines. Drilling suspended at 3,006 feet. Company states oil not expected at depth shallower than 4,000 feet.

MANAGUA.
Antillian Corporation—

Well No. 2—Some three miles south of Managua. Well 2,825 feet deep. Company states that oil not expected at depth shallower than 3,500 feet.

CALVARIO.
El Triunfo Oil Company—

Well No. 1—Said to have been abandoned at a depth of 76 feet.

ARROYO APOLO.
El Triunfo Oil Company—

Well No. 2—Drilling at 156 feet.

GUAYABAL.
Sinclair Gulf-Shaler Williams—

Well No. 1—Depth 1,565 feet. The log of this well shows limestone, clay, and sandstone to 1,110 feet, the depth of the well in 1915; with sulphur water at 382 feet, gas at 535 feet, a flow of gas at 742-805 feet, water at 800-805 feet, oil at 885 feet and 895 feet, gas at 908 feet and oil at 912 feet. The well is at present reported making gas and a very small quantity of oil from 1,300-1,565 feet.

PUENTES GRANDES.
Tropical Engineering Company—

Well No. 1—This well, north of the brewery buildings, came in a gasser at a depth of 718 feet on December 6, 1913. It is now abandoned. E. B. Hopkins* reports log of the well as follows:

0-60 feet—White limestone.
60-718 feet—Limestones, serpentine, and shales. Gas at 700-718 feet.

Well No. 2—Drilling at 1,377 feet.

*Personal communication with the author.
V. OCCURRENCE OF THE OIL.

One of the most remarkable things about the occurrence of the various members of the petroleum family in this region is their association with igneous rocks and with serpentines believed to have been derived from the alteration of igneous rocks. The area presents a paradise to those who argue igneous origin of petroleum from every association with igneous rocks.

The author believes that the oil has ultimately been derived from the Jurassic limestones or older sedimentaries, that the igneous rock from which the serpentines are derived were intruded, for the most part, into the Cretaceous rocks which overlie the Jurassic, and that the asphalt deposits and oil seepages found in the serpentine and igneous rock are the result of oil seeping from the underlying sedimentaries or from patches of the sedimentary rocks which have been caught up in the serpentine.
If such conditions exist, and if the serpentine is thin enough to be penetrated by the drill, one might find oil underneath the serpentine. No well drilled into the main mass of the serpentine has yet gone through it so far as is known to the author.

Because oil has been found in a serpentine at Thrall, Texas, attempts have been made to argue an analogy to the Cuban occurrence. No mass of serpentine in Cuba occurs under conditions similar to those at Thrall.

Whatever the origin and source of the oil, all yet produced in anything like quantity has come from the serpentines or from its contact with sedimentary rocks. Three most interesting tests now drilling, the Shaler Williams well and the wells of the Antil- lian Corporation, should reveal further information as to the possibility of oil being found in the sedimentaries, though it is entirely possible that any of the three wells may go into the serpentine or igneous rock.

The author will not attempt to repeat the various theories he has advanced as to the effect of structures and unconformity in connection with Cuban petroleum geology, but will call attention to the wide-spread occurrence of hard asphalt and natural naphtha as evidence that the original oils of Cuba have been subjected to metamorphism as well as the containing rocks and to the consequent probability that much oil has been lost.

There is ample evidence that oil still remains, but, in the author's opinion, the probability of developing a great oil field in the Island is not good and the operator must face conditions which increase several fold the hazards of that most hazardous of all operations,—wildcatting.

In conclusion, the author would like to call attention to remarks by Samuel Peckham, author of our first great compendium on petroleum. These remarks were published in comment regarding prospects in Cuba some eighteen years ago but might well have been written yesterday.

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“Until a sufficient amount of work has been done by parties personally interested in the property, to demonstrate beyond question the existence upon or under it of actual value, these surface indications, though exhibited on a large scale and over a wide area, are not in any manner in themselves a source of prospective wealth but are rather only an incentive to cautious, and very careful prospective drilling. The wells that have been drilled, while demonstrating that oil can be produced by drilling, have been very moderate producers and extremely short lived and are, therefore, quite as largely indications to extreme caution as a stimulus to even experimental outlay.”

New York, February 11, 1918.