Petroleum in the Argentine Republic

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AT THE present time five localities in the Argentine Republic are known to bear direct evidences of the presence of petroleum. The segregation of these localities is more or less arbitrary inasmuch as minor indications may be found to extend from one locality to the other at no regular distance apart, especially in the northern and western part of the republic. These localities are listed as follows: North Argentine-Bolivian region, Salta-Jujuy district, provinces of Mendoza and Neuquen, Comodoro Rivadavia, and the Gallegos-Punta Arenas region.

Economic conditions attract us to the possibilities of developing these and other regions of countries in the southern hemisphere. Development work will, naturally, be undertaken first in such localities as present direct manifestations of the presence of petroleum; "hidden fields" may exist, but, unless discovered by accident, their development will be left to the last.

The problems to be solved in the development of the petroleum resources of the Argentine republic are mainly of stratigraphy, structure, and transportation. We are not here concerned with the unfavorable climate of the countries to the north in the tropics where, for us of the "far north," life hangs by a thread ready to be severed by a mosquito, gnat, or tropical germ.

NORTH ARGENTINE-BOLIVIAN REGION

The North Argentine-Bolivian region has already been described by the author.¹ Geographically and geologically this is admittedly one field extending from Argentine into Bolivia. It is not necessary to repeat here the various conditions pertaining to this field, though the summary may be quoted as follows:

Extending from northern Argentina northward into central Bolivia is a belt of petroleum seepages. On account of the remoteness of the district it has, heretofore, been little considered by oil operators. The regional geology is comparatively well understood but the local features have not been carefully detailed.

Development work in the past has been done on an unscientific basis and has led to failures. At the present time, access to the region is somewhat difficult but no

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¹ *Trans.* (1919) 61, 544.

serious problem would be encountered in improving the conditions. The nearest railroad terminal is at Embarcación, 114 mi. (183 km.) south of the Bolivian border, or 72 mi. (116 km.) from the nearest manifestation of petroleum in natural springs.

The oil is of high quality and the seepages occur in creek beds along the Sierra de Aguaraquí fault, and at other isolated places.

Native labor is good and government policies are sympathetic toward foreign exploitation.

Though the structural features of the region, as a unit, have been worked out by reconnaissance surveys, there still remain many local sections upon which no detailed study has been made.

Several small areas have been proved unfavorable for production, though the region as a whole cannot be condemned on this account.

Since writing the above there has been no further development in this district, to the author's knowledge, though individuals have had their geologists there.

THE SALTA-JUJUY DISTRICT

The Salta-Jujuy district lies to the west of the foregoing area, northwest and north of the town of Salta, extending into Bolivia. There may be no logical reason for separating these fields except that the latter lies in the mountainous and somewhat inaccessible part of the country. The stratigraphy of one is closely related to that of the other. Seepages are small and widely scattered, of high quality oil, and not of continuous flow, for heavy rains may either temporarily efface or bring to light slight showings of petroleum, depending on local conditions.

The structure of the district is rather complex due to the folding and faulting of the strata lying on the side of igneous formation protruded in the Andes uplift. As the surface is made up of steep mountains and narrow gorges largely, there is small probability of extensive development. The seepages occur along the exposures of beds dipping at high angle and along faults.

PROVINCES OF MENDOZA AND NEUQUEN

These two provinces lie on the eastern flank of the Andes Mountains due west from Buenos Aires and adjoining the Republic of Chile. The province of Mendoza is traversed by the trans-Andean railway which extends from coast to coast. Seepages, generally of tar or asphalt and heavy oil, extend in a north-and-south line along the frontal ranges, paralleling the main trend of the range. The author made but a casual observation in this district and is therefore not competent to enter a detailed discussion of stratigraphic conditions. The main features are beds of steep dip and numerous faults. Some development has been undertaken in the past but up to autumn of the year 1917 no success had been met. The area has its possibilities.

COMODORO RIVADAVIA

At Comodoro Rivadavia is situated the only successfully developed oil field in the Argentine Republic. It is located in the southeast corner of the territory of Chubút along the Atlantic seacoast, immediately north of the town of Comodoro Rivadavia, on the Gulf of St. George (San Jorge) at approximately latitude south $45^{\circ} 45'$ and longitude west $67^{\circ} 20'$ from Greenwich. From Buenos Aires, the field lies in a direction of south 30° west, 1164 mi. (1875 km.) distant, as the ships sail.

The area includes the reserved land of the Argentine Government of 5000 ha. (12,050 acres), 5000 by 10,000 m. along the coast covering the town of Comodoro Rivadavia itself. Furthermore, it includes various areas adjoining this reservation to the north, west, and south. Three properties were producing petroleum in the latter part of the year 1917: namely, the government reservation, the *Compañía Argentina de Comodoro Rivadavia*, and the Astro property, the latter situated about 20 km. north. Many claims or concessions have been taken up by local parties, some of which appear to be favorable for production.

Previous to the accidental discovery of oil by drilling for water there were said to be absolutely no signs of the existence of oil or gas under the surface in this region. The domestic water supply of the town of Comodoro Rivadavia was very poor and in such condition as to render the district unhealthy. In the year 1908, the Argentine Government sent a drilling outfit there to prospect for water, a site having been chosen opposite the bank building in town. No water was encountered so the drill was removed to a place $3\frac{1}{2}$ km. north. Drilling proceeded until a strong flow of gas was encountered and later a gusher of oil at 1770 ft. (540 m.) below sea level. The well was probably not over 70 ft. above the sea.

Since discovery, drilling has been continued with more or less regularity until, in the latter part of 1917, about sixty wells had been put down on the reservation, a fair proportion of which proved successful. Water is now brought from the hills to the west through pipe and supplies all requirements.

Within the government area, at least three sedimentary series exposed at the surface have been differentiated. The lowest stratum exposed is that of a white, soft, tufaceous formation lying at the base of the hills immediately to the north of the oil field. Traces of carboniferous matter have been found in this formation but no fossils capable of recognition were on record at the time of the author's visit. Its age was considered to be Lower Eocene or possibly Upper Cretaceous. About 50 ft. of the series is exposed.

The next younger formation is a series of sandstones and shales. The sandstone is light brown in color, soft, and easily eroded. Sand

grains are of medium size. Beds vary in thickness from 10 to 50 ft., bedding planes well defined. The shale is also light brown where exposed and very soft. The entire thickness of the series is approximately 200 ft. Fossils of this formation were considered to be of Eocene Age.

The third and youngest stratified series is the so-called "Patagonia" series, a formation composed largely of soft, light brown, thinly bedded sandstone. Some shale occurs. It is this formation that stands in high cliffs to the west of the field. At least 300 ft. of the series is exposed in the immediate vicinity. Fossils are very abundant. They are probably of Oligocene age.

In addition to these stratified deposits there is a great amount of chert, water-worn pebbles lying loosely on the ground above the Patagonia series and particularly along the beach. These pebbles are predominantly of yellow, red, green, and black colors and undoubtedly were transported from a distance.

The formations below the tuff penetrated by the drill are mostly gray shales and sandstones, the hardness of which varies somewhat in the different strata. They may be Lower Eocene or Upper Cretaceous.

The beds at the surface lie at a very low angle, somewhat similar to conditions in the Mid-Continent fields. The normal dip is toward the southeast with sufficient undulation to produce flat dome structures with closures in contours on the northwest. At the close of Patagonia time, a gentle but extensive uplifting took place throughout the entire region, leaving the strata almost horizontal, producing the great "pampas," or high plains, to the west toward the Andes. Evidently little, if any, lateral pressure was exerted upon the strata, for they appear little disturbed except for their elevation. The sea and rains have ravaged the coast line, leaving a shelf with low relief along the coast; it is on this shelf that we find the development of the field.

The oil is found on the above-mentioned domes in a sand that lies conformably to the series at the surface at a depth close to 530 m. (1740 ft.) below sea level. The texture of the sand seems to vary considerably, producing non-porous parts sufficiently tight to exclude the oil. For this reason oil is not always encountered as soon as the oil formation is struck. In some wells it was reported that oil was not encountered until a depth of 580 m. (1900 ft.) had been reached. Overlying the oil series is a soft bluish-gray shale. The age of the series was thought to be Upper Cretaceous, though this was not certain. Water has been encountered but no difficulty is experienced in shutting it off.

The wells of this field have been drilled by a combination of the rotary drill to a depth of 462 m. (1515 ft.) and the Fauck system with rods to the oil strata. The rigs are of the closed-in type, covered with sheet iron on four sides to the top. They must be heavily guyed to prevent damage from strong winds prevailing during certain seasons. At the

time of the writer's visit, two American rigs had recently been built to use cable tools in combination with the rotary outfit. As far as they had been used, they were making an admirable record compared with the rods. It seems quite necessary to use the rotary for the upper part of the hole, as the walls are subject to caving. Strong flows of briny water are encountered at 350 m. (1150 ft.) and at 435 m. (1428 ft.). Gas is often struck at 150 m. (492 ft.) and at 400 m. (1312 ft.).

In August, 1917, twenty-five wells were producing 4000 bbl. of oil per day and an average of 60 m. (195 ft.) of new hole per day was being drilled. The oil is heavy, about 18° Bé. on an average, black in color, with a low content of gasoline. There is a small refinery on the ground for extracting the gasoline. The refuse is returned to the storage tanks for shipping to Buenos Aires, where it is used by industrial plants as fuel. The government maintained a fleet of four tankers at that time. Loading was often done with difficulty on account of lack of harbor facilities, since the Gulf of St. George is quite open to the Atlantic. Although but twenty-five wells were producing, about thirty-five others had been drilled and had either been dry, lost holes, or abandoned as no longer profitable to operate. It is understood that this record has been considerably improved since that time.

A fair proportion of the territory can be surveyed in detail, as is being done in the Mid-Continent field. The most favorable localities may therefore be selected for the drill with a minimum of failures. Stratigraphic conditions are favorable for a considerable extension of present known producing area. Transportation presents little difficulty, since the field adjoins the sea and market conditions are capable of great expansion; all oil not needed by the industries in Buenos Aires may be devoted to use in oil-burning vessels, which would call if fuel were available.

GALLEGOS-PUNTA ARENAS REGION

At the southernmost section of the continent is located the Gallegos-Punta Arenas region. In addition to the well-known gas springs near the town of Punta Arenas, the manifestations extend northward to a district due west of the port of Gallegos. In the latter locality, the streams are reported by competent observers to be carrying small quantities of crude oil toward Lake Blanca. The author has not studied this region, so is unable to give information regarding conditions and possibilities of development.

DISCUSSION

THE CHAIRMAN (E. DEGOLYER, New York, N. Y.).—The production of petroleum in the Argentine is entirely in the hands of the government. Some years ago, in attempting to develop a water supply for the Patagonian region, the department in charge of drilling brought in a

gushing well. The president immediately withdrew a considerable reserve around this well; subsequently, the government reduced the size of the reserve to 5000 hectares and proceeded to develop the property. I have studied several of the reports of the Commission that has the matter in charge, and am not able to determine whether or not it is a profitable venture for the government, but it seems to have developed a distinct policy of exclusion. The mining laws, like the mining laws in most Latin-American countries, practically made no provision for petroleum. They were a development of the old Spanish mining codes when petroleum was not recognized as a mineral. In most of these Latin-American countries, some sort of special legislation has been required to make it possible for one to go in to develop the petroleum resources. As the tendency in the Argentine seems to be to keep the thing in the hands of the government, there is the peculiar condition that a nation that has no coal fuel, and where fuel is the utmost importance, seems to be determined to have no oil development either.

S. C. HEROLD (author's reply to discussion).—At the present time, development work is carried on in various parts of the Argentine Republic by several distinct companies largely financed by foreign capital, though one or two have included a fair proportion of local capital. While some of these operating companies have not brought in producing wells, the possibilities are particularly good in some instances.

The Argentine Government now has two reserved zones; namely, that referred to by Mr. DeGolyer at Comodoro Rivadavia at the southeast corner of the Territory of Chubut adjacent to the coast line along the Gulf of St. George, and that at Station Plaza Huincul in the Territory of Neuquen, both of 5000 hectares area. It is understood that a third zone may be set aside near the Cerro Negro region, Neuquen Territory. The favored location for work by the private companies has been, so far, near the zones reserved by the Government. These zones, with their adjoining lands, are within "Territorial" jurisdiction; as the territories are controlled from the national seat of government in Buenos Aires, the national laws providing for petroleum development are the only laws prevailing. The provinces may have their own departments of mining, etc., and may detail their laws respecting oil claims so long as such details do not conflict with the spirit of the national laws; within the territories no such detail can be worked out.

It cannot be properly stated that there is any intentional exclusion policy on the part of the country. Any exclusion prevailing is due rather to that which the Government has failed to do than to what it has done. We can hardly expect a country that has only reached the stage of development in petroleum which the Argentine has experienced to date to have all matters worked out in detail. Capital invested in that country will, therefore, be exposed to a risk when the day for the

interpretation of the present laws is at hand. Assurances that are now generously given will avail little in the interpretation of the law when there are invested possibly several millions and the coveted fluid is gushing from the wells.

The Argentine Government's venture at Comodoro Rivadavia would appear to be profitable. The price of Comodoro crude at Buenos Aires last November was 100 pesos per metric ton, approximately \$6.50 per bbl. It is improbable that the rate has changed, for the Government has practically a monopolistic control over the production to date. As the production of the field is about 5000 bbl. per day, with the actual delivery of that amount to the market, it is quite obvious that there would be "something wrong" if there is no profit. As a matter of fact, the books do show a handsome gain over expenditures. The property is not handled in a most efficient manner, nor do the men in charge think it is, for they admit the difficulties of Government control.