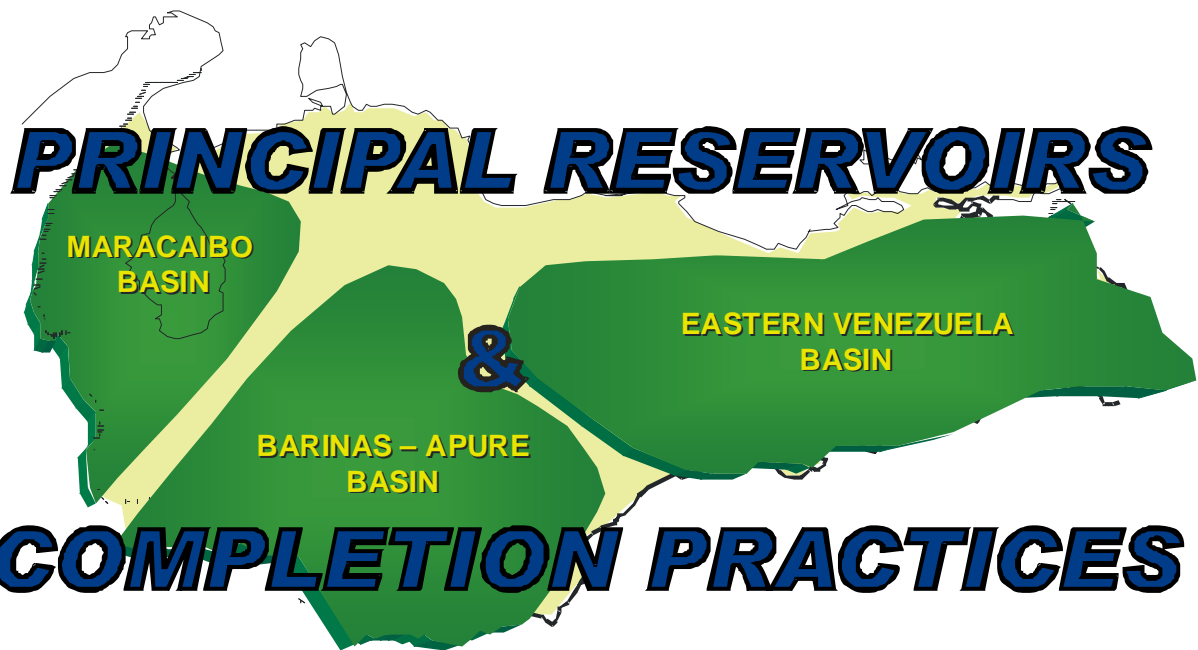


VENEZUELA SEDIMENTARY BASINS



By
Donald A. Goddard
(2006)

VENEZUELA SEDIMENTARY BASINS

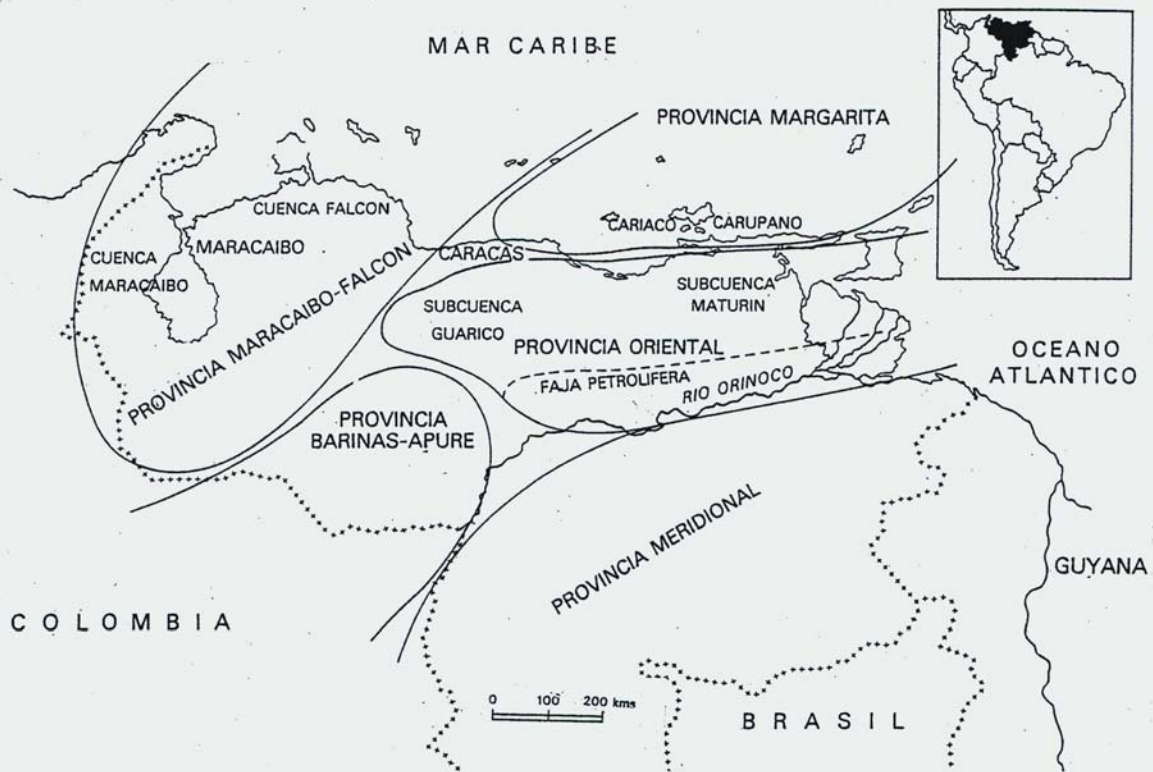


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PREFACE

The information presented in this report was obtained from several publications such as those in the Selected Bibliography (Chapter 5). Much of the information regarding the clastic reservoirs of the Venezuelan sedimentary basins is scattered throughout a large volume of mostly Spanish literature. Therefore, the need exists to summarize, translate, and integrate the more important, basic geological parameters of these reservoirs. The geologic summary presented here can be considered an initial attempt at synthesizing some of the data.

Those not familiar with the principal producing intervals in these basins will find this to be a useful set of notes. A few figures are presented to give the reader an idea as to the general location of the reservoirs, as well as to their stratigraphic relationship with the overlying and underlying units. Also included in this publication are several well completion diagrams that can help the user plan the drilling strategies required in the different basins. Also presented are authorizations for expenditure (AFE) estimates for five depth ranges (2500', 5000', 10,000', 15,000' and 19,000'). The costs presented here are for the region of North America. It is estimated that drilling costs for Venezuela are approximately 20% higher. The date of the estimated costs is December 2005. During 2006 these costs have continued to increase.

1. MARACAIBO BASIN RESERVOIRS

1.1 MIOCENE LAGUNILLAS FORMATION

In the Coastal Bolivar Fields, from Cabimas to Bachaquero on the eastern shores of Lake Maracaibo, the Lagunillas Inferior Member has been the most prolific heavy oil producer in the area since the early 1920's (Fig. 1). The Lagunillas Formation is a subsurface deltaic interval that extends from the center of Lake Maracaibo to its eastern shore. Consisting of interbedded semi-consolidated sandstone, shale, and lignite, the interval has been subdivided into an upper member (Bachaquero), a middle member (Laguna) and a lower member (Lagunillas Inferior) (Fig. 2). The producing reservoirs are located between 2000 and 5000 feet (610 - 1525 m) in depth and consist of a series of stacked meandering distributary channels, levee overbank and bay fill sands, and some delta front deposits. Locally, these are typically unstructured reservoirs with oil located in stratigraphic traps for the most part. Where large anticlinal structures occur in Pueblo Viejo and Bachaquero, commonly they are flanked by updip sand pinch-outs. Porosity of the Miocene reservoirs is intergranular and related to the depositional facies. However, because of the loose and well-sorted nature of the sand grains, they tend to be high, ranging from 25 to 40%. Permeability is also high averaging approximately 600 md. Since most of the reservoirs consist of distributary channel sands, net oil sand intervals are large, averaging 120 feet (37 m) in thickness.

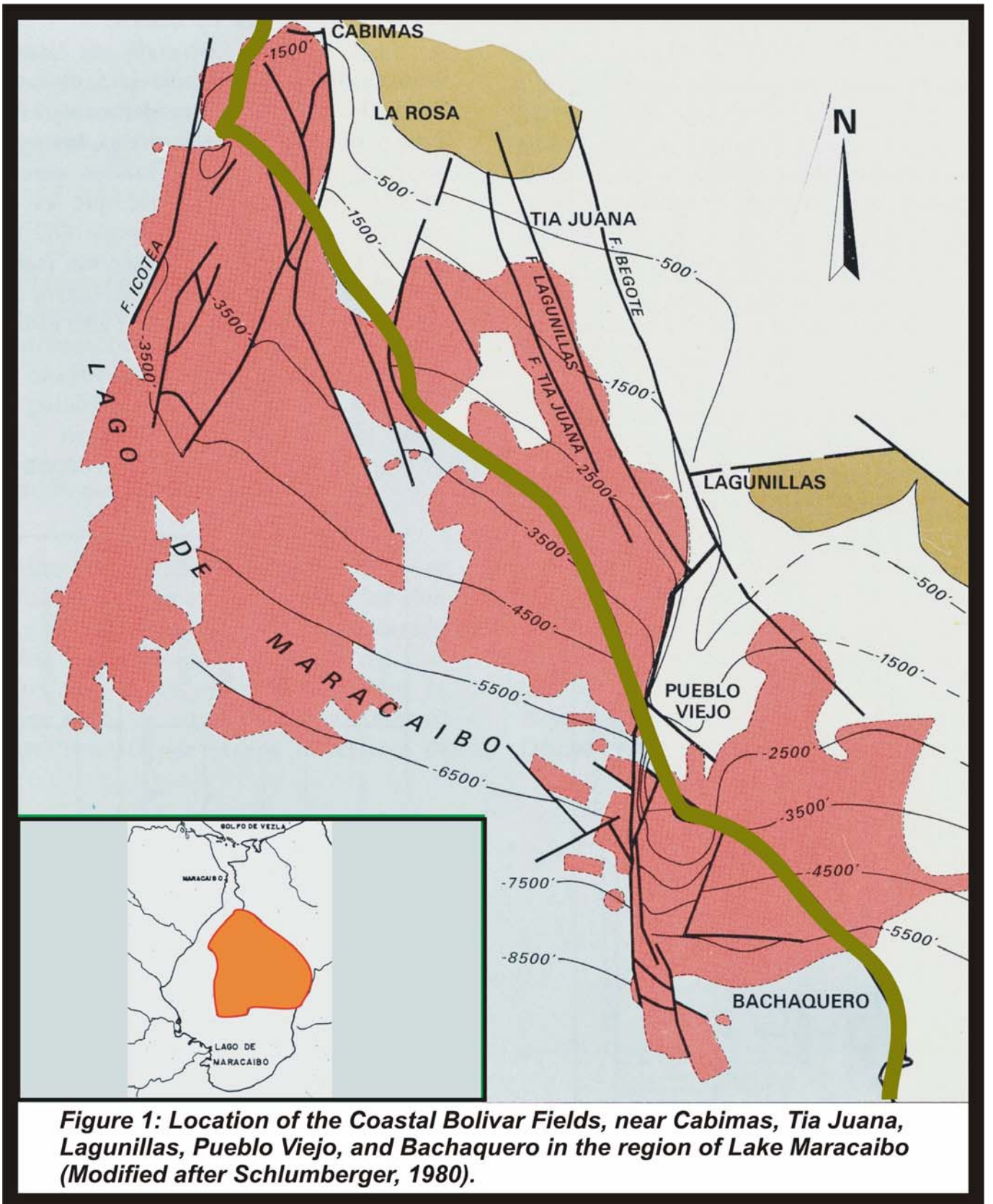


Figure 1: Location of the Coastal Bolivar Fields, near Cabimas, Tia Juana, Lagunillas, Pueblo Viejo, and Bachaquero in the region of Lake Maracaibo (Modified after Schlumberger, 1980).

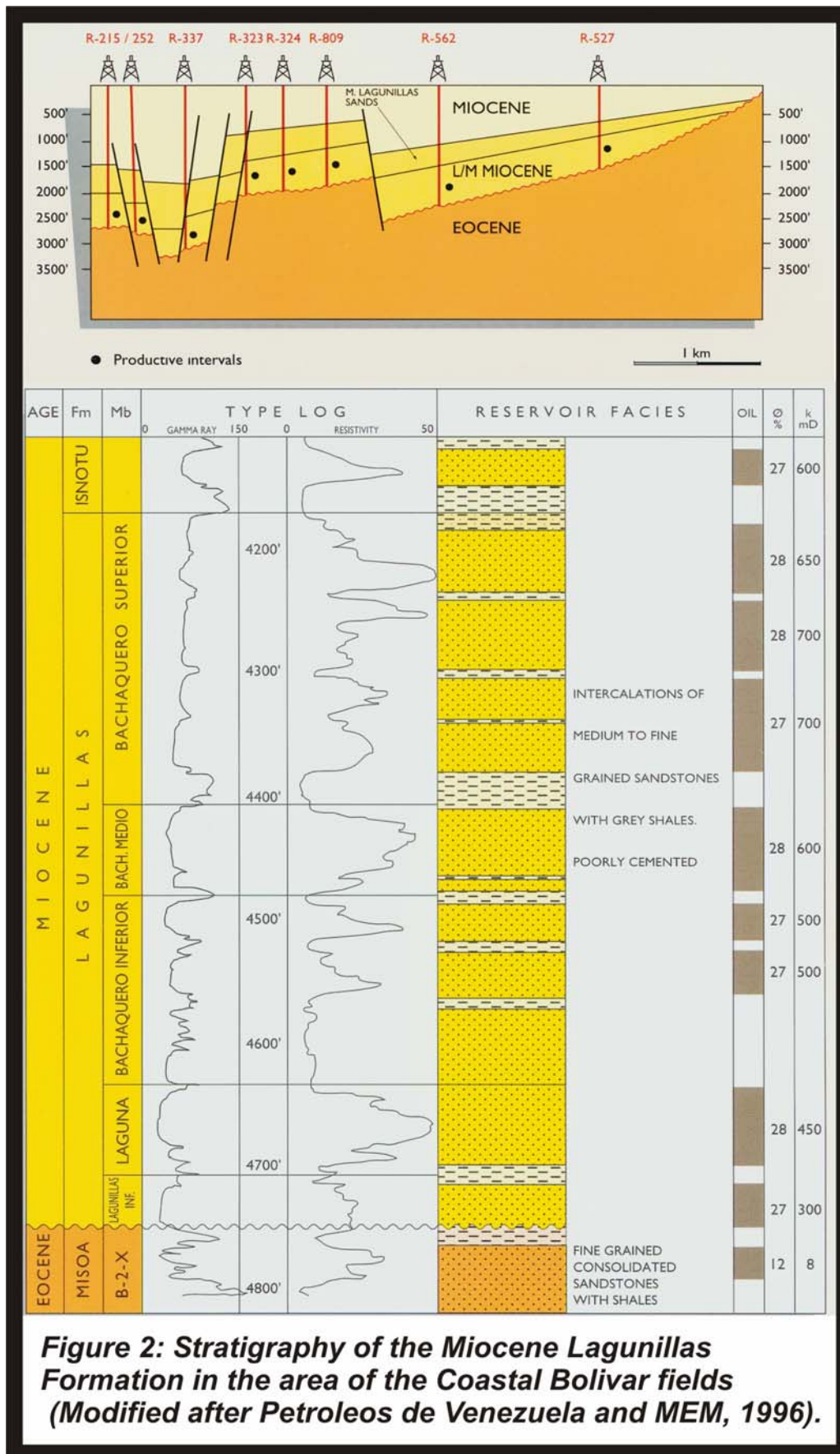


Figure 2: Stratigraphy of the Miocene Lagunillas Formation in the area of the Coastal Bolivar fields (Modified after Petroleos de Venezuela and MEM, 1996).

1.2 EOCENE MIRADOR FORMATION

A prolific producer in the subsurface of the Colon District of Zulia State, this Eocene, fluvial sequence of interbraided channels can be found cropping out in the Perija Range to the west and northwest and in the Venezuela Andes near San Cristobal to the southeast. In the subsurface, at depths between 1200 and 6000 feet (369-1800 m), the clean massive sandstone that comprises the producing intervals of the Mirador Formation, have porosity that ranges from 14 to 21% and permeability values averaging 600 md (Fig. 3). Based on palinological evidence, the Mirador correlates laterally with the lower Misoa Formation, a more deltaic facies located to the east and northeast of the Colon District.

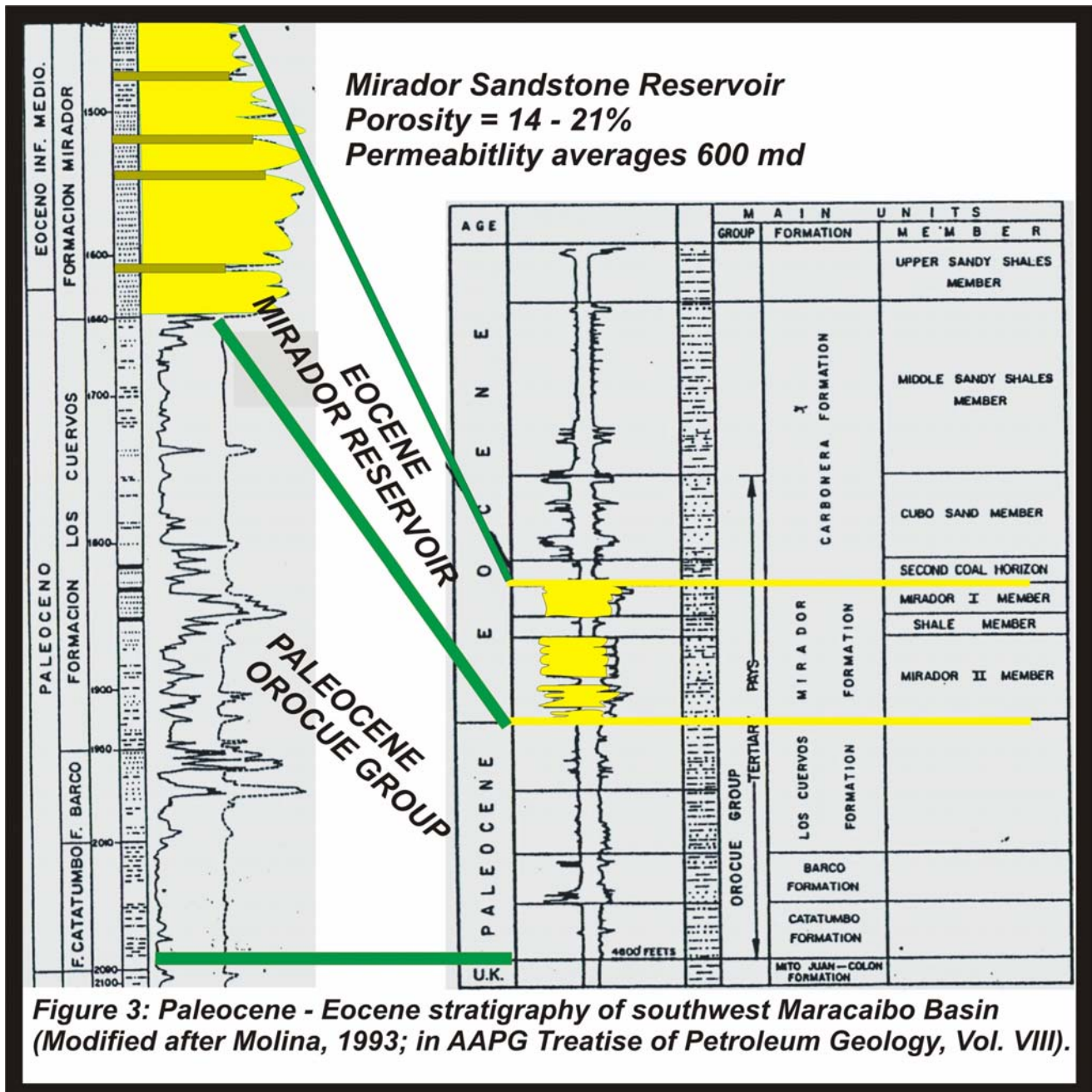


Figure 3: Paleocene - Eocene stratigraphy of southwest Maracaibo Basin (Modified after Molina, 1993; in AAPG Treatise of Petroleum Geology, Vol. VIII).

1.3 EOCENE MISOA FORMATION

In the subsurface in the center of Lake Maracaibo (Lama Field) and on its eastern shores (Coastal Bolivar, Ceuta and Barua-Motatan Fields) the Misoa deltaic sandstones are the principal producers. This formation consists of two sandy/shaly transgressive sequences, the upper B (B1 to B9) and the lower C (C1 to C7) sandstones. [Figure 4](#) shows the general subsurface extent of the Misoa and [Figure 5](#) gives the generalized lithology of the C6 – C7 interval.

In the center of Lake Maracaibo, e.g. Lama Field, depth to the top of the Misoa reservoirs varies between 7000 and 13500 feet (2100 - 4120 m). Average intergranular porosity is 22% and average permeability is 300 md.

The following abstract obtained from the 1993 AAPG, Caracas Meeting gives a brief description of the Lower Misoa C: CASAS, J.E. and CHACARTEGUI, F., Maraven S.A. Caracas, Venezuela.

“Sedimentological and Diagenetic Study of Lower Misoa (C6 and C7 Members) in Lama Field, Maracaibo Lake, Venezuela.”

This sedimentological study describes the Lower Misoa Formation in the Lama Field and is a part of a project to simulate the reservoirs for E.O.R. purposes. The reservoirs were cored in four wells for a total of 1500 ft. The Lower Misoa (C6i-C7) is divided into six sedimentary units, four corresponding to C7 and the other two within C6i. Using integrated sedimentological and petrophysical data, four flow units are defined, two within C7 and two within C6i. Sporomorphous species observed at the top of C7, identify this unit as the palynological zone M corresponding to Lower Eocene. By defining sedimentary units using log character, it is possible to construct trend surface and isopach maps that show the geometry of the reservoir as an elongated body with a northeast-southwest orientation. Petrophysical and petrographical characterization of facies suggest that sedimentary facies control the variations observed in permeability, porosity, and oil accumulation in the reservoir. The most important diagenetic alterations are carbonate cementation, silica overgrowths and kaolinite precipitation. For the reservoir C6i the flow unit with the best performance is the number III characterized by $\emptyset = 23\%$, and $K = 300$ md. For C7 which is the best Lower Misoa reservoir in the field, the flow unit II has the best performance with $\emptyset = 25\%$, and $K = 600$ md. Characteristics such as primary sedimentary structures, lithofacies analysis and the floral-faunal analysis of samples, suggest that these sequences were deposited as a large barrier island complex with extensive coastal lagoons.

In an easterly direction, depth to the top of Misoa in the Ceuta-Tomoporo Field can be located from 14000 feet (4300 m) to 16000 ft. (4900 m). Onshore, approximately 30 km ENE of Ceuta, the prolific Barua-Motatan Fields produce from Misoa sandstone reservoirs at 11,000 to 12,000 feet (3350 - 3650 m). The fluvio-deltaic nature of the Misoa deposits persist and reservoir parameters vary according to the facies characteristics. Porosity ranges from 14 to 20% and permeability from 150 - 400 md.

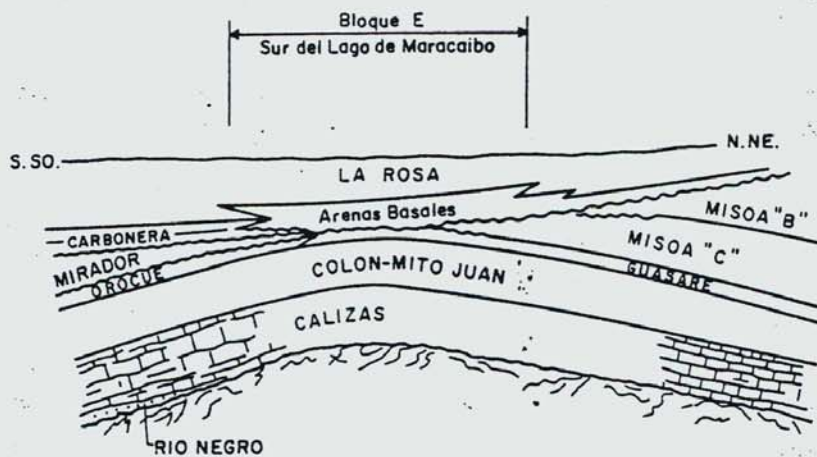
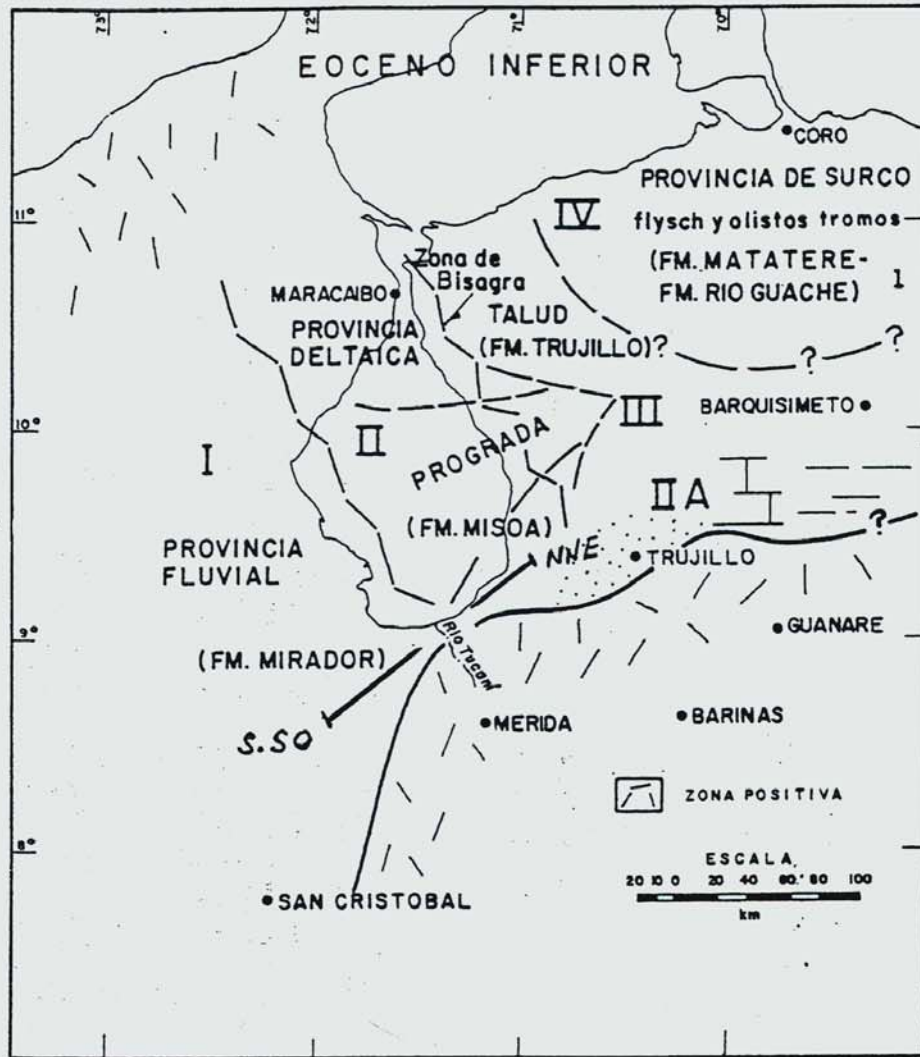


Figure 4: Distribution of Lower Eocene deposits in the Maracaibo Basin (After Gonzalez de Juana et al., 1980).

The following AAPG abstract also from the 1993 Caracas Meeting briefly describes the Ceuta area:

CHACARTEGUI, F., M. C. COLL, J. URDANETA, J. PINTO and D. LUGO, Maraven S.A., Caracas, Venezuela: "Laminated Sandstone Reservoir Characterization, Middle Eocene Lower Misoa Formation, Ceuta Field, Maracaibo Lake."

This study presents the results of a multidisciplinary, project and methodology used to describe a clastic reservoir, known as C-2/C-3, characterized by thin sandstones units masked by a mainly argillaceous sequence. The area, known as Area 2 of the Ceuta field, is located to the southeast of Maracaibo Lake, comprising an area of 75 km². Sedimentological facies description, characterization and analysis resulted in the identification of seven different lithofacies, of which only two are productive. Additionally, ten sedimentary units were recognized, based on related facies associations and nature of facies contacts. These sedimentary units were deposited by a prograding, fluvially dominated delta in a large estuarine environmental setting. Integration of sedimentological and petrophysical data were used to recognize and predict prospective intervals from well logs and to characterize them. A deconvolution of MICRO LOG resistivities proved to be the most successful technique to delineate productive intervals, and set the basis for flow unit identification. Production data, integrated with petrophysical and sedimentological parameters, were use to identify and characterize six flow units from the entire sequence. Log correlations, based on the sedimentological framework and stratigraphic sequence analysis techniques, in addition to 3-D seismic interpretations, were used to establish the external geometry and extension of flow units and thus, delineating the area and vertical limits of the reservoir. Reservoir application of this project include successful placing of appraisal wells to the south, grass-root drilling to the north, optimization of workover wells ove the entire area and a more realistic reserves quantification.

In a southerly direction, downdip from Ceuta and Barua-Motatan in the La Ceiba area, Misoa deltaic deposits exist with similar reservoir characteristics to those in the above mentioned fields. These deposits can be found at depths between 17500 and 18500 ft (5300 - 5600 m). Located at the eastern limit of the Misoa deltaics (Fig.4), delta front facies such as massive distributary mouth bar and barrier bar sands can be expected within the Misoa lower B and lower C intervals.

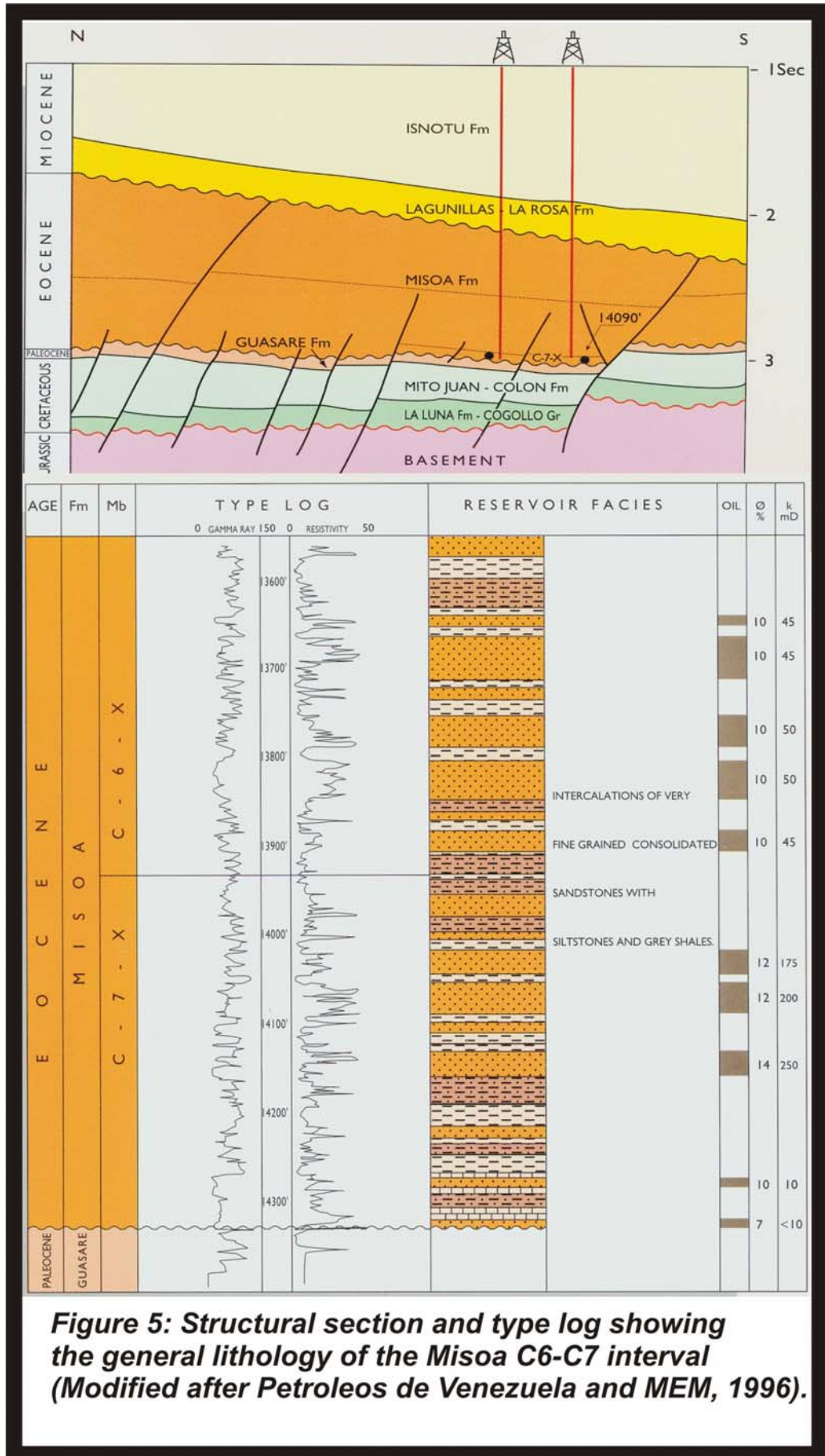
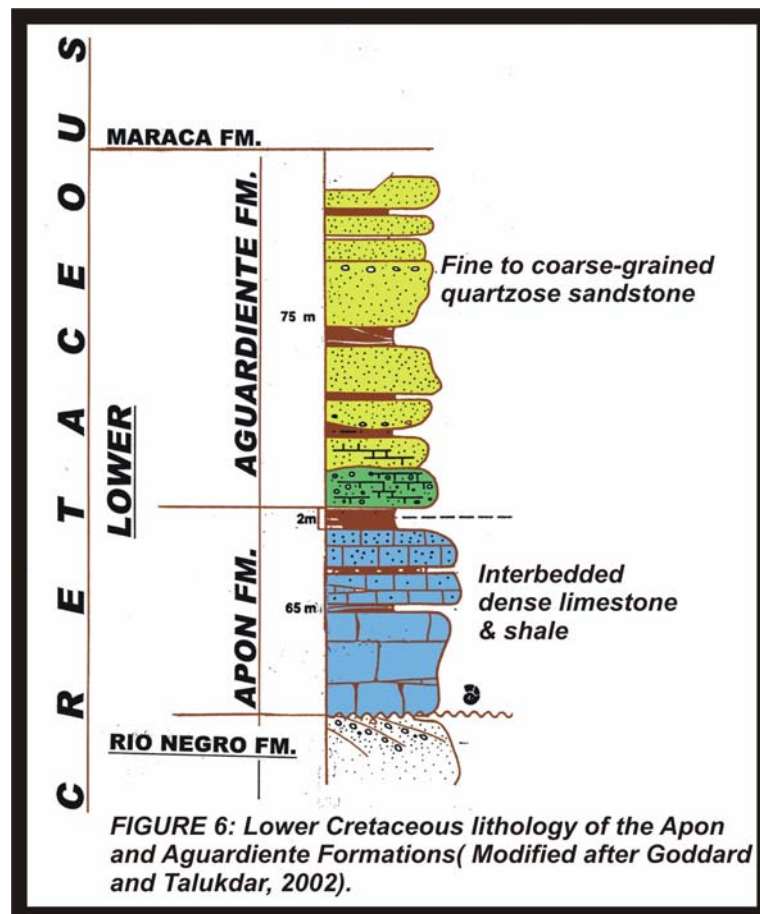


Figure 5: Structural section and type log showing the general lithology of the Misoa C6-C7 interval (Modified after Petroleos de Venezuela and MEM, 1996).

1.4 CRETACEOUS SANDSTONE (AGUARDIENTE FORMATION)

Excellent outcrops of the Albian Aguardiente Formation can be found in the Venezuelan Andes States of Trujillo, Merida, and Tachira, located east-southeast and south of the Maracaibo Basin. Its clastic facies consists primarily of fine to coarse-grained, clean quartzose sandstone (Fig. 6). Crossbedding and thin laminations can be observed in the basal sections. In outcrop, the Aguardiente measures from 1000 to 1600 ft. (300 - 500 m) in thickness. In southwest Zulia State and nearby in neighboring Colombia, outcrops average 525 ft (160 m) in thickness. The lithologic characteristics of the sand facies indicate fluvio-deltaic to coastal marine deposition. In the subsurface, in the southern areas of the Maracaibo Basin and in Barinas/Apure Basin, the Aguardiente Fm. lies unconformably on pre-Cretaceous rocks. In the subsurface of the Colon District, southwest of Lake Maracaibo, fine to coarse calcareous sandstones of the Aguardiente Formation are important reservoirs. The depth of hydrocarbon production, which occurs both from fractured carbonates and fractured calcareous cemented sandstone intervals, is at approximately 7500 feet (2280 m) in Tarra Field, and at about 15000 feet (4500 m) in Rosario Field. Fracturing plays an important role in the porosity which ranges from 4.55 to 20%. Permeability is rather low, between 0.1 and 4 md.

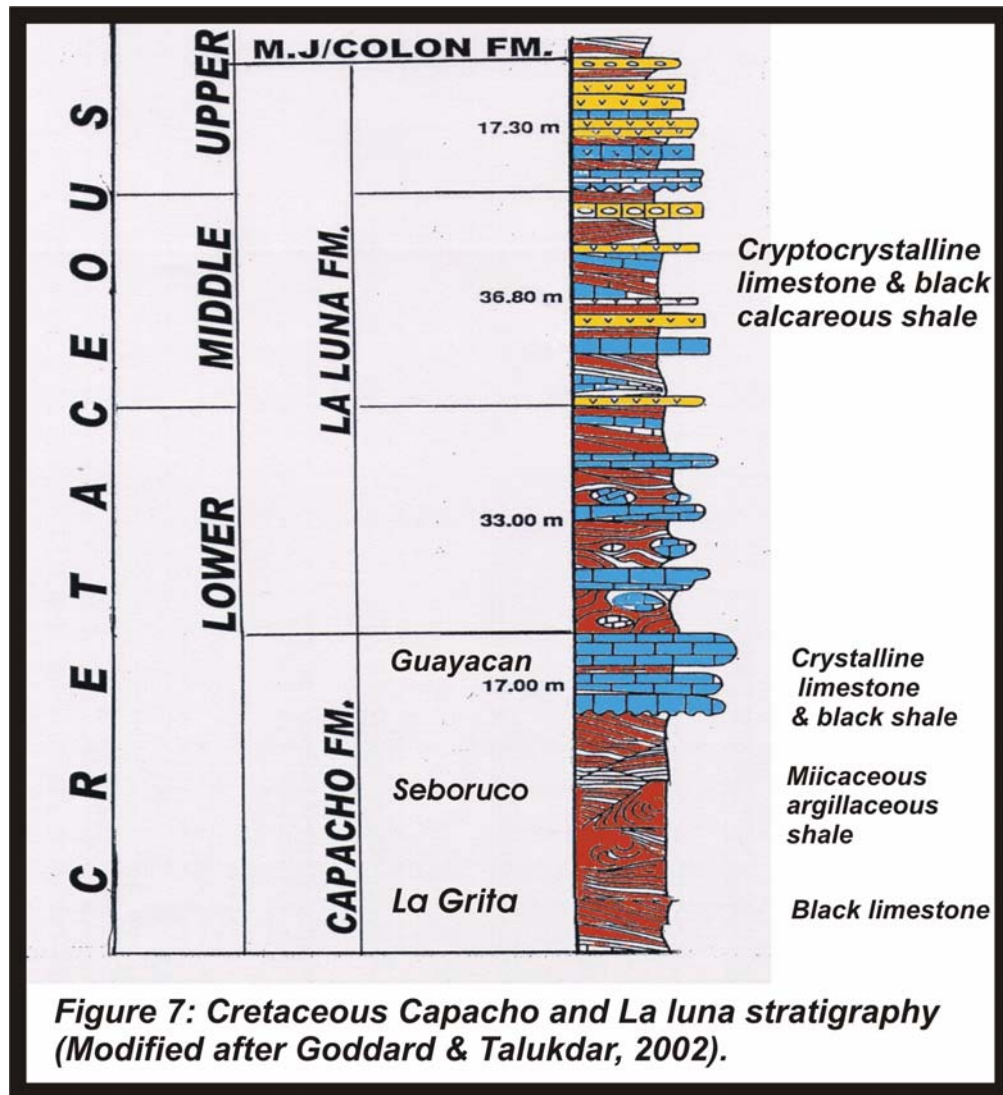


1.5 CRETACEOUS LIMESTONE (APON, LA LUNA/CAPACHO & COGOLLO GROUP)

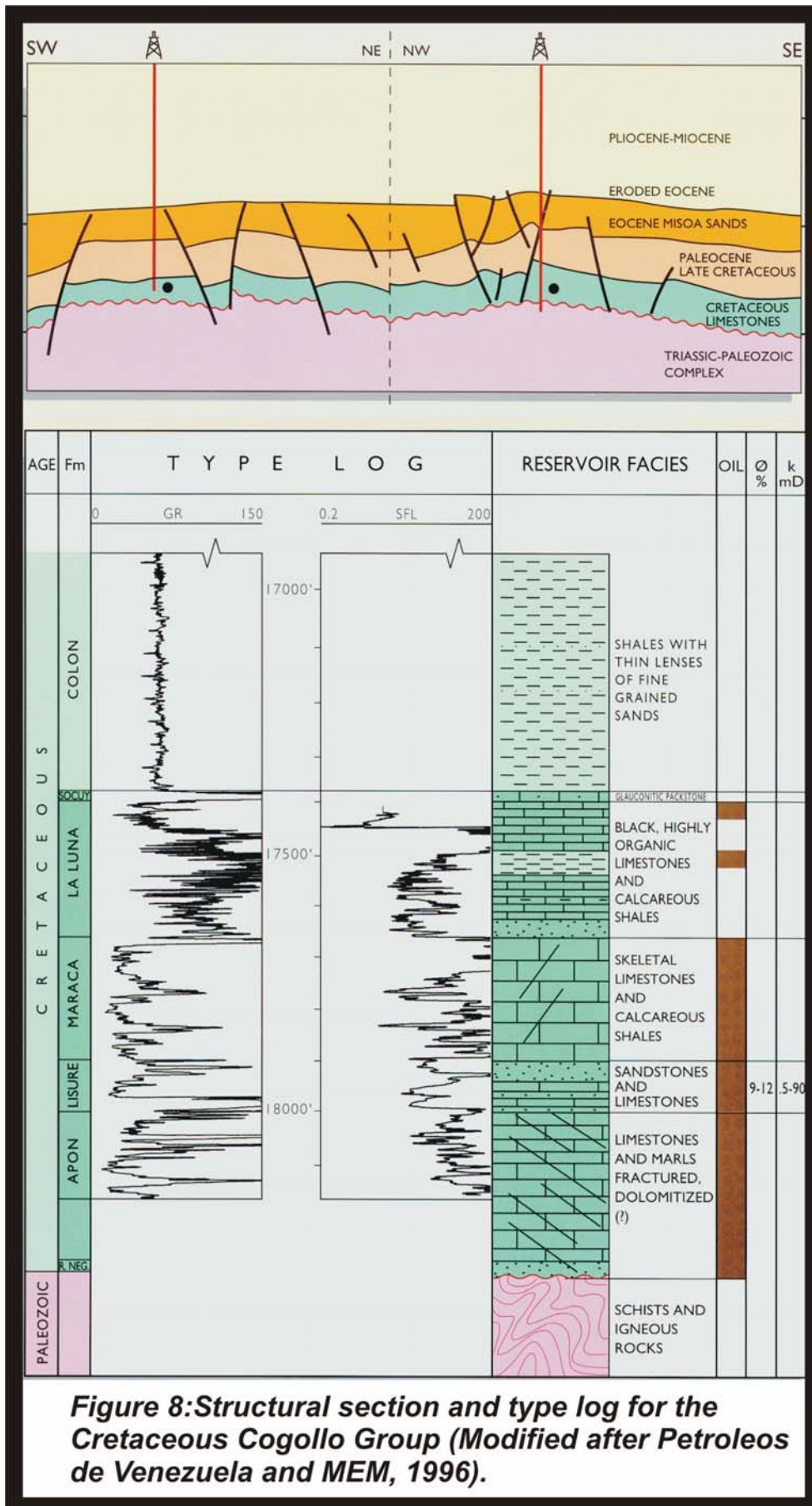
In the southern region of the Maracaibo Basin, the Apon Formation consists of hard, nodular limestone and numerous interbeds of black, calcareous shale. The thickest of these shale layers, the Guaimaros Member, is approximately 100 feet (33 m) thick and is considered an important source rock and an excellent producer of oil and gas after fracture stimulation (Fig. 6).

La Luna Formation's importance as a reservoir, as well as its excellent sourcing characteristics and the Capacho Formation's hydrocarbon generation potential in the south, have made them the subject of numerous geological and geochemical studies. Since they also outcrop extensively in the mountains bordering the Maracaibo basin their lithologies have been well described by oil companies that have worked in the area.

The Capacho Formation is over 500 feet (170 m) thick, and consists predominantly of black limestone (basal La Grita Member) and overlying thick, black micaceous argillaceous shale (Seboruco Member). Its uppermost unit (Guayacan Member) is a crystalline limestone interbedded with black shale. The overlying La Luna Formation also consists of black calcareous shale interbedded with cryptocrystalline limestone and calcareous cherts (Fig. 7). Under the microscope, thin alternating bands of carbonate and shale can be observed mimicking the thicker layers. These rocks give off a strong petroliferous odor on a fresh break. In certain outcropping areas of the Venezuelan Andes, phosphatic interbeds occur within siliceous limestone intervals. In the north, the La Luna Formation attains a thickness of 400 feet (140 m) and thins gradually to the south to a thickness of 100 feet (34 m) in the Andean region where its source potential has diminished.



In the northwestern onshore oil fields (La Paz, Mara, La Concepción) and the fields in Lake Maracaibo, the reservoirs in the Cogollo Group (Apon, Lisure, Maraca) produce where the wells intersect natural fractures and faults (Fig 8). The unit consists predominantly of micrite-rich carbonates with interbedded mudstone, wackestone, and shale. On modern resistivity and porosity logs through this unit, the porosity highs (9-12 %) tend to be erratic from top to bottom. Permeability tends to be low, and ranges from 0.5 to 10 md. It has been suggested that the high porosity zones are attributed not only to matrix porosity in the carbonates but also to the fracture-dominated mudstone and shale intervals. Therefore, optimum productivity of the Cogollo reservoirs occurs where both fractures and matrix porosity are present, and is independent of lithology.



2. FALCON BASIN RESERVOIRS

2.1 MIOCENE LOWER LA PUERTA GROUP

The lower La Puerto Group sandstone deposits of Miocene age are the principal hydrocarbon reservoirs in southwest Falcon Basin (Tiguaje and Hombre Pintado Fields). The lenticular sandstones in this interval belong to a progradational deltaic complex that existed in the Dabajuro Block (Fig. 9). The abundant coal beds found in the basal La Puerto Group are an integral part of this Miocene deltaic deposition. Average porosities in the sandstone reservoirs are 22% and the permeability ranges from 74 to 1800 md. Producing depths are located between 800 and 3600 feet (245-1100 m). The average oil gravity is 22° API.

2.2 MIOCENE CAUJARAO AND SOCORRO FORMATIONS

Toward the east and northeast parts of the Falcon Basin, the Miocene Socorro and Caujarao Formations are shallow water marine deposits that contain the principal hydrocarbon reservoirs in the Cumarebo Field. These reservoirs are located between 500 and 3000 feet (150- 900 m) in depth. Discovered in 1931, the cumulative production by 1950 was 42.4 million barrels of oil. The principal reservoirs responsible for this production are: 1) the calcareous sand facies of the Lower Miocene Socorro Formation, and 2) the sandy limestone of the Middle Miocene Caujarao Formation. Their average porosity is 22%, with moderately high permeability ranging from several hundred millidarcies to 3 darcies. Gravity of the oil is 47.5° API.

2.3 LOWER MIOCENE AGUA CLARA FORMATION

The shallow water marine sediments that were deposited in seas of the Falcon basin during the early Miocene transgression are represented by the Agua Clara Formation and the lower part of the Agua Salada Group. In the La Vela Gulf, the Agua Clara interval consists of the lower Cauderalito Member of thin sandy fossiliferous limestone beds and the upper Santiago Member consisting of interbedded shale and sandstone deposits. In the offshore, the Cauderalito limestone is the reservoir of interest. Typically, these reefal deposits, averaging 100 feet (30 m) in thickness, are located between 8000 and 11,000 feet (2440 – 3350 m) in depth on top of basement horst blocks (Fig.10). Fractured and vuggy porosity of the reservoir section averages 15% and the permeability averages 120 md.

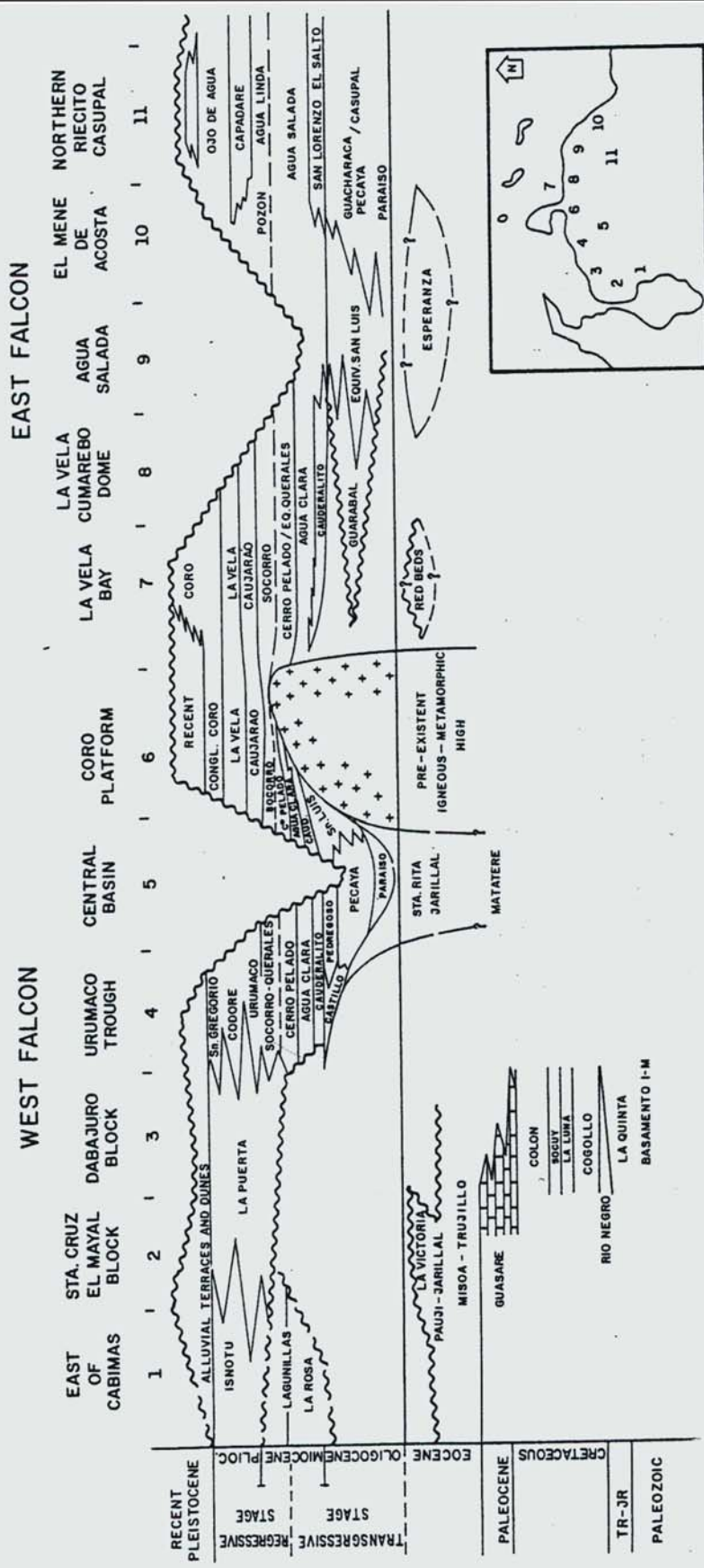


Figure 9: Stratigraphy of the Falcon Basin (After Boesi and Goddard, 1991 in AAPG Memoir 52.

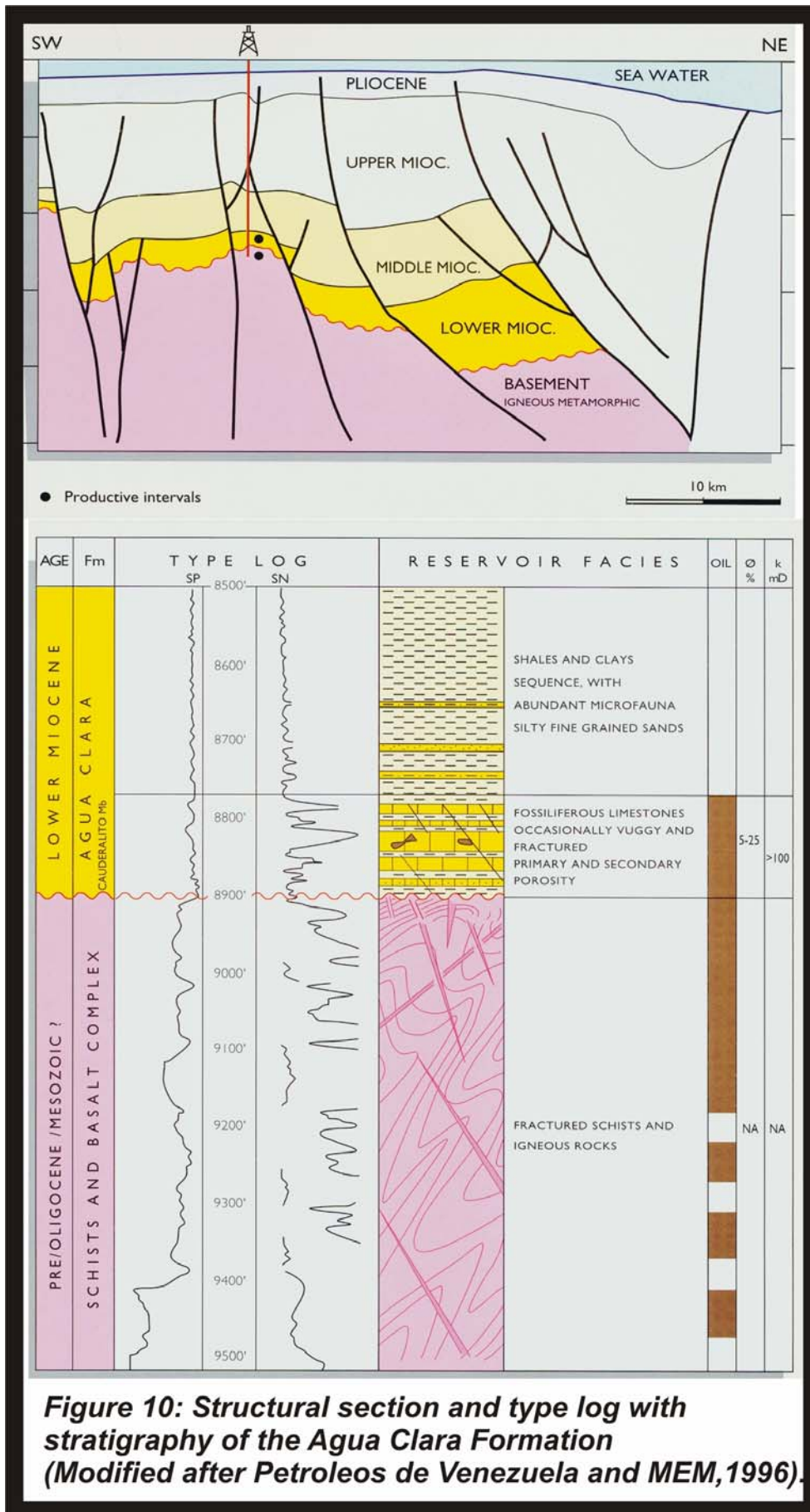


Figure 10: Structural section and type log with stratigraphy of the Agua Clara Formation (Modified after Petroleos de Venezuela and MEM, 1996).

3. BARINAS/APURE BASIN RESERVOIRS

3.1 OLIGOCENE GUAFITA FORMATION

The basal portion of the Guafita Formation, known as the Arauco Member, is the main producer in the Guafita Field situated in southwest Barinas-Apure Basin). The reservoirs, located at approximately 7500 feet (2300 m), consist of crossbedded, medium to coarse-grained, poorly consolidated sandstone with net oil pays of 20 - 150 feet. This Oligocene interval is a deltaic sequence consisting of interbedded distributary channels, crevasse splays, and interdistributary bay shales. The Guafita Shale, a lagoonal deposit, is believed to be the effective seal overlying the oil sands of the Arauca Member. These distributary channel sands have average porosities of 25% and high permeability that ranges from 1.5 to 7 darcies.

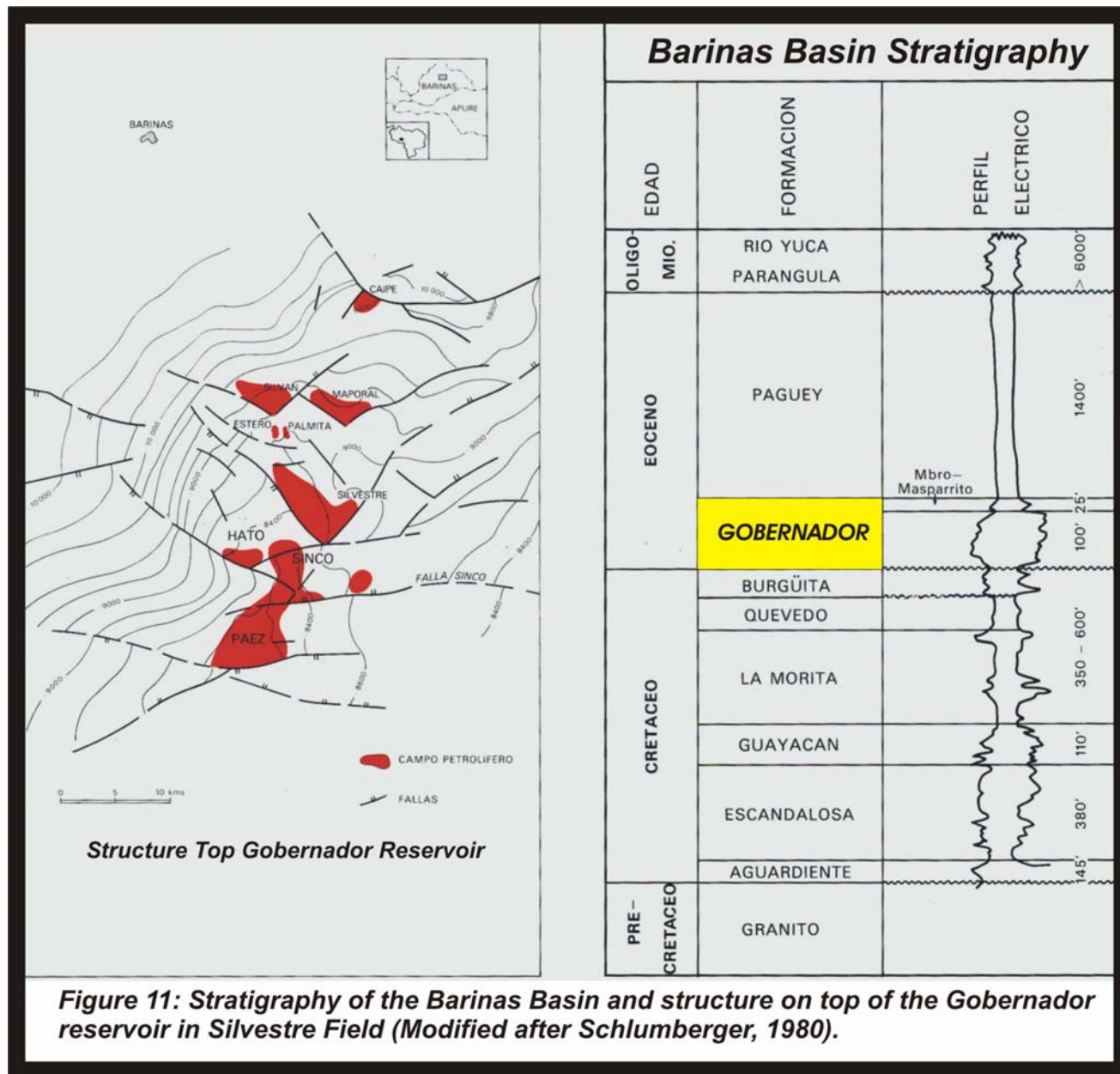
3.2 EOCENE GOBERNADOR FORMATION

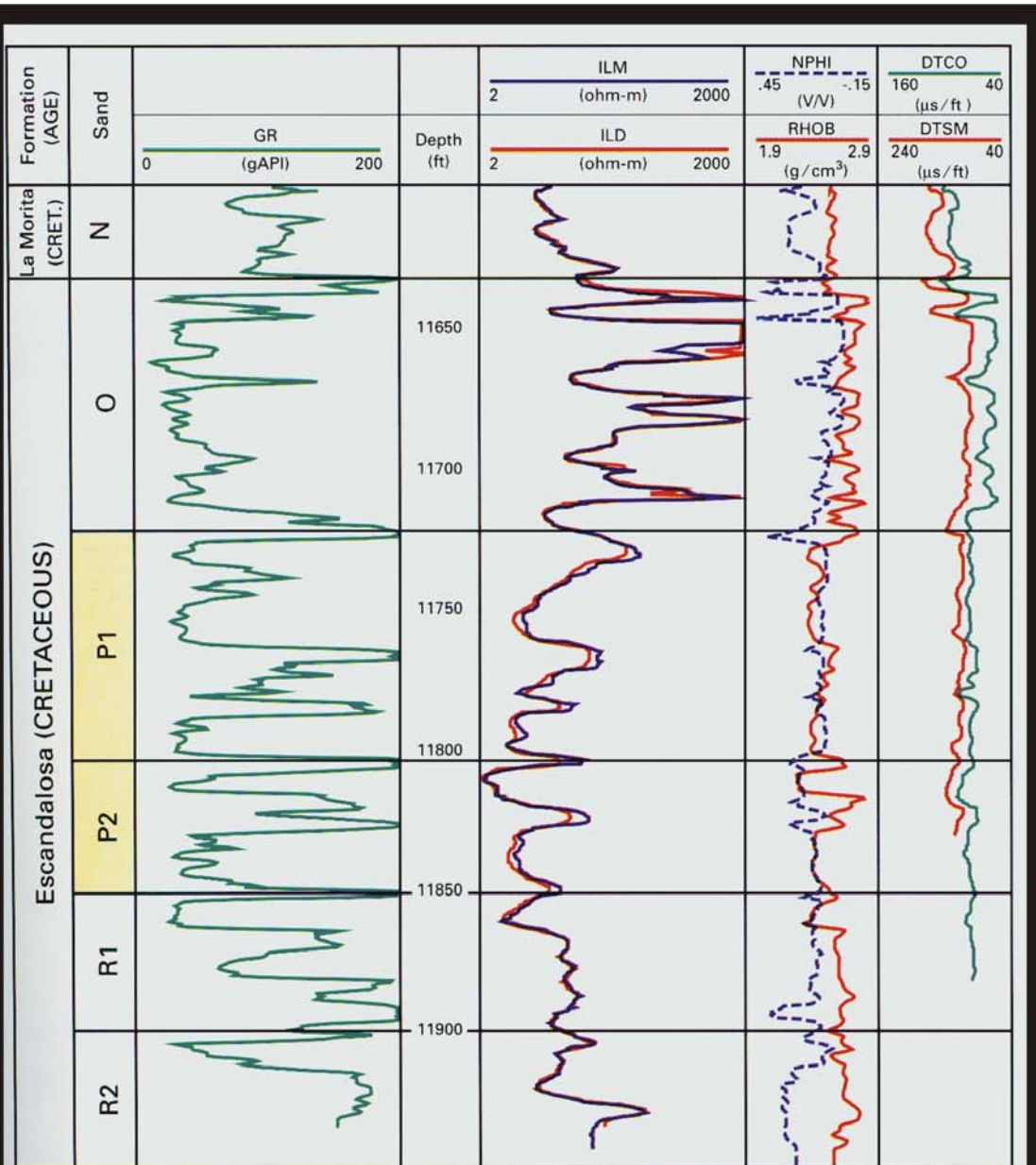
The Eocene transgression in the Barinas/Apure Basin is represented by the development of a thick basal clastic unit which is the Gobernador Formation (Fig.11). Similar to its equivalent, the Misoa Formation in the Maracaibo Basin, it consists of a series of thin stacked deltas. The interval is made up of friable quartzose sandstone interbedded with siltstone, shale, and thin lignite layers. The highly productive sandstone interval in the Silvestre oil fields of the Barinas area averages 100 ft. (30 m) in thickness. Located between 8000 and 10,000 feet (2400-3050 m) in depth, the reservoirs have porosity that varies between 20 and 28%, these being affected by abundant clay particles. Permeability values can be as low as 200 and as high as 2 darcies. Gravity of the oil found in the Gobernador reservoirs is 22° API.

3.3 CRETACEOUS ESCANDALOSA FORMATION

In the Barinas Basin, the Cretaceous Escandalosa Formation contains the main producing sandstone intervals in the Silvestre and Sinco Fields. Outcrop studies in the Andean foothills northeast of San Cristobal show the deposits to consist of glauconitic massive quartzose sandstone and black shale. Based on their faunal contents (Ostrea spp. and foraminifera), these sediments are believed to have been deposited in shallow water to neritic environment. Porosity in the producing sandstone intervals average 20% and permeability can be as high as 1 darcy, but averages 500 md (Fig.12). The sandstones, located between 10,000 and 11,000 feet (3050-3350 m) in depth in the Barinas fields, contain from 20 to 120 feet of net pay. The gravity of the oil from the producing interval averages 25° API. Geochemical analyses on Cretaceous

calcareous shale and limestone in the Morita and Quevedo Formations indicate a type II kerogen with predominantly marine organic matter. These rocks are equivalent in age and depositional environment to the La Luna Formation in the Maracaibo Basin. Therefore, they are considered the principal source rocks for the hydrocarbons found in the Oligocene Guafita, Eocene Gobernador, and Cretaceous Escandalosa reservoirs in Barinas-Apure Basin. However, other Cretaceous and Eocene marine shales deposited within the Barinas/Apure Basin cannot be ruled out as secondary source rocks.





	From cores	From logs
Porosity (%)	18.7	20.1
Water saturation (%)	39.0	34.0
Permeability (md)	556	90–753*

Figure 12: Type log and reservoir quality of the Cretaceous Escandalosa producing interval (Modified after Schlumberger, 1997) .

4. EASTERN VENEZUELA BASIN RESERVOIRS

GREATER OFICINA AND ANACO AREAS

4.1 MIOCENE OFICINA FORMATION

The Oficina Formation, first described in the Oficina No. 1 well (1937), is a subsurface unit of thin stacked deltas that extends along the southern portion of the Eastern Venezuelan Basin in the States of Monagas and Anzoategui. This thick deltaic interval consists of interbedded sandstone, shale and lignite layers. In the Greater Oficina area the entire sequence is around 5000 feet (1500 m) thick, more than 9000 ft.(2750 m) in the Anaco area, and approximately 1000 feet (305 m) thick in the area of Temblador. The reservoirs consist mainly of stacked distributary channel and bay fill sands with porosity ranging from 20-35% and permeability from 50 - 1000 md (Fig.13). Short distant lateral pinch-outs are common, but reservoir pressures and oil gravities indicate that many of the channels are in communication. In the Oficina and Anaco areas most of the oil is light (34° - 57° API) and highly paraffinic. To the south, in the Heavy Oil Belt, the gravity of the oils in the Oficina Formation reservoirs range from 8° to 12° API. Here, these shallow producing intervals (1000 - 3000 feet.) consist of unconsolidated distributary channel sands with porosity averaging 30% and very high permeability averaging 2 darcies.

4.2 OLIGOCENE MEREURE FORMATION

The Mereure Formation is also a thick (1600 - 2200 feet) subsurface unit in the Anaco and Oficina areas which was deposited in a more fluvial, continental environment. It consists of abundant massive, fine to coarse grained, crossbedded sandstone interbedded with thin, black carbonaceous shale. The sandstone layers are more abundant and continuous than those in the overlying Oficina Formation. In a northerly direction, toward the Maturin Sub-Basin, the Mereure Formation thickens and its equivalent is termed the Mereure Group. This Group is made up of the Los Jabillos, Areo, and Naricual Formations. These are predominantly two sandstone units (Los Jabillos and Naricual) separated by a thick prodelta shale interval (Areo). The prolific oil reservoirs of the Mereure Formation appear to be stacked interbraided channels whose sandstones have porosity that fluctuates between 20 and 25%. The permeability ranges between 150 and 350 md. The reservoirs, located at depths between 4000 and 8000 feet (1200 - 2400 m) also contain light oil averaging 35° API (Fig. 13).

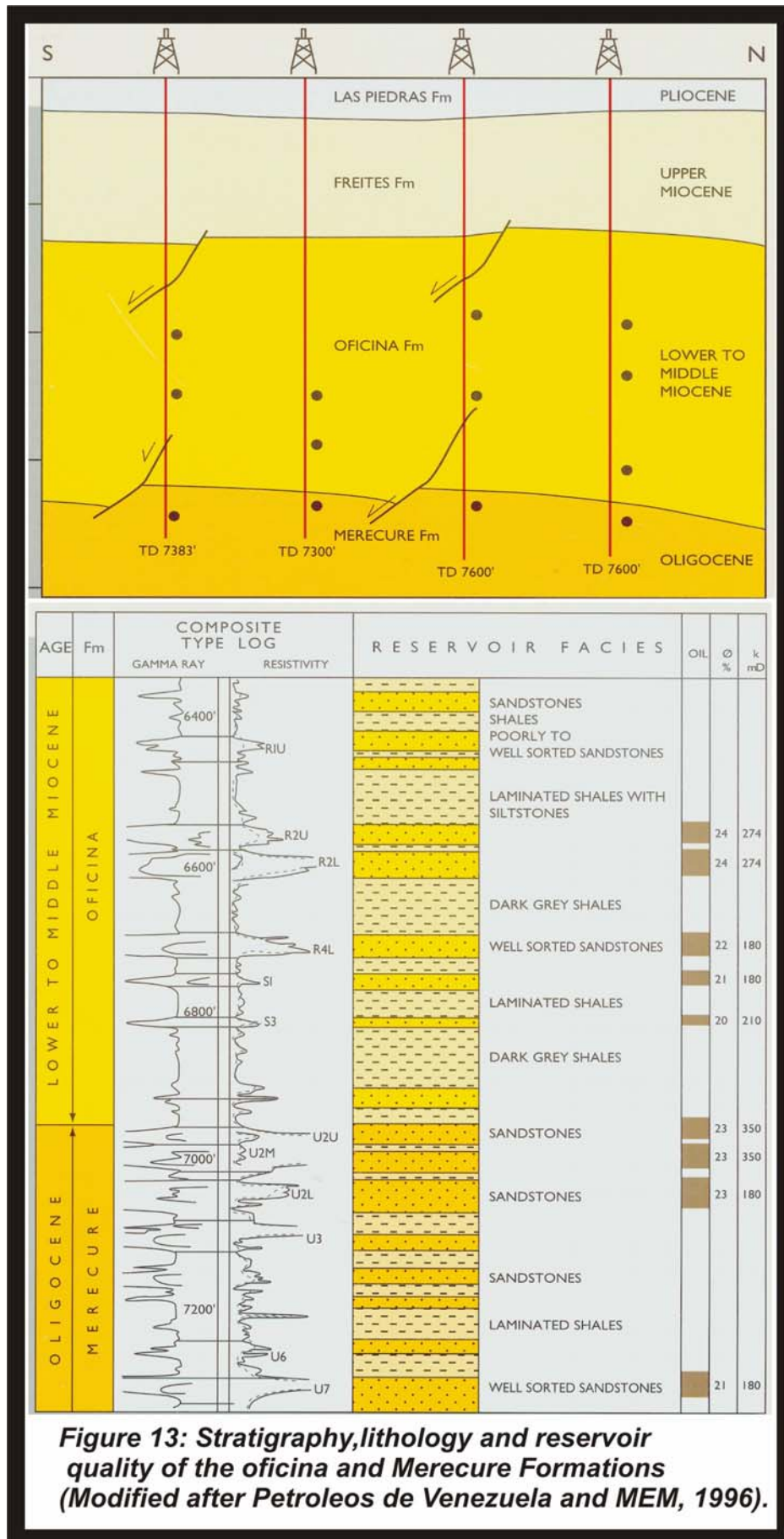


Figure 13: Stratigraphy, lithology and reservoir quality of the Oficina and Merecure Formations (Modified after Petroleos de Venezuela and MEM, 1996).

MATURIN SUB-BASIN

4.3 MIOCENE LA PICA FORMATION

Lower delta plain to shallow marine (delta front) deposits of the La Pica Formation contain prolific reservoirs that produce in the areas of Santa Barbara and Jusepin in northern Monagas State (Fig. 14). The interval consists of alternating loose fine sands, shale, and lignitic, micaceous silty clay. The shallow marine facies (*Textularia* and *Sigmoilina* sands) contain the principal reservoirs. The entire La Pica interval measures 3000 to 6000 feet (900-1800 m) thick, and extends as far east as Pedernales. In this area of the northern Orinoco Delta, the lenticular, fine sand facies of the La Pica are also the important oil producers. Here, the average porosity is 27% and average permeability is 300 md. Gravity of the oil ranges from 17.5° to 31° API.

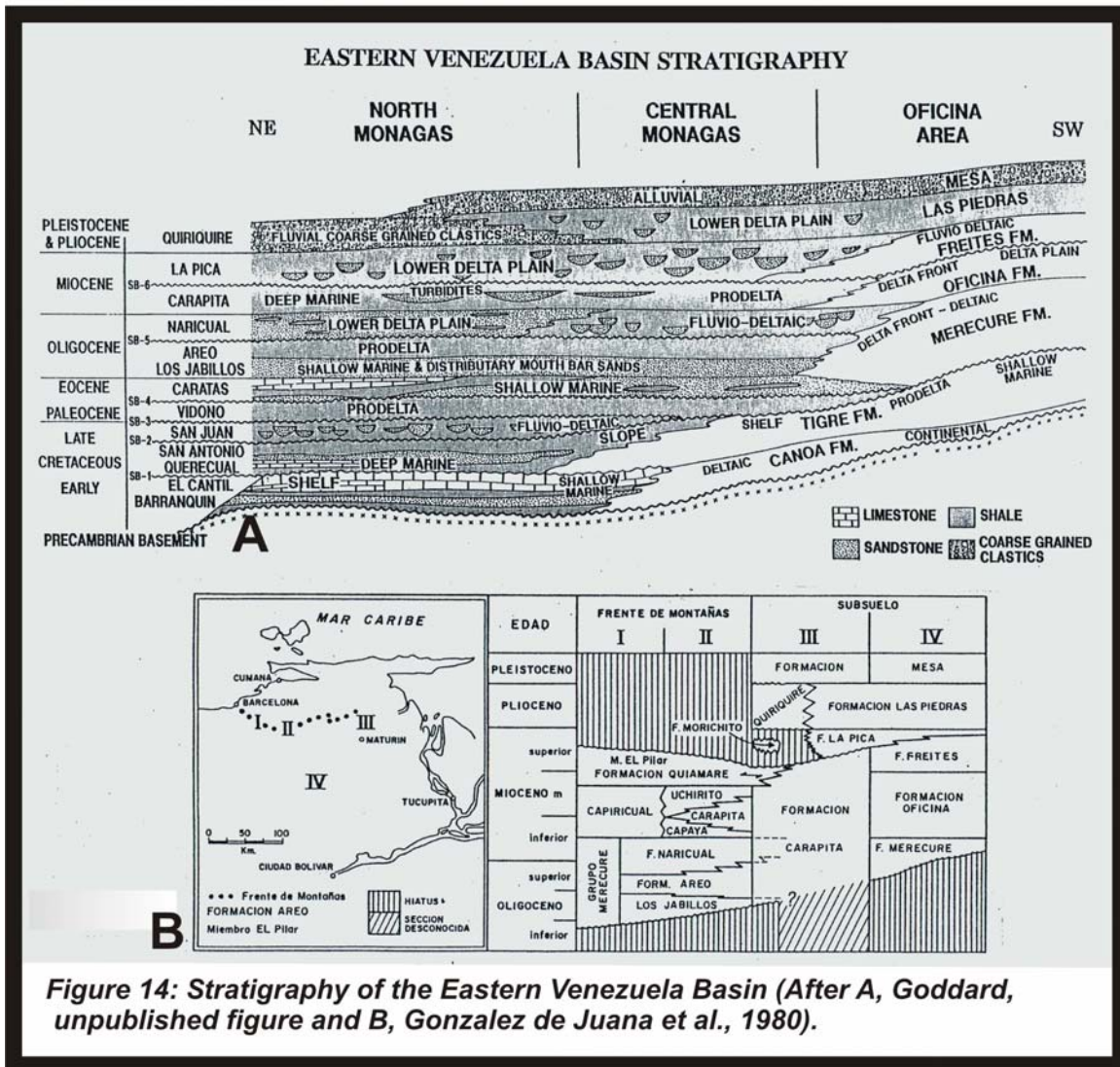


Figure 14: Stratigraphy of the Eastern Venezuela Basin (After A, Goddard, unpublished figure and B, Gonzalez de Juana et al., 1980).

4.4 OLIGOCENE NARICUAL FORMATION

The upper deltaic interval of the Merecure Group, the Naricual Formation, was originally described at its type location near Barcelona where it drew much attention because of its abundant coal measures. Here the interval measures 1750 feet (530 m) in thickness. It extends as far west as the frontal thrusts of Guarico State. In the subsurface toward the east it extends to the Santa Barbara and Jusepin Fields within the fold and thrust belt of the Maturin Sub-Basin. It was not until 1986, however, that Corpoven and Lagoven's intensive exploration efforts in these areas, using 3-D seismic methods, could locate adequate traps at the Naricual level. Successful drilling penetrated the Naricual prolific reservoirs between 14000 and 17500 feet (4250 -5350 m) in what is called today the Furrial Trend. The reservoirs are located in the upper part of the formation and consist of thick distributary channel sandstones. This Naricual deltaic sequence disappears farther to the east toward the Quiriquire Field where the Los Jabillos Formation becomes the interval containing important hydrocarbon reservoirs below the shallow Pliocene producers (Fig.15).

The following abstract from the 1994, AAPG Annual Meeting in Denver gives a brief description of the Oligocene Naricual sequence found beneath the Pirital allochthonous block: LANDER, R. A., A. GONZALEZ, J. FUENTES, and J.DAAL, Exploration Management, Corpoven S.A., Venezuela; "Exploration of the Late Cretaceous and the Oligocene Sequences Underneath the Pirital Allochthonous Block, Northern Monages Area, Eastern Venezuela Basin."

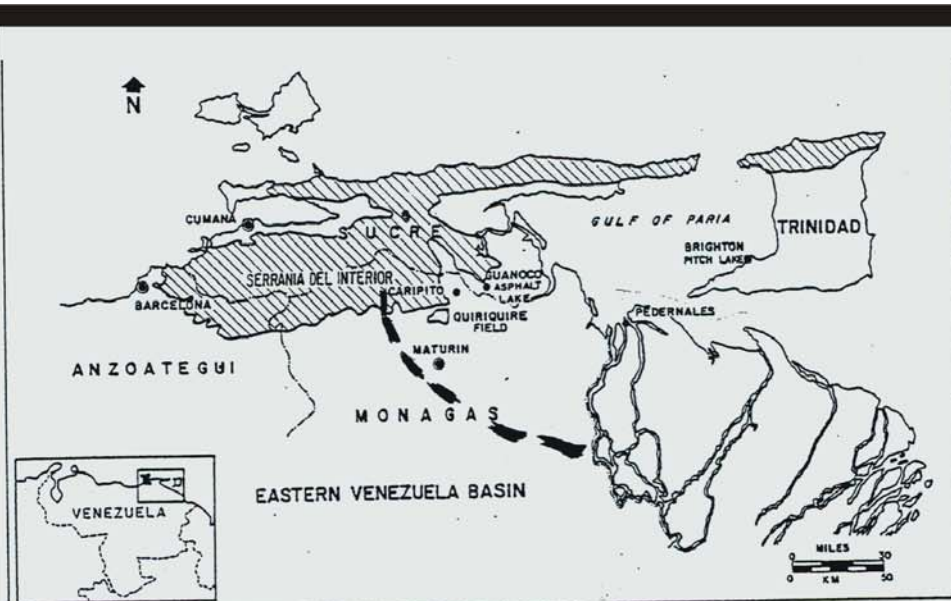
The search for prospective formations underneath the Pirital allochthonous block began in the 50th decade, when Mene Grande Oil Company drilled seven exploration wells. These penetrated the Pirital allochthonous block, but due to mechanical problems they did not reach the programmed objectives. At that time, the proposed exploratory model suggested a high-angle reverse fault at the base of the allochthonous block, which restricted the prospective section towards the north. Since 1989, after the drilling of 1 exploratory well along the El Furrial-El Tejero trend, a new exploratory model is proposed: the base of the Pirital block is a sub-horizontal plane, and the Upper Cretaceous and Oligocene-Lower Miocene sediments are extended northward, beneath it. The SBC-3E well was drilled in order to test the new model. It was completed in December 1989, with a production of 6100 BOPD (35 degree API) and 47 MMCFGD. A second well, PIC-1E, located 7.5 km northwest of the SBC-3E well, was drilled in order to investigate the quality of the reservoir rocks underneath the pirital block. This well was completed in April 1992, with a production of 4500 BOPD (36 degree API) and 37 MMFGD. The successful results of these two wells drilled north of the Pirital thrust suggest an exploratory area as big as the El Furrial-El Tejero trend, but two geological risks must be taken into account: the allochthonous block's thickness and the depth of the prospective sequences.

4.5 OLIGOCENE LOS JABILLOS FORMATION

The Los Jabillos Formation outcrops along the Interior Mountain Range in northwest Anzoategui and central Monagas States. To the south, in the subsurface beneath the overthrust mountain front, it extends east past Quiriquire towards Trinidad. Beneath the Quiriquire Field the producing reservoirs consist of fine to medium quartz sandstone that averages 200 feet (60 m) thick. Both intergranular and fracture porosity exist and together reach as high as 18%, but average 15%. The permeability tends to be low between 70 and 120 md. The reservoirs contain light oil (38° API), gas and condensate (68° API). Depth to the producing intervals varies from 7000 to 10500 feet (2150-3200 m), but deepens rapidly in a southerly direction. The characteristics of the Los Jabillos reservoirs, and their stratigraphic position between the overlying Area prodelta shales and the underlying shallow marine deposits of the Caratas Formation (Fig. 15), leads one to conclude that they are probably delta front, distributary mouth bar, and barrier bar deposits.

4.6 CRETACEOUS SAN JUAN FORMATION

The basal sandy unit of the Santa Anita Group, the San Juan Formation, outcrops in northeast Anzoategui and northern Monagas States. It consists mainly of thick, massive layers of fine to medium, well-sorted sandstone (Fig. 15). In the subsurface, wells have penetrated intervals of 350 to 700 feet (105-215 m) within the fold and thrust belt in the Maturin Sub-Basin. Reservoirs located between 13,500 and 15,000 feet (4100-4575 m) in depth have produced light oil (37° - 40° API) in the area of Orocuál northeast of Jusepin Field. Located beneath the the Vidono prodelta shale, which acts as a regional seal, the San Juan sandstone reservoir characteristics are similar to those of: 1) delta front, thick distributary mouthbars, and 2) shallow marine glauconitic sheet sands that are calcareous cemented in places.



PERIOD & EPOCH		FORMATION	LOG.	THK.	LITHOLOGY AND OIL & GAS OCCURRENCE	
TERTIARY	MIOCENE	MORICHITO		0' - 400'	Morichito: Ss, Siltst, Congl and Shs. La Pica: Shs and siltst, only SE of the field.	
		LA PICA		0 - 122 m		
		ZONE "A"				
	MIDDLE	CARAPITA		ZONES "B" "C"	2000'-5000'	Dark gray foraminiferal shales. Locally sandy and conglomeratic (turbiditic).
				ZONE "D"		Same as above
	EARLY	CARAPITA		ZONE "E"		Same as above
				ZONE "F"	610-1525 m	Same as above
				AREO	100' - 200'	Dk gray foraminiferal sh and siltst, often glauconitic.
	OLIGOCENE	LOS JABILLOS		LOS JABILLOS	165' - 230'	Thk-bedded f- to md-grained qtz ss, locally pebbly. Gas/condensate bearing 38' to 68' API.
				LOS JABILLOS	50 - 70 m	
EOCENE	STA. ANITA GR.	CARATAS	985'-1150'	Gray to grnsh gray, calc, glauconitic siltst f.g. calc ss occasionally dolomitic ls. Oil bearing 12' to 52' API.		
		VIDOÑO	300-350 m	Dk gray glauconitic, foraminiferal shs and ss. Oil bearing 12' to 25' API.		
PALEOCENE	STA. ANITA GR.	SAN JUAN	425'	Thk bedd, f- to md-gr, well sorted qtz ss, locally calc. Gas and condensate bearing 56' API.		
CRETACEOUS	LATE	QUAYUTA GR.	SAN ANTONIO	130 m		
			SAN ANTONIO	2550'- 4920'	Dk gray to blk thin-bedded carbon bituminous, calc shs and shly ls interbedded w/ ss. Poor reservoir. Tested condensate 52' API.	
			QUERECUAL	780-1500 m	Same as above. More shly and less sdy. Not penetrated by wells.	
	EARLY	SUCRE GR.	EL CANTIL	2130'-3000'	Thk-bedded mass ls and calc sh. Not penetrated by wells.	
			BARRANQUIN	650-915 m		
			5000' +	1524 m +	Md- to crse-gr cross bedded ss, siltst, sdy carb sh. Not penetrated by wells. Base unknown.	

Figure 15: Stratigraphy of the Maturin Subbasin (After Salvador and Leon, 1992; in the AAPG Treatise of Petroleum, Vol. III).

GUARICO SUB-BASIN

4.7 OLIGOCENE LA PASCUA FORMATION

A prolific producer in the Las Mercedes oil fields in central Guarico State the La Pascua Formation consists of a series of thin stacked deltas (Fig. 16). Its lithology is characterized by interbedded sandstone (50%), shale, and thin lignite layers. The shale contains abundant plant material, molluscs and foraminifera, which is consistent with lower delta plain and delta front, interdistributary bay and lagoonal facies. The La Pascua deltas were formed during Lower Oligocene time on the northern margin of the Guyana Precambrian Shield, the source of its sediments. In northern Guarico state, in the frontal thrust zone out from the delta plain, a shaly lagoonal facies developed in the delta front. In the Yucal-Placer Field, a few reservoir quality sandstones (barrier bars, tidal channels) were found to be excellent gas producers within the La Pascua, and in the overlying Roblecito and Chaguaramas prodelta shaly formations (Fig. 16). The depth of this gas production ranges from 5,000 to 10,000 feet (1525 - 3050 m). To the south, in the Las Mercedes area, oil production, mainly from the La Pascua reservoirs, is located between 3,000 and 5,000 feet in sandstones with average porosity of 25% and permeability of 350 md. Geochemical studies carried out by INTEVEP in the 1980's, demonstrated that the principal source rock interval for the hydrocarbons in the Guarico Sub-Basin is the Cretaceous Tigre Formation of the Temblador Group, which contains type II marine kerogen. Because the source rocks are thermally over mature (1.2% to 2% Ro), due to deep burial, abundant gas has been generated in the area.

PERIOD	AGE	FORMATION	LITHOLOGY	DESCRIPTION	
TERTIARY	PLEISTOCENE	ALLUVION		FLUVIAL SANDSTONES	
	MIOCENE	CHAGUARAMAS		SAND-SHALE-LIGNITE SERIES	
		600-1400 m			
	OLIGOCENE	UPPER	ROBLECITO		PREDOMINANTLY MARINE SHALE, DARK GRAY TO BLACK WITH FEW SAND TONES
		MIDDLE			
		LOWER	LA PASCUA	300-430 m	BRACKISH-WATER TO MARINE SANDSTONES AND DARK SHALES WITH A FEW LIGNITES.
EOCENE					
PALEOCENE					
CRETACEOUS	MAESTRICHTIAN to TURONIAN	GRUPO TEMBLADOR	GUAVINITA	SANDS AND THIN LIMESTONES ASSOCIATED WITH FISH REMAINS AND CHERT BEDS	
		INFANTE	250	LOCALLY GLAUCONITIC, COMPACT, FOSSILIFEROUS LIMESTONE.	
	CENOMANIAN to APTIAN	LA CRUZ		KAOLINIC SANDS WITH MINOR INTERCALATIONS OF BLACK CARBONACEOUS FOSSILIFEROUS SHALE.	
		CANOA		LENTICULAR CONTINENTAL SANDSTONES WITH MINOR SHALE INTERVALS	

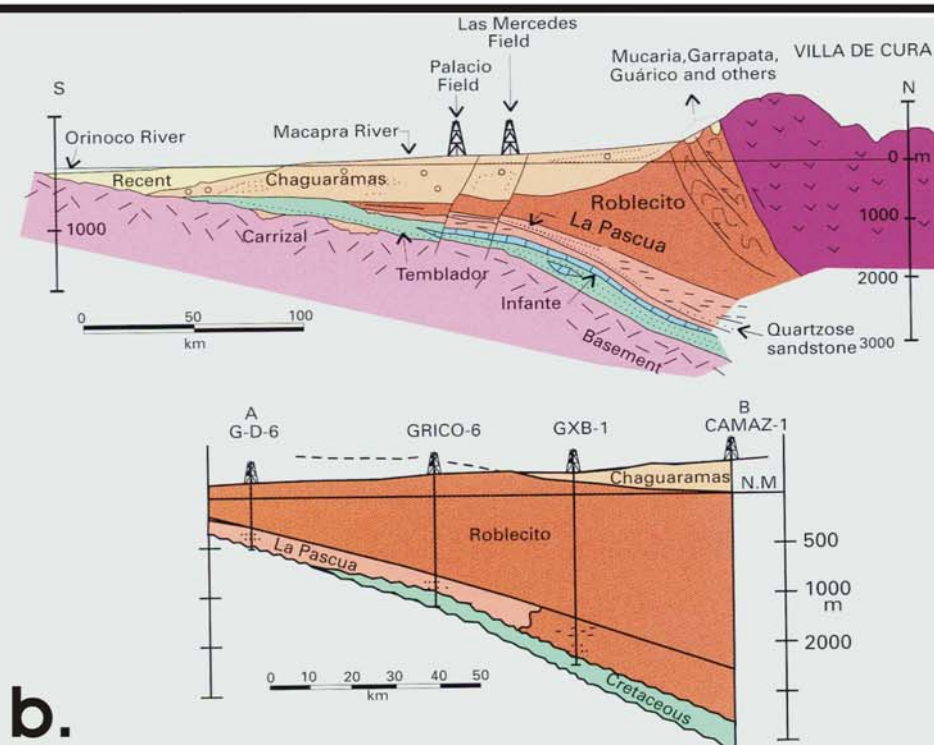


Figure 16: General Structure & Stratigraphy of the Guarico Subbasin (16a modified after Daal and Lander, 1993; in the Treatise of Petroleum Geology, Vol. VIII, and 16b modified after Gonzalez de Juana, et al., 1980)

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APPENDIX # 1

Authorizations for Expenditure (AFE)

Authorization for Expenditure (AFE)

Estimate for a 2500' Straight Hole (Precompletion Estimate Included)

				ESTIMATED INTANGIBLE COSTS		
				DRILLING	PRECOMPL.	TOTAL
				COST	COST	AFE
Surveys and Permits/Environmental				\$8,000	\$2,000	\$10,000
	Day Rate	Days	Precompl.			
Rig Move (Mob. & Demob.)	\$5,000	2		\$10,000	\$0	\$10,000
Drilling Per Day	\$5,000	2	1	\$10,000	\$5,000	\$15,000
Fuel, Lubes and Water	\$1,000	2	1	\$2,000	\$1,000	\$3,000
Rental Equipment	\$1,000	2	1	\$2,000	\$1,000	\$3,000
Drill Bits				\$10,000	\$1,000	\$11,000
Drilling Mud & Chemicals		2	1	\$40,000	\$0	\$40,000
Mud Logging				\$0	\$0	\$0
Cement & Squeeze Services				\$25,000	\$5,000	\$30,000
Casing Crews & Tools				\$10,000	\$5,000	\$15,000
Open Hole Logging+MWD/LWD				\$50,000	\$0	\$50,000
Sidewall Cores & Analysis				\$2,000	\$0	\$2,000
Transportation	\$3,000	2	1	\$6,000	\$3,000	\$9,000
Labor	\$2,000	2	1	\$4,000	\$2,000	\$6,000
Supervision	\$850	2	1	\$1,700	\$850	\$2,550
P&A Costs	\$10,000	2	0	\$20,000	\$0	\$20,000
Pipe Inspection				\$5,000	\$2,000	\$7,000
Overhead	\$500	2	1	\$1,000	\$500	\$1,500
Insurance	\$400	2	1	\$800	\$400	\$1,200
Communications	\$250	2	1	\$500	\$250	\$750
				\$208,000	\$29,000	\$237,000

TANGIBLE COSTS

	<u>Depth (Ft)</u>	<u>Diameter</u>	<u>\$/Ft</u>			
Drive Pipe		30"	220 (not needed)	\$0	\$0	\$0
Conductor		20"	60 (not needed)	\$0	\$0	\$0
Surface Casing		16"	16 (not needed)	\$0	\$0	\$0
Intermediate Casing	100	8-5/8"	25	\$2,500	\$0	\$2,500
Production Liner	2500	5 1/2 "	12	\$0	\$30,000	\$30,000
Wellhead Equipment				25,000	\$5,000	\$30,000
TOTAL TANGIBLES				\$27,500	\$35,000	\$62,500
TOTAL AFE COSTS				\$235,500	\$64,000	\$299,500

Range of Total Costs

	Base Case	Lower Limit	Higher Limit
Total Rig Cost	\$25,000	\$21,250	\$27,500
Fuel, Lubes and Water	\$3,000	\$2,550	\$3,300
Rental Equipment	\$3,000	\$2,550	\$3,300
Drilling Mud & Chemicals	\$40,000	\$34,000	\$44,000
Mud Logging	\$0	\$0	\$0
Transportation	\$9,000	\$7,650	\$9,900
Labor	\$6,000	\$5,100	\$6,600
Supervision	\$2,550	\$2,168	\$2,805
P&A Costs	\$20,000	\$17,000	\$22,000
Insurance	\$1,200	\$1,020	\$1,320
Communications	\$750	\$638	\$825
Drive Pipe	\$0	\$0	\$0
Conductor	\$0	\$0	\$0
Surface Casing	\$0	\$0	\$0
Intermediate Casing	\$2,500	\$2,125	\$2,750
Production Liner	\$30,000	\$25,500	\$33,000

Authorization For Expenditure (AFE)

Estimate for a 5000' Straight Hole w/1000HP Rig (Precompletion Estimate Included)

ESTIMATED INTANGIBLE COSTS				DRILLING	PRECOMPL.	TOTAL
				COST	COST	AFE
Surveys and Permits/Environmental				\$10,000	\$2,500	\$12,500
	Day Rate	Days	Precompl.			
Rig Move (Mob. & Demob.)	\$5,000	4		\$20,000	\$0	\$20,000
Drilling Per Day	\$5,000	5	3	\$25,000	\$15,000	\$40,000
Fuel, Lubes and Water	\$1,000	5	3	\$5,000	\$3,000	\$8,000
Rental Equipment	\$1,000	5	3	\$5,000	\$3,000	\$8,000
Drill Bits				\$20,000	\$2,000	\$22,000
Drilling Mud & Chemicals		5	3	\$75,000	\$0	\$75,000
Mud Logging	\$800	2		\$1,600	\$0	\$1,600
Cement & Squeeze Services				\$50,000	\$15,000	\$65,000
Casing Crews & Tools				\$15,000	\$10,000	\$25,000
Open Hole Logging+MWD/LWD				\$100,000	\$0	\$100,000
Sidewall Cores & Analysis				\$5,000	\$0	\$5,000
Transportation	\$5,000	5	3	\$25,000	\$15,000	\$40,000
Labor	\$2,000	5	3	\$10,000	\$6,000	\$16,000
Supervision	\$850	5	3	\$4,250	\$2,550	\$6,800
P&A Costs	\$25,000	3	0	\$75,000	\$0	\$75,000
Pipe Inspection				\$10,000	\$5,000	\$15,000
Overhead	\$500	5	3	\$2,500	\$1,500	\$4,000
Insurance	\$400	5	3	\$2,000	\$1,200	\$3,200
Communications	\$250	5	3	\$1,250	\$750	\$2,000
				\$461,600	\$82,500	\$544,100

TANGIBLE COSTS						
<u>Depth (Ft)</u>	<u>Diameter</u>	<u>\$/Ft</u>				
Drive Pipe	30"	220 (not needed)		\$0	\$0	\$0
Conductor	20"	60 (not needed)		\$0	\$0	\$0
Surface Casing		16" (not needed)		\$0	\$0	\$0
Intermediate Casing	400	8-5/8"	25	\$10,000	\$0	\$10,000
Production Liner	5,000	5 1/2 "	12	\$0	\$60,000	\$60,000
Wellhead Equipment				50,000	\$10,000	\$60,000
TOTAL TANGIBLES				\$60,000	\$70,000	\$130,000
TOTAL AFE COSTS				\$521,600	\$152,500	\$674,100

Range of Total Costs

	Base Case	Lower Limit	Higher Limit
Total Rig Cost	\$60,000	\$51,000	\$66,000
Fuel, Lubes and Water	\$8,000	\$6,800	\$8,800
Rental Equipment	\$8,000	\$6,800	\$8,800
Drilling Mud & Chemicals	\$75,000	\$63,750	\$82,500
Mud Logging	\$1,600	\$1,360	\$1,760
Transportation	\$40,000	\$34,000	\$44,000
Labor	\$16,000	\$13,600	\$17,600
Supervision	\$6,800	\$5,780	\$7,480
P&A Costs	\$75,000	\$63,750	\$82,500
Insurance	\$3,200	\$2,720	\$3,520
Communications	\$2,000	\$1,700	\$2,200
Drive Pipe	\$0	\$0	\$0
Conductor	\$0	\$0	\$0
Surface Casing	\$0	\$0	\$0
Intermediate Casing	\$10,000	\$8,500	\$11,000
Production Liner	\$60,000	\$51,000	\$66,000

Authorization For Expenditure (AFE) (12/2005)

Estimate for a 10,000' Straight Hole w/1500HP Rig (Precompletion Estimate Included)

	<u>ESTIMATED INTANGIBLE COSTS</u>			DRILLING	PRECOMPL.	TOTAL
	<u>Day Rate</u>	<u>Days</u>	<u>Precompl.</u>	COST	COST	AFE
Surveys and Permits/Environmental				\$20,000	\$5,000	\$25,000
Rig Move (Mob. & Demob.)	\$12,000	7		\$84,000	\$0	\$84,000
Drilling Per day	\$12,000	30	5	\$360,000	\$60,000	\$420,000
Fuel, Lubes and Water	\$1,500	30	5	\$45,000	\$7,500	\$52,500
Rental Equipment	\$2,000	30	5	\$60,000	\$10,000	\$70,000
Drill Bits				\$50,000	\$5,000	\$55,000
Drilling Mud & Chemicals		30	5	\$250,000	\$0	\$250,000
Mud Logging	\$800	5		\$4,000	\$0	\$4,000
Cement & Squeeze Services				\$100,000	\$30,000	\$130,000
Casing Crews & Tools				\$30,000	\$20,000	\$50,000
Open Hole Logging+MWD/LWD				\$300,000	\$0	\$300,000
Sidewall Cores & Analysis				\$15,000	\$0	\$15,000
Transportation	\$8,000	30	5	\$240,000	\$40,000	\$280,000
Labor	\$2,000	30	5	\$60,000	\$10,000	\$70,000
Supervision	\$850	30	5	\$25,500	\$4,250	\$29,750
P&A Costs	\$80,000	5	0	\$400,000	\$0	\$400,000
Pipe Inspection				\$20,000	\$10,000	\$30,000
Overhead	\$700	30	5	\$21,000	\$3,500	\$24,500
Insurance	\$500	30	5	\$15,000	\$2,500	\$17,500
Communications	\$250	30	5	\$7,500	\$1,250	\$8,750
				\$2,107,000	\$209,000	\$2,316,000

TANGIBLE COSTS

	<u>Depth (Ft)</u>	<u>Diameter</u>	<u>\$/Ft</u>			
Drive Pipe		30"	220 (not needed)	\$0	\$0	\$0
Conductor		20"	60 (not needed)	\$0	\$0	\$0
Surface Casing		16"	16 (not needed)	\$0	\$0	\$0
Intermediate Casing	3,100	9-5/8"	30	\$93,000	\$0	\$93,000
Production Liner	10,000	7 "	13	\$0	\$130,000	\$130,000
Wellhead Equipment				100,000	\$15,000	\$115,000
TOTAL TANGIBLES				\$193,000	\$145,000	\$338,000
TOTAL AFE COSTS				2,300,000	\$354,000	\$2,654,000

Range of Total Costs

	<u>Base Case</u>	<u>Lower Limit</u>	<u>Higher Limit</u>
Total Rig Cost	\$504,000	\$428,400	\$554,400
Fuel, Lubes and Water	\$52,500	\$44,625	\$57,750
Rental Equipment	\$70,000	\$59,500	\$77,000
Drilling Mud & Chemicals	\$250,000	\$212,500	\$275,000
Mud Logging	\$4,000	\$3,400	\$4,400
Transportation	\$280,000	\$238,000	\$308,000
Labor	\$70,000	\$59,500	\$77,000
Supervision	\$29,750	\$25,288	\$32,725
P&A Costs	\$400,000	\$340,000	\$440,000
Insurance	\$17,500	\$14,875	\$19,250
Communications	\$8,750	\$7,438	\$9,625
Drive Pipe	\$0	\$0	\$0
Conductor	\$0	\$0	\$0
Surface Casing	\$0	\$0	\$0
Intermediate Casing	\$93,000	\$79,050	\$102,300
Production Liner	\$130,000	\$110,500	\$143,000

Authorization For Expenditure (AFE)

Estimate for a 15,000' Straight Hole w/2000HP Rig (Precompletion Estimate Included)

ESTIMATED INTANGIBLE COSTS

				<u>DRILLING COST</u>	<u>PRECOMPL. COST</u>	<u>TOTAL AFE</u>
Surveys and Permits/Environmental				\$20,000	\$5,000	\$25,000
	<u>Day Rate</u>	<u>Days</u>	<u>Precompl.</u>			
Rig Move (Mob. & Demob.)	\$15,000	7		\$105,000	\$0	\$105,000
Drilling Per day	\$15,000	50	7	\$750,000	\$105,000	\$855,000
Fuel, Lubes and Water	\$1,500	50	7	\$75,000	\$10,500	\$85,500
Rental Equipment	\$2,000	50	7	\$100,000	\$14,000	\$114,000
Drill Bits				\$50,500	\$5,500	\$56,000
Drilling Mud & Chemicals		50	7	\$300,000	\$0	\$300,000
Mud Logging	\$800	8		\$6,400	\$0	\$6,400
Cement & Squeeze Services				\$110,000	\$35,000	\$145,000
Casing Crews & Tools				\$35,000	\$21,500	\$56,500
Open Hole Logging+MWD/LWD				\$350,000	\$0	\$350,000
Sidewall Cores & Analysis				\$15,500	\$0	\$15,500
Transportation	\$8,000	50	7	\$400,000	\$56,000	\$456,000
Labor	\$2,000	50	7	\$100,000	\$14,000	\$114,000
Supervision	\$850	50	7	\$42,500	\$5,950	\$48,450
P&A Costs	\$85,000	5	0	\$425,000	\$0	\$425,000
Pipe Inspection				\$20,000	\$10,000	\$30,000
Overhead	\$700	50	7	\$35,000	\$4,900	\$39,900
Insurance	\$500	50	7	\$25,000	\$3,500	\$28,500
Communications	\$250	50	7	\$12,500	\$1,750	\$14,250
				\$2,977,400	\$292,600	\$3,270,000

TANGIBLE COSTS

	<u>Depth (Ft)</u>	<u>Diameter</u>	<u>\$/Ft</u>			
Drive Pipe		30"	220 (not needed)	\$0	\$0	\$0
Conductor		20"	60 (not needed)	\$0	\$0	\$0
Surface Casing	100	16"	16	\$1,600	\$0	\$1,600
Intermediate Casing	4,000	9-5/8"	30	\$120,000	\$0	\$120,000
Production Liner	15,000	5-1/2 "	12	\$0	\$180,000	\$180,000
Wellhead Equipment				100,000	\$15,000	\$115,000
TOTAL TANGIBLES				\$221,600	\$195,000	\$416,600
TOTAL AFE COSTS				3,199,000	\$487,600	\$3,686,600

Range of Total Costs

	<u>Base Case</u>	<u>Lower Limit</u>	<u>Higher Limit</u>
Total Rig Cost	\$960,000	\$428,400	\$554,400
Fuel, Lubes and Water	\$85,500	\$44,625	\$57,750
Rental Equipment	\$114,000	\$59,500	\$77,000
Drilling Mud & Chemicals	\$250,000	\$212,500	\$275,000
Mud Logging	\$6,400	\$3,400	\$4,400
Transportation	\$456,000	\$238,000	\$308,000
Labor	\$114,000	\$59,500	\$77,000
Supervision	\$48,450	\$25,288	\$32,725
P&A Costs	\$425,000	\$340,000	\$440,000
Insurance	\$28,500	\$14,875	\$19,250
Communications	\$14,250	\$7,438	\$9,625
Drive Pipe	\$0	\$0	\$0
Conductor	\$0	\$0	\$0
Surface Casing	\$0	\$0	\$0
Intermediate Casing	\$120,000	\$79,050	\$102,300
Production Liner	\$180,000	\$110,500	\$143,000

Authorization For Expenditure (AFE)

Estimate for a 19,000' Straight Hole w/2500HP Rig (Precompletion Estimate Included)

	<u>ESTIMATED INTANGIBLE COSTS</u>			<u>DRILLING</u>	<u>PRECOMPL.</u>	<u>TOTAL</u>
	<u>Day Rate</u>	<u>Days</u>	<u>Precompl.</u>	<u>COST</u>	<u>COST</u>	<u>AFE</u>
Surveys and Permits/Environmental				\$20,000	\$5,000	\$25,000
Rig Move (Mob. & Demob.)	\$30,000	10		300,000	\$0	\$300,000
Drilling Per day	\$30,000	150	7	4,500,000	\$210,000	\$4,710,000
Fuel, Lubes and Water	\$1,500	150	7	\$225,000	\$10,500	\$235,500
Rental Equipment	\$2,000	150	7	\$300,000	\$14,000	\$314,000
Drill Bits				\$75,500	\$7,500	\$83,000
Drilling Mud & Chemicals		150	7	\$500,000	\$0	\$500,000
Mud Logging	\$1000	90		\$90,000	\$0	\$90,000
Cement & Squeeze Services				\$150,000	\$35,000	\$185,000
Casing Crews & Tools				\$50,000	\$25,000	\$75,000
Open Hole Logging+MWD/LWD				\$500,000	\$0	\$500,000
Sidewall Cores & Analysis				\$15,500	\$0	\$15,500
Transportation	\$8,000	150	7	\$1,200,000	\$56,000	\$1,256,000
Labor	\$2,000	150	7	\$300,000	\$14,000	\$314,000
Supervision	\$1000	150	7	\$150,000	\$7,000	\$157,000
P&A Costs	\$85,000	15	0	\$1,275,000	\$0	\$1,275,000
Pipe Inspection				\$20,000	\$10,000	\$30,000
Overhead	\$700	150	7	\$105,000	\$4,900	\$109,900
Insurance	\$500	150	7	\$75,000	\$3,500	\$78,500
Communications	\$250	150	7	\$37,500	\$1,750	\$39,250
				\$9,888,500	\$404,150	\$10,292,650

<u>TANGIBLE COSTS</u>						
	<u>Depth (Ft)</u>	<u>Diameter</u>	<u>\$/Ft</u>			
Drive Pipe		30"	220 (Not needed)	\$0	\$0	\$0
Conductor	3000	26"	60	\$180,000	\$0	\$180,000
Surface Casing		9900	13 3/8"	20	\$198,000	\$0
Intermediate Casing	12,600		9-5/8"	30	\$378,000	\$0
Production Liner	16,700-19,000		4-1/2 "	12	\$0	\$27,600
Wellhead Equipment				\$100,000	\$15,000	\$115,000
TOTAL TANGIBLES				\$856,000	\$42,600	\$898,600
TOTAL AFE COSTS				\$10,744,500	\$446,750	\$11,191,250

	<u>Range of Total Costs</u>		
	<u>Base Case</u>	<u>Lower Limit</u>	<u>Higher Limit</u>
Total Rig Cost	\$5,010,000	\$4,258,500	\$5,511,000
Fuel, Lubes and Water	\$235,500	\$200,175	\$259,050
Rental Equipment	\$314,000	\$266,900	\$345,400
Drilling Mud & Chemicals	\$500,000	\$425,000	\$550,000
Mud Logging	\$90,000	\$76,500	\$99,000
Transportation	\$1,256,000	\$1,067,600	\$1,381,600
Labor	\$314,000	\$226,900	\$345,400
Supervision	\$157,000	\$133,450	\$172,700
P&A Costs	\$1,275,000	\$1,083,750	\$1,402,500
Insurance	\$78,500	\$66,725	\$86,350
Communications	\$39,250	\$33,363	\$43,175
Drive Pipe	\$0	\$0	\$0
Conductor	\$180,000	\$153,000	\$198,000
Surface Casing	\$198,000	\$168,000	\$217,800
Intermediate Casing	\$378,000	\$321,300	\$415,800
Production Liner	\$27,600	\$23,460	\$30,360

APPENDIX # 2

Venezuela Wellbore

Completion Schematics (in Spanish)

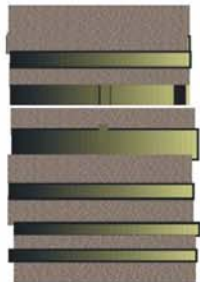
LITHOLOGY LEGEND



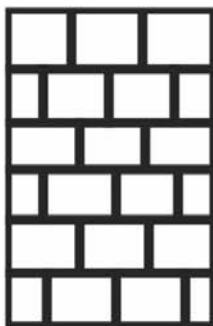
Predominantly Sandstone



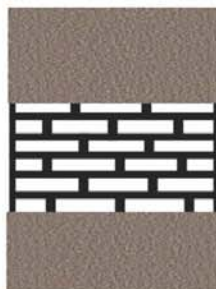
Predominantly Shale & Siltstone



**Predominantly Interbedded
Sandstone & Shale**



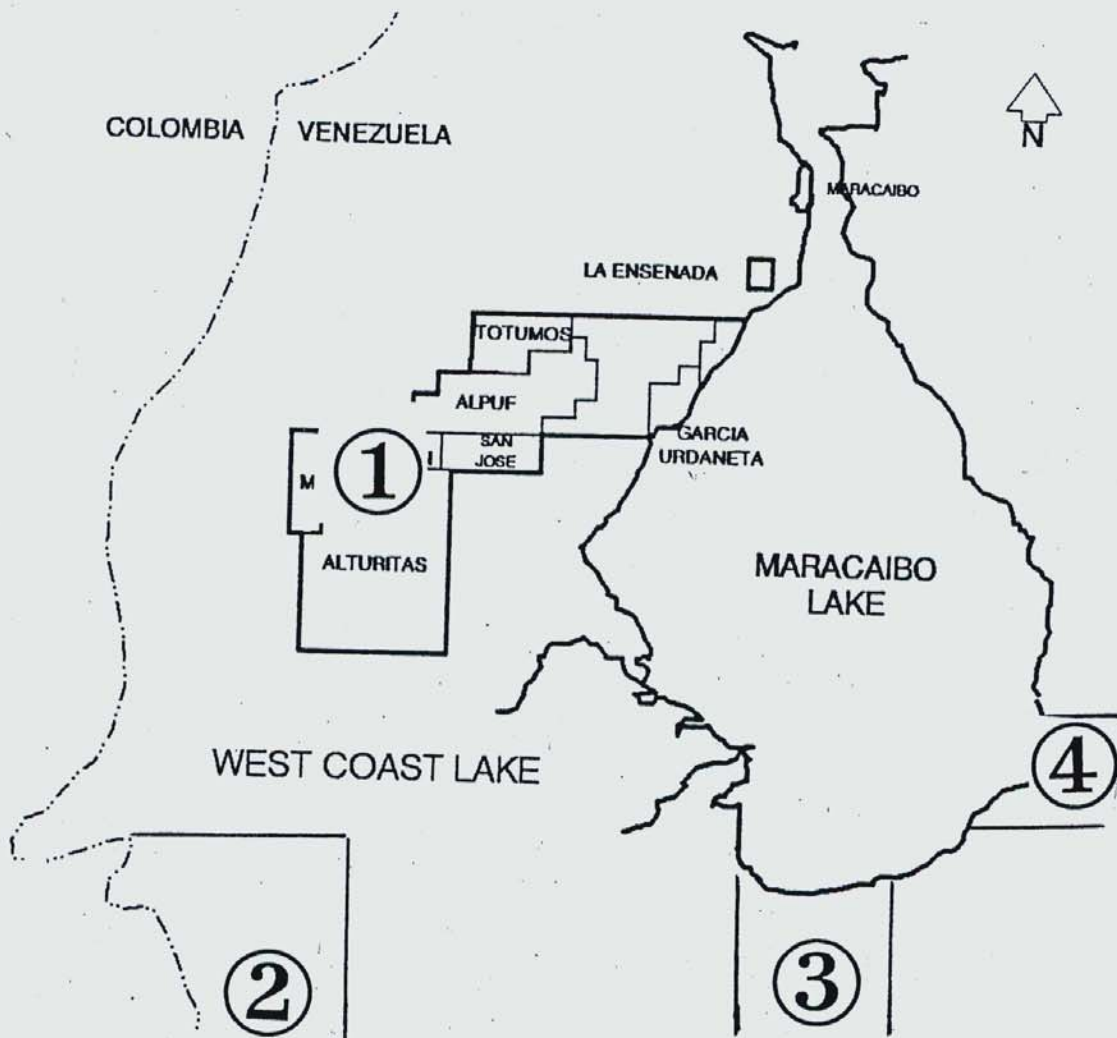
**Predominantly Limestone
and/or Dolomite, Chalk & Marl**



**Predominantly Calcareous
Sandstone & Limestone**

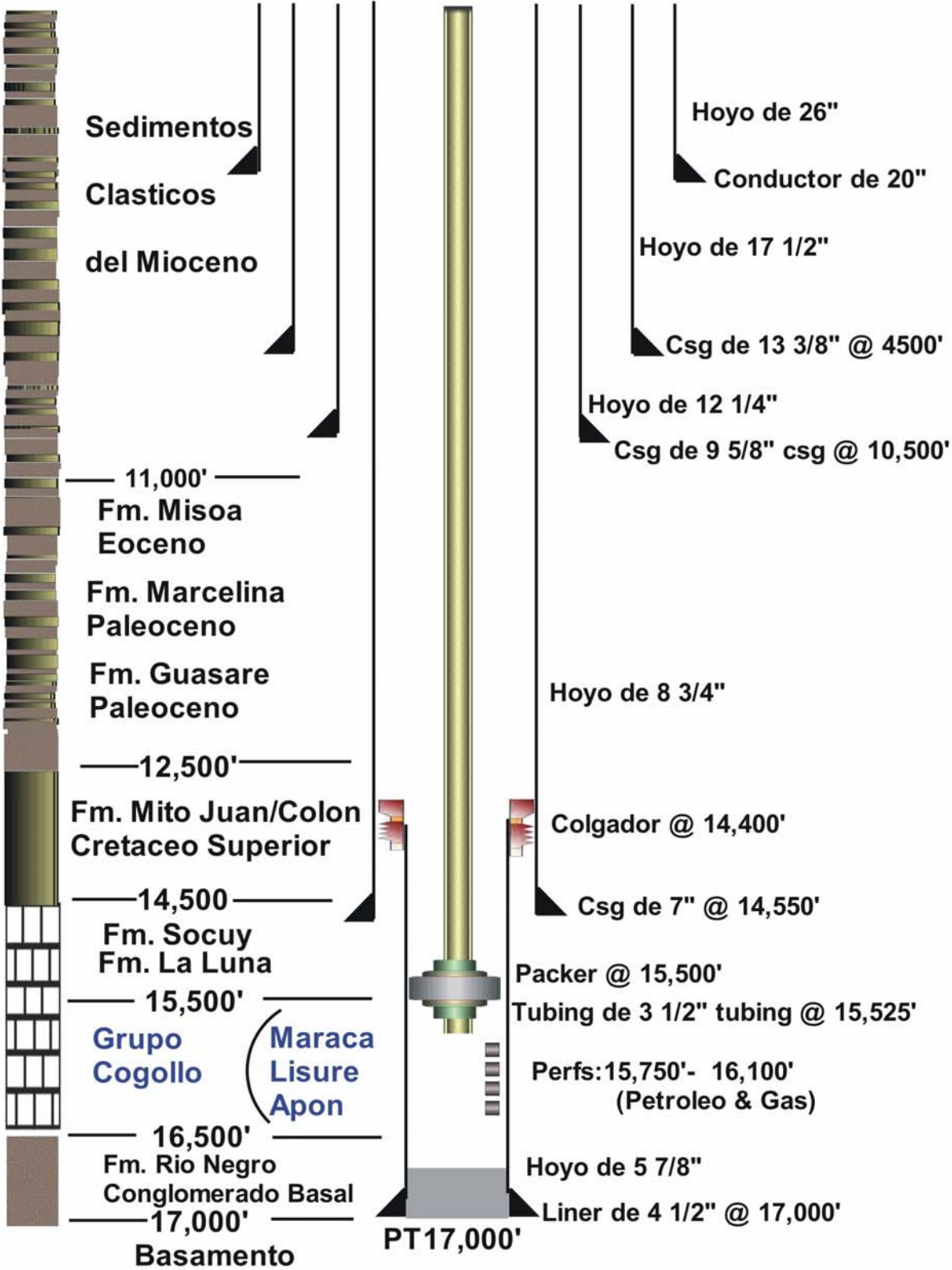
MARACAIBO BASIN

Example Well Locations

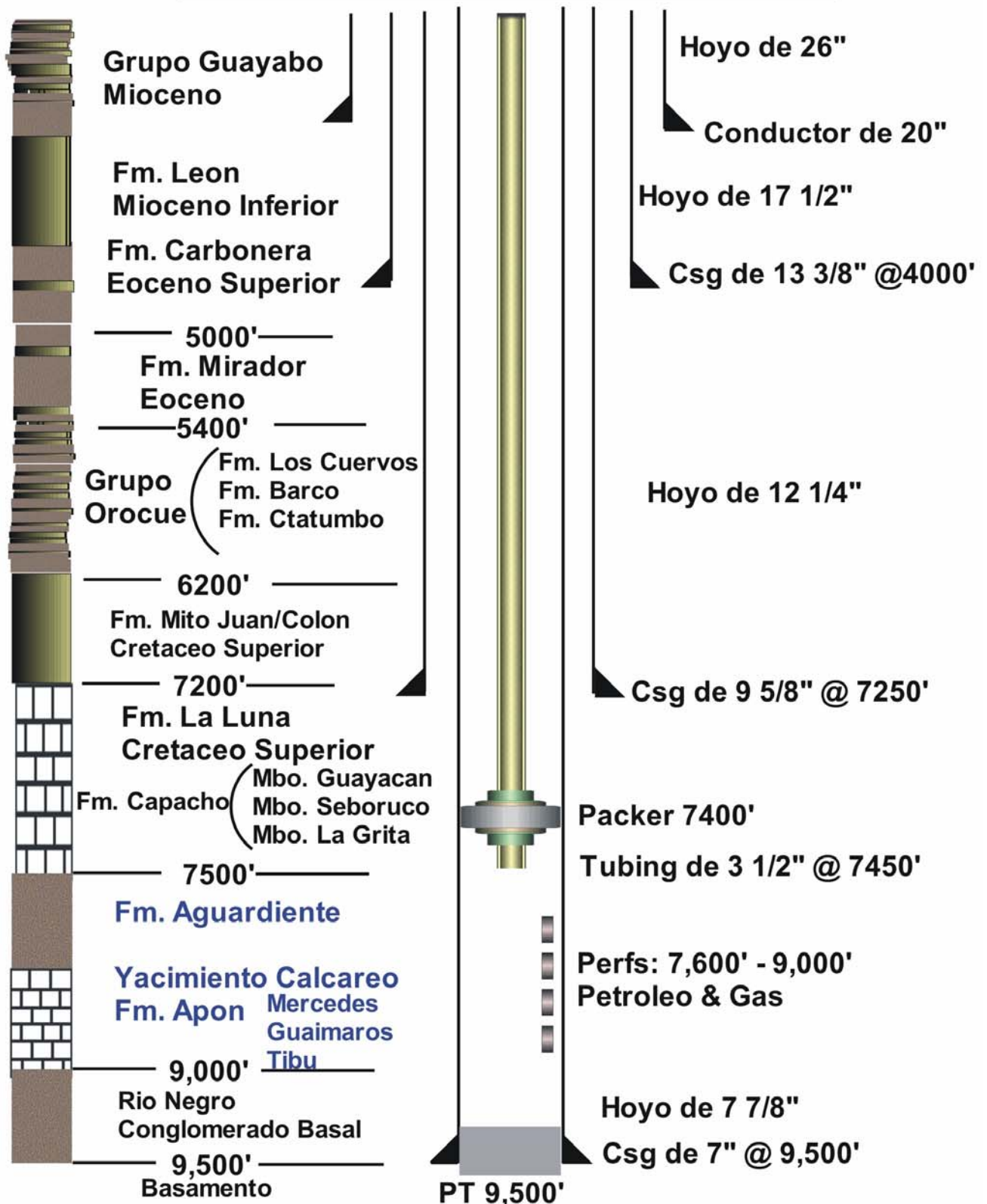


1. WEST LAKE FIELDS (ALTURITAS, ALPUF)
2. COLON DISTRICT (TARRA, BONITO, LAS CRUCES)
3. CATATUMBO (BLOCK 1)
4. LA CEIBA (BLOCK 2)

1 CUENCA DE MARACAIBO
 POZO DE 17,000' HASTA BASAMENTO
 YACIMIENTO GRUPO COGOLLO
 AREA ALPUF-ALTURITAS

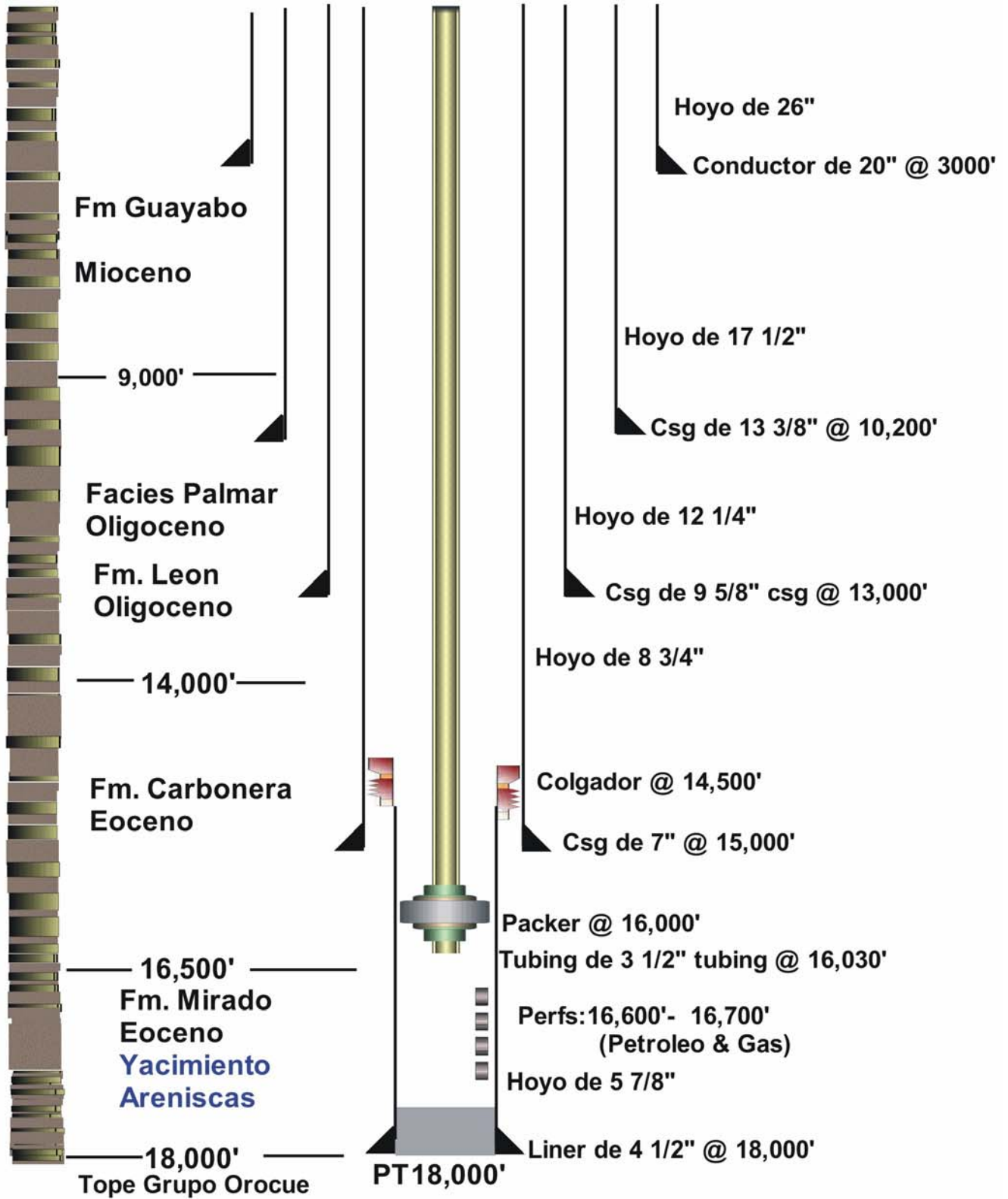


**2 CUENCA DE MARACAIBO
POZO DE 9,500' HASTA BASAMENTO
YACIMIENTO AGUARDIENTE - APON
DISTRITO COLON**

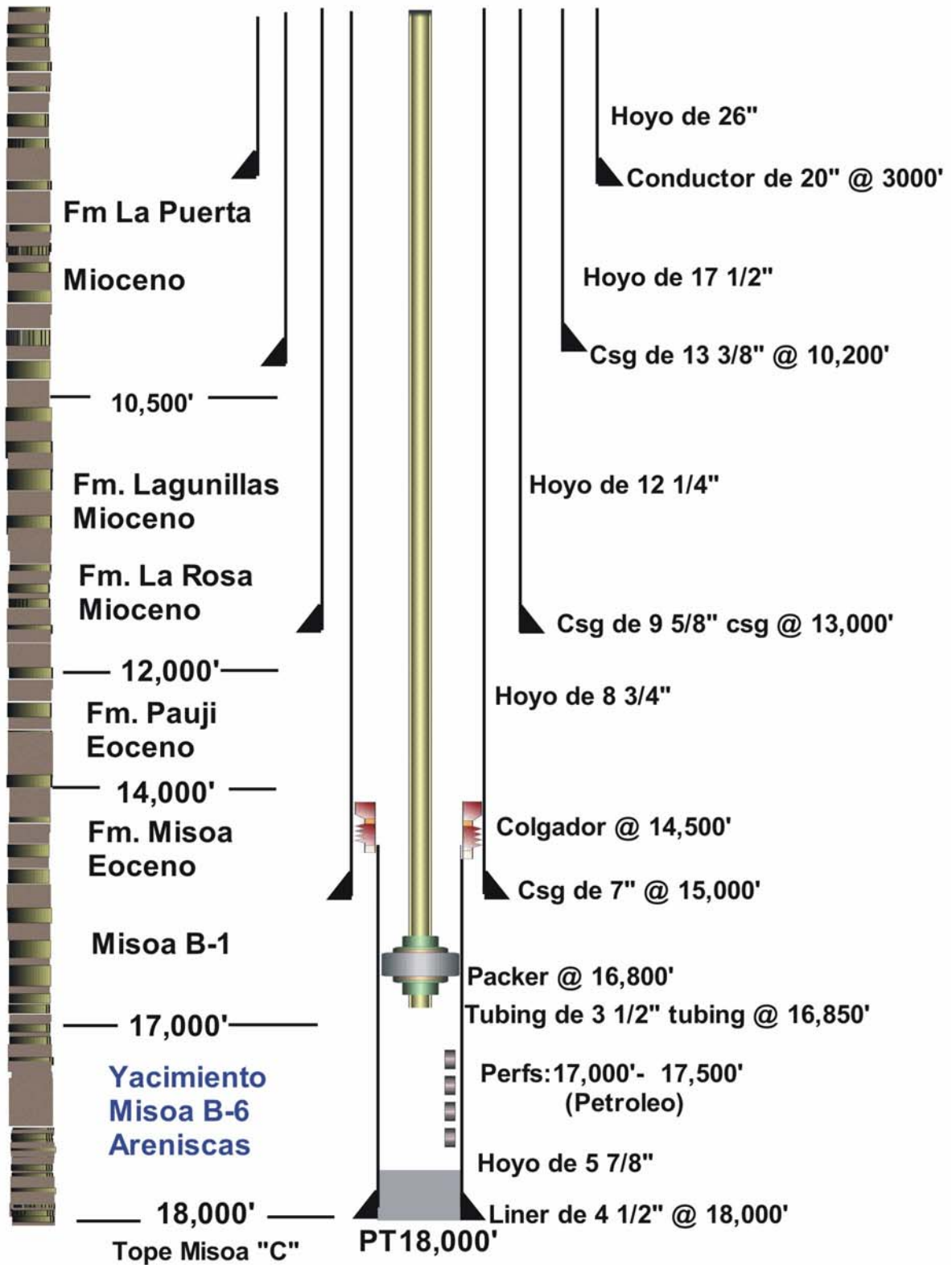


3

**CUENCA DE MARACAIBO
POZO DE 18,000' HASTA GRUPO OROCUE
YACIMIENTO FM. MIRADOR
AREA CATATUMBO**

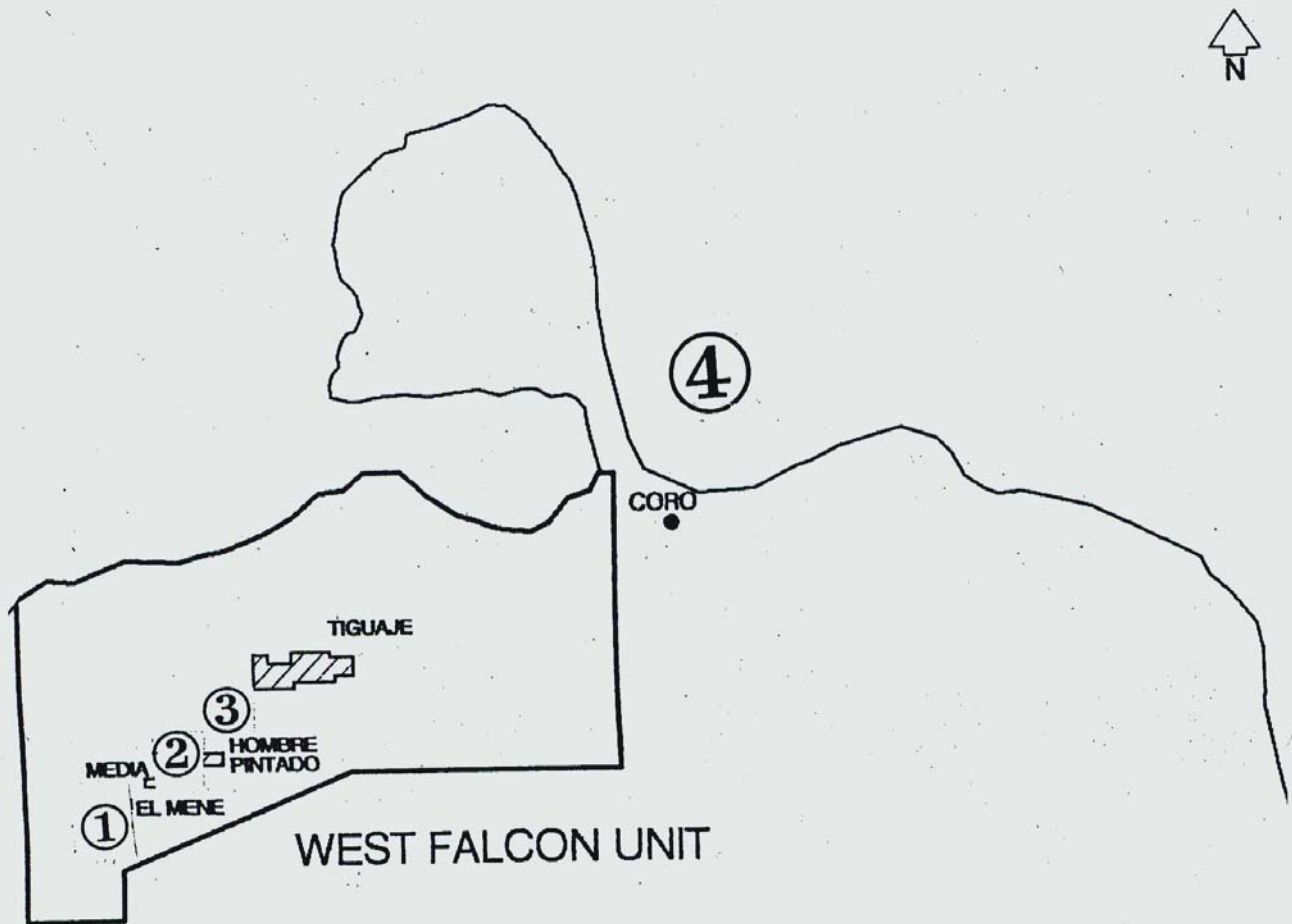


**4 CUENCA DE MARACAIBO
POZO DE 18,000' HASTA MISOA "C"
YACIMIENTO MISOA B-6
AREA LA CEIBA**



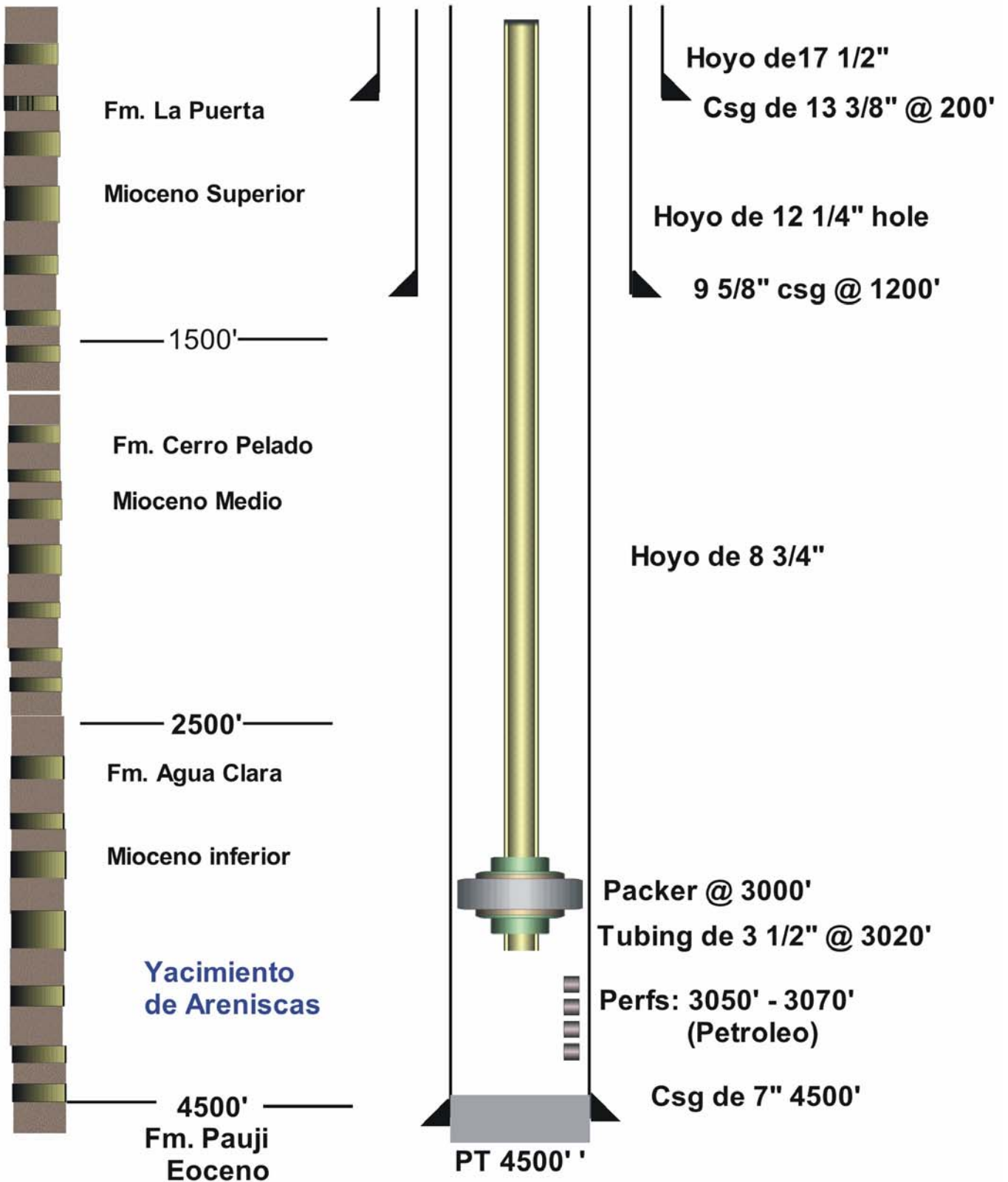
FALCON BASIN

Example Well Locations



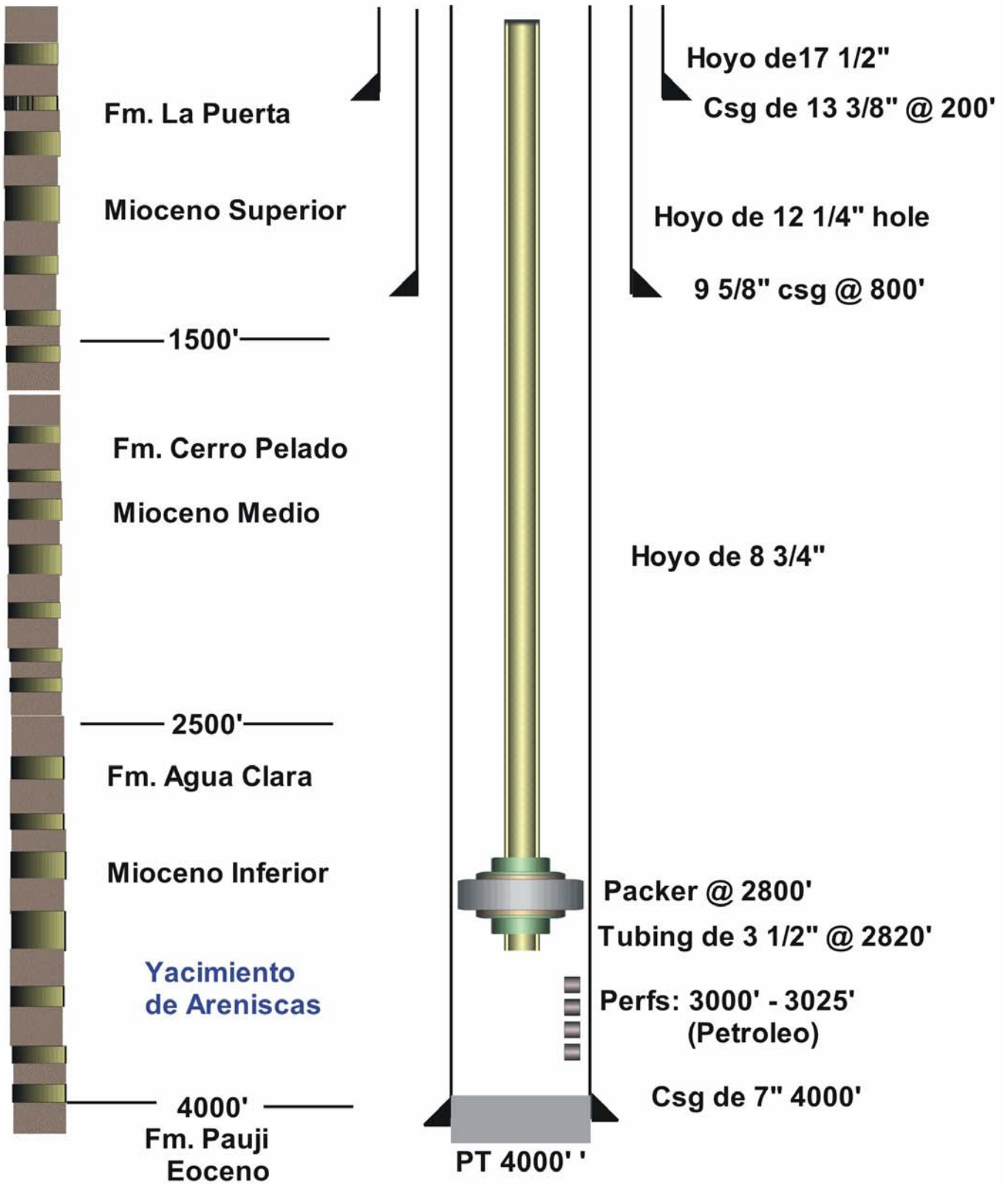
1. EL MENE FIELD
2. MEDIA FIELD
3. HOMBRE PINTADO FIELD
4. LA VELA OFFSHORE

1
CUENCA DE FALCON
POZO SOMERO DE 4500' HASTA FM. PAUJI
YACIMIENTO AGUA CLARA - CAMPO EL MENE



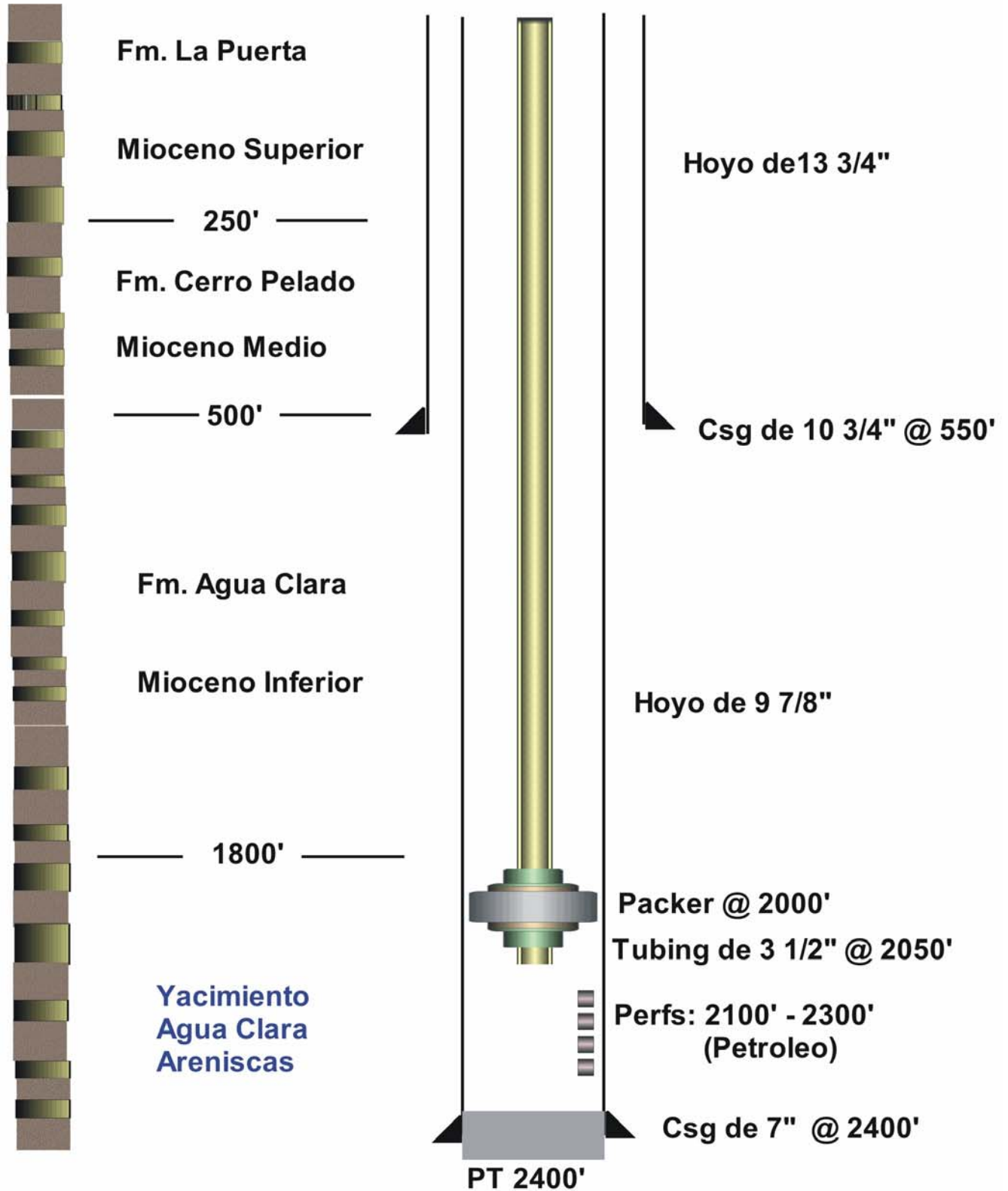
2

**CUENCA DE FALCON
POZO SOMERO DE 4000' HASTA FM. PAUJI
YACIMIENTO AGUA CLARA - CAMPO MEDIA**

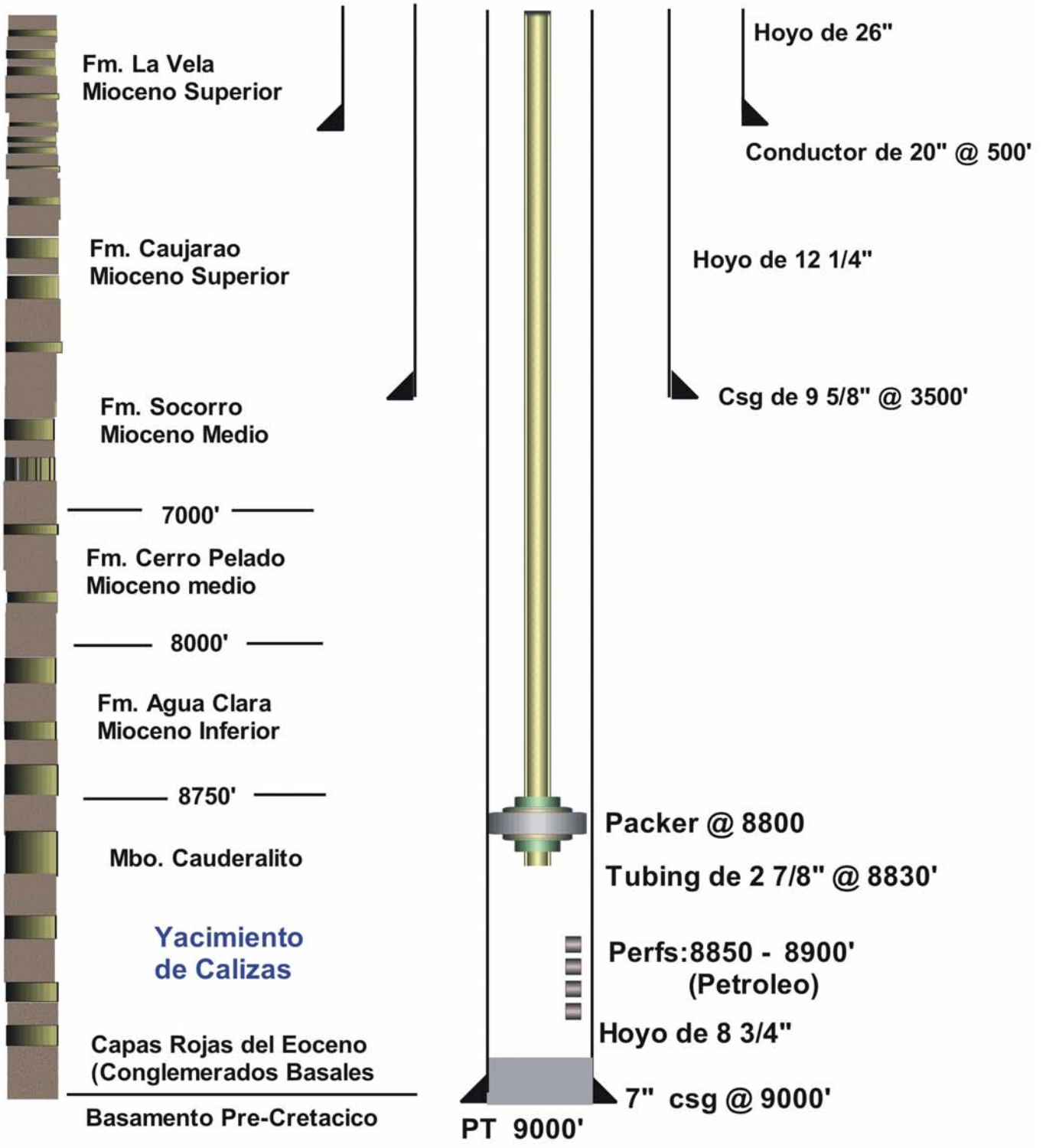


3

**CUENCA DE FALCON
POZO SOMERO DE 2400' HASTA FM. AGUA CLARA
YACIMIENTO AGUA CLARA - CAMPO HOMBRE PINTADO**

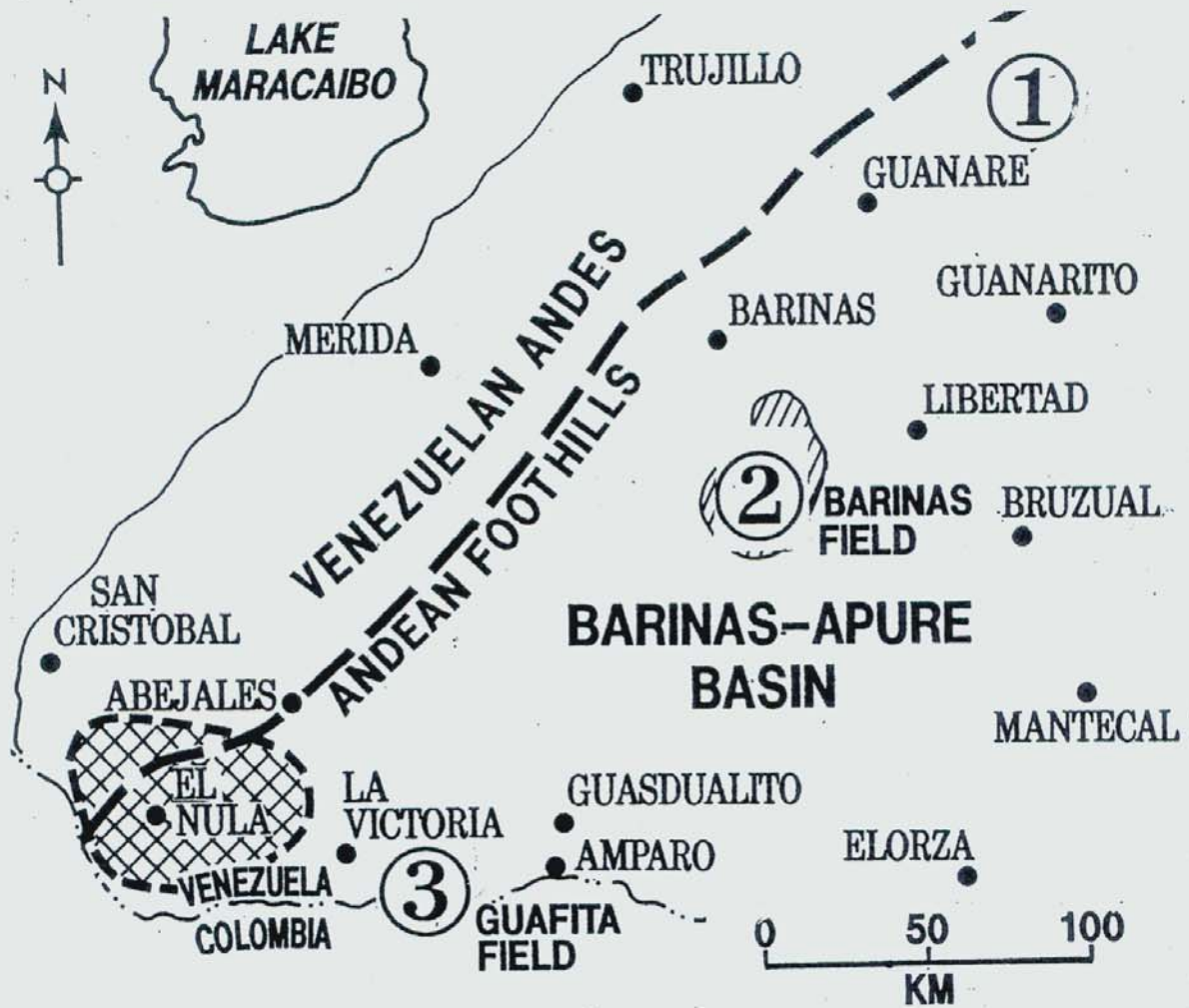


**4 CUENCA DE FALCON
POZO MEDIANO HASTA 9000'
YACIMIENTO CAUDERALITO
LA VELA - COSTA FUERA**



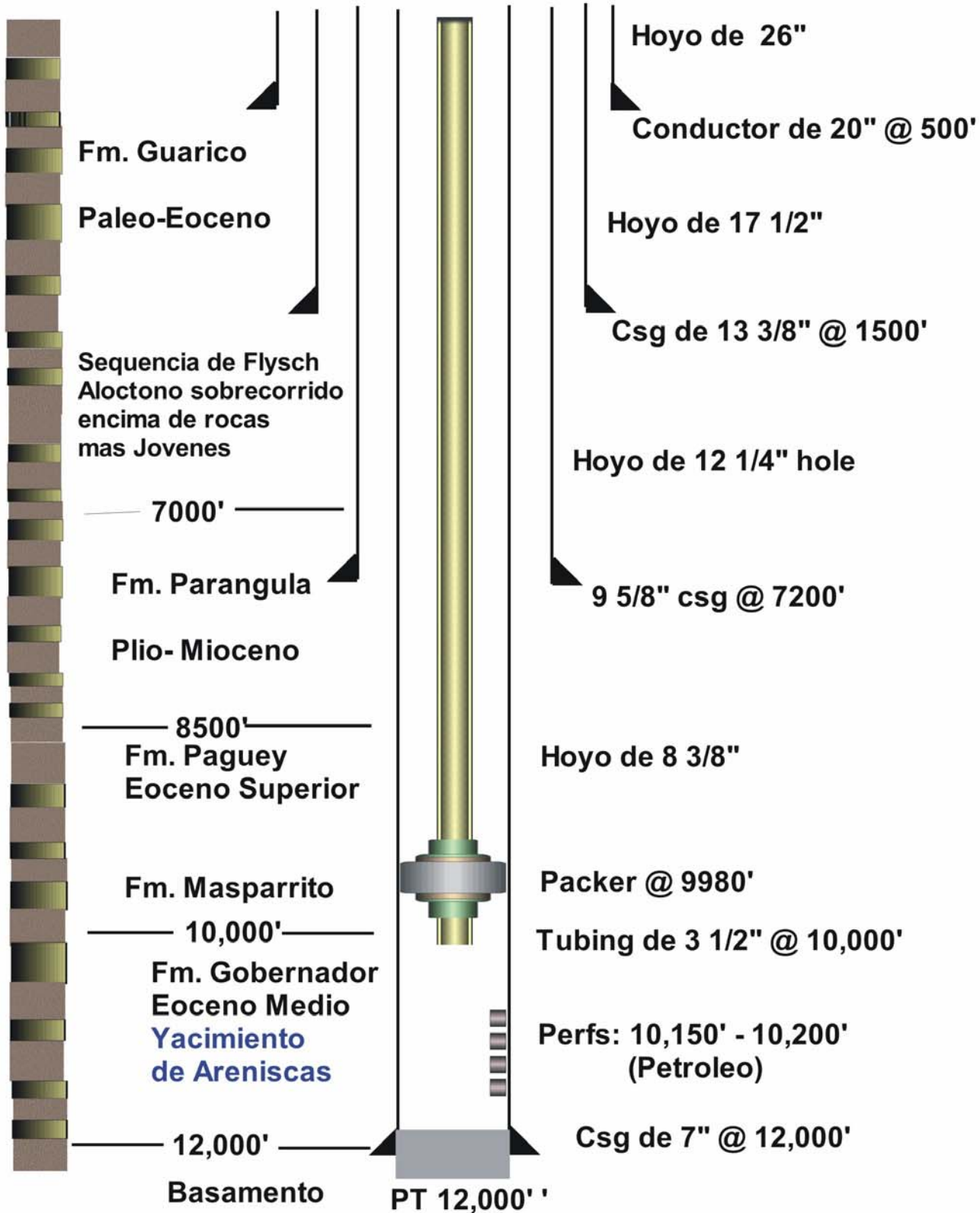
BARINAS - APURE BASIN

Example Well Locations

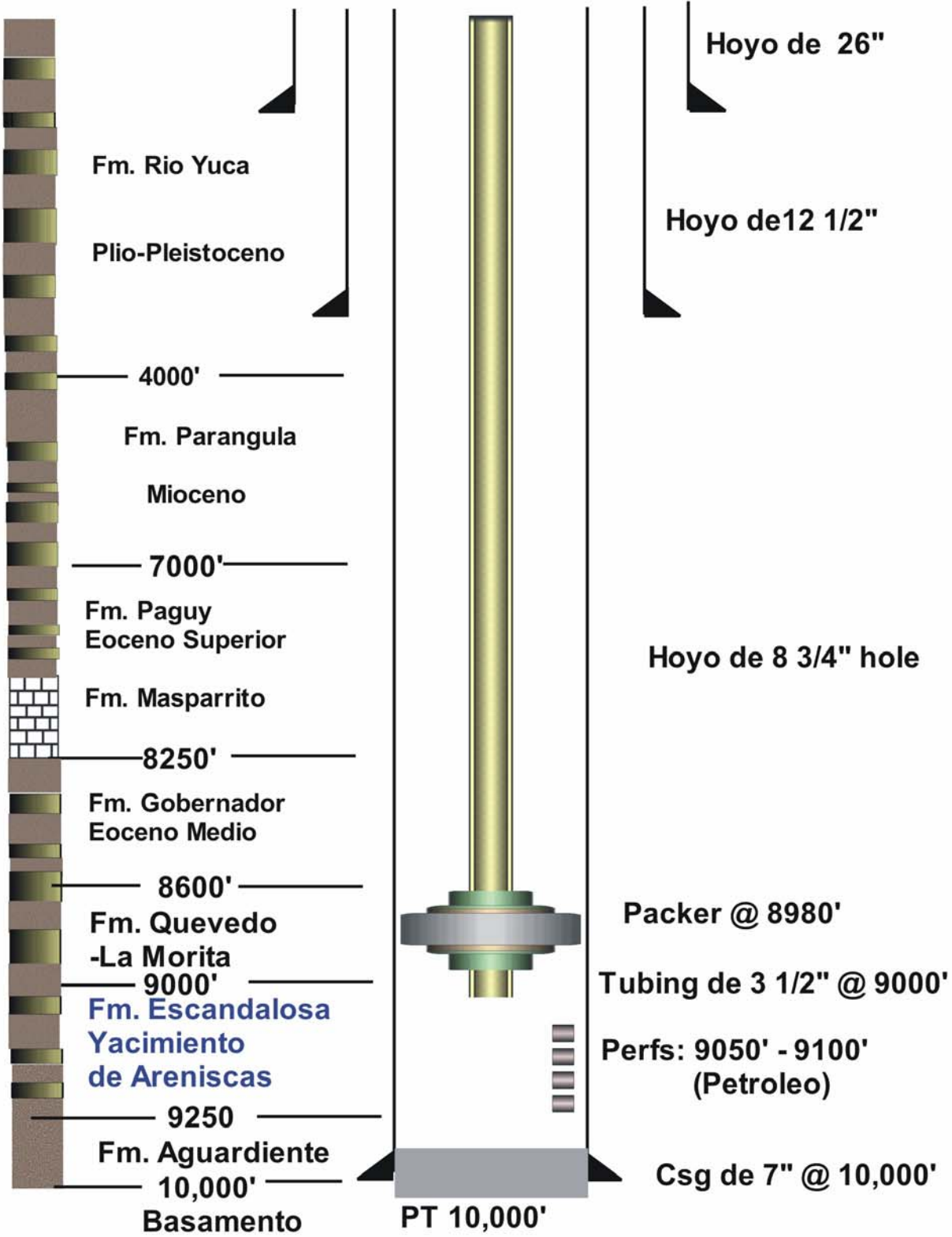


1. GUANARE - GAURUMEN (BLOCKS 3 & 4)
2. BARINAS FIELDS (SINCO, SILVESTRE)
3. GUAFITA FIELD (S.W. APURE)

**1 CUENCA BARINAS- APURE
 POZO DE 12,000' HASTA BASAMENTO
 YACIMIENTO GOBERNADOR - GUANARE-GUARUMEN**

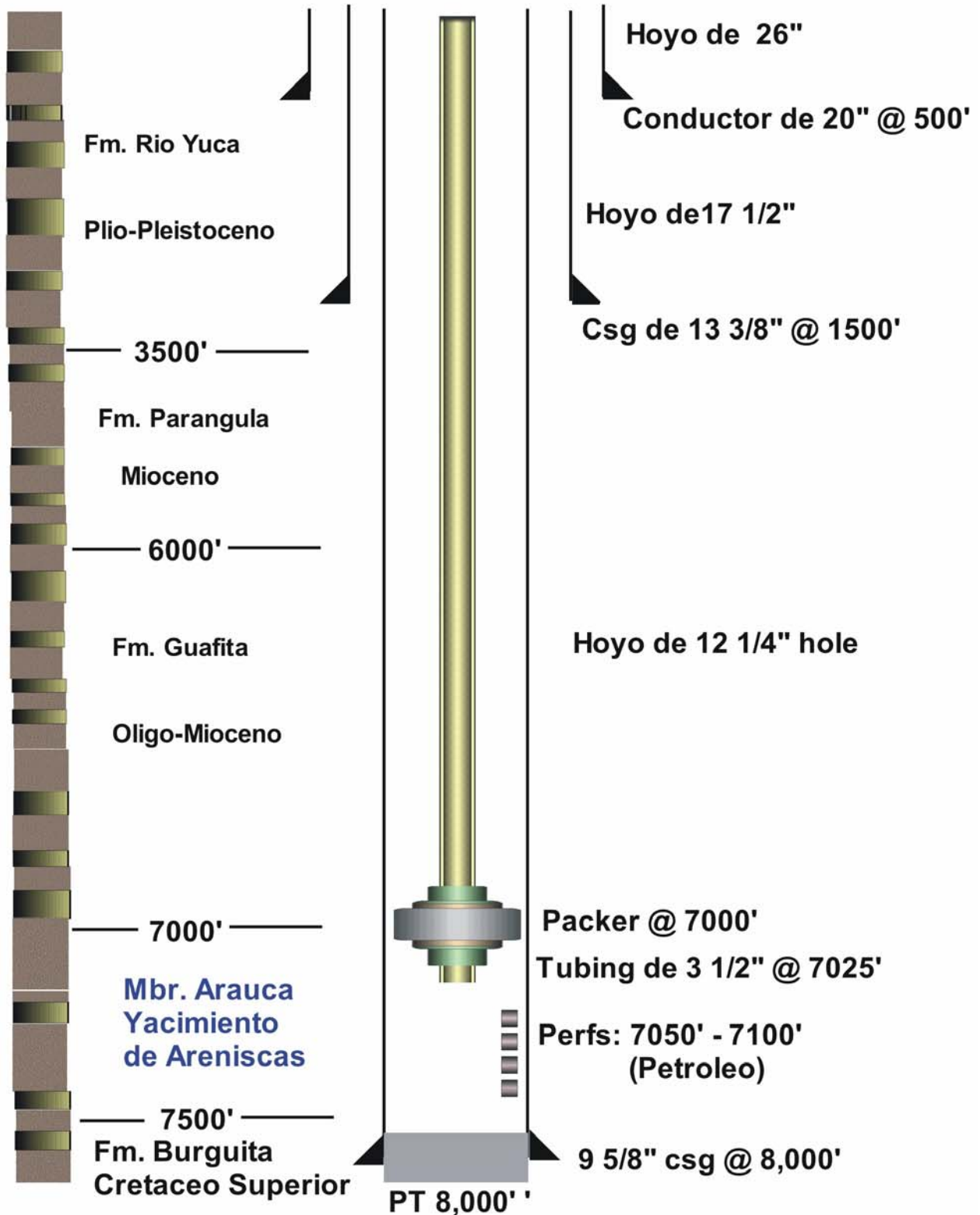


**2 CUENCA BARINAS- APURE
 POZO DE 10,000' HASTA EL BASAMENTO
 YACIMIENTO ESCANDALOSA - CAMPO BARINAS**



3

**CUENCA BARINAS- APURE
POZO DE 8,000' HASTA FM. BURGUITA
YACIMIENTO MBR. ARAUCA - CAMPO GUAFITA**



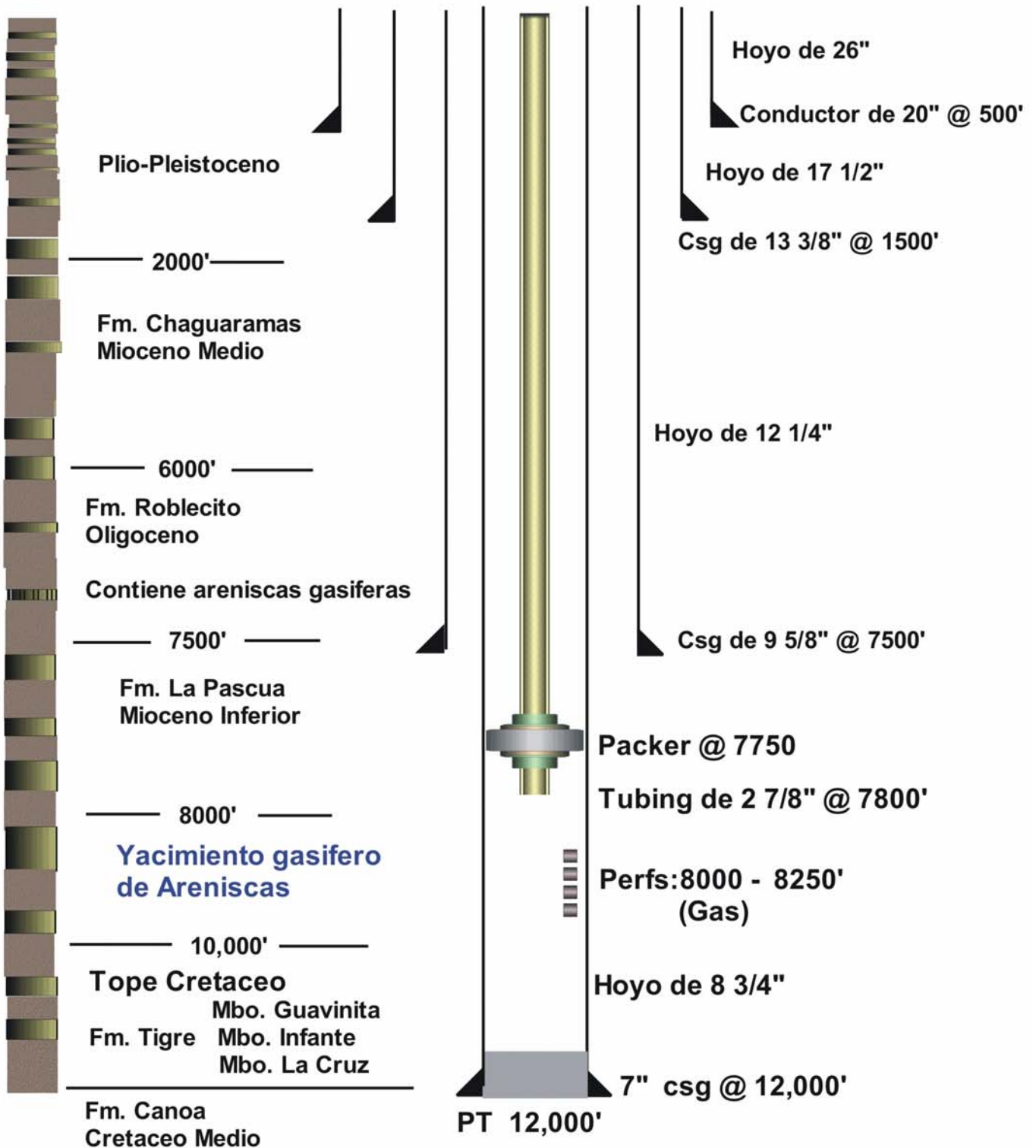
EASTERN VENEZUELA BASIN

Example Well Location



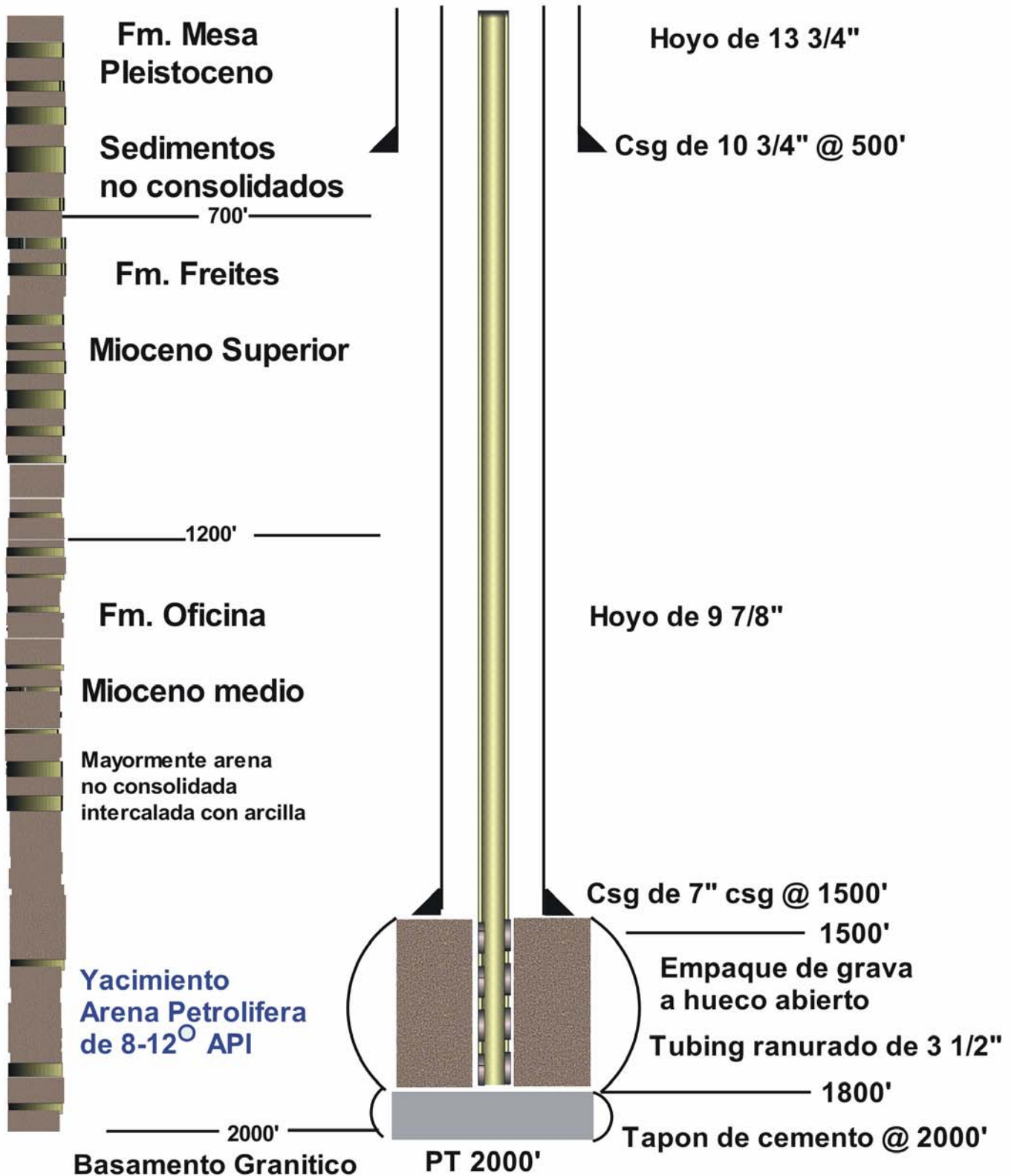
1. YUCAL PLACER FIELD (GUARICO SUB-BASIN)
2. HEAVY OIL BELT (ZUATA AREA)
3. SANTA ROSA FIELD (OFICINA AREA)
4. QUIRIQUIRE AREA (MATURIN SUB-BASIN)
5. PUNTA PESCADOR (BLOCK 9)
6. DELTA CENTRO (BLOCK 10)

1
CUENCA DE ORIENTE
SUBCUENCA DE GUARICO
POZO HASTA 12,000'
YACIMIENTO LA PASCUA
CAMPO YUCAL-PLACER



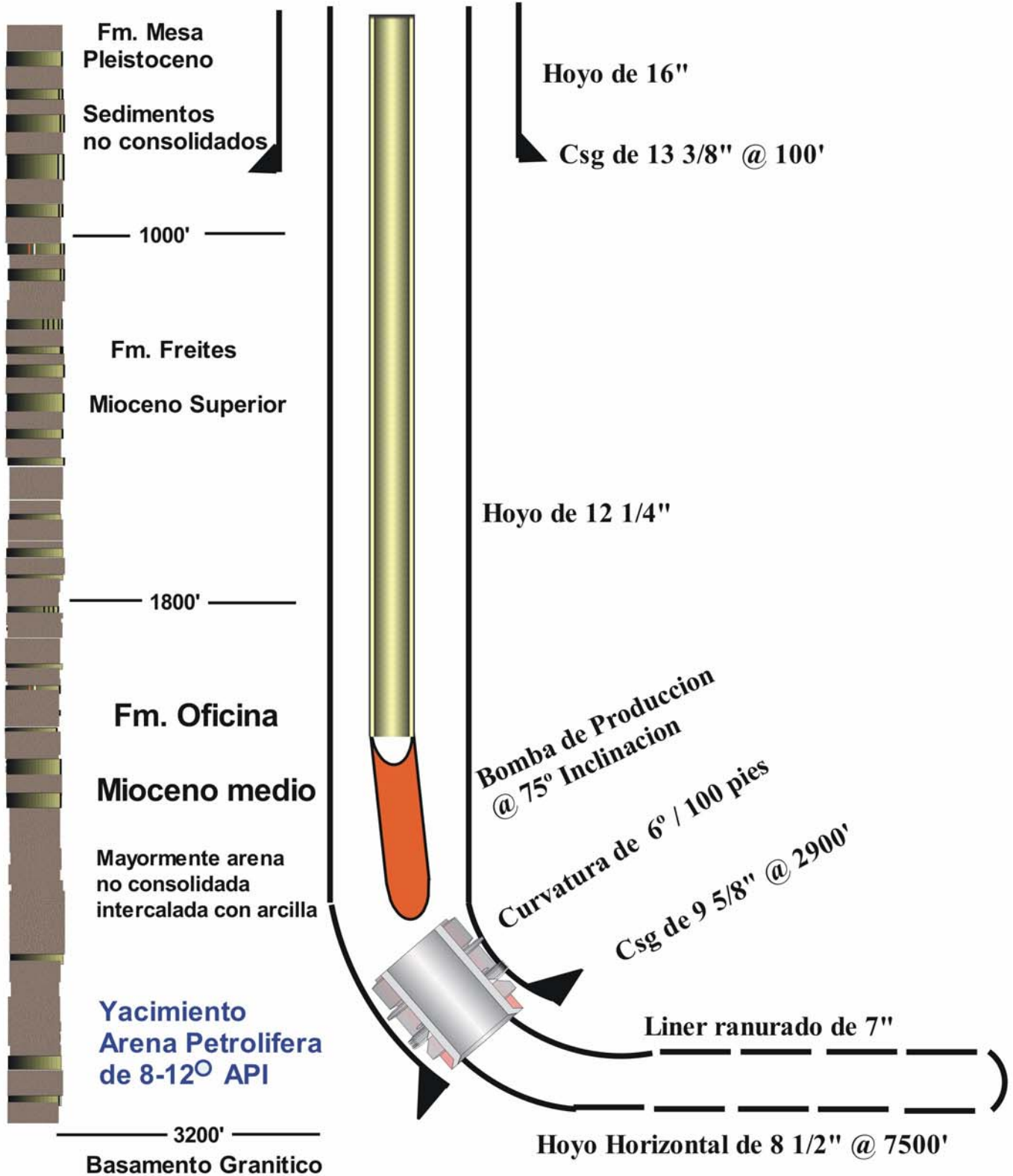
2A

**CUENCA DE ORIENTE (1980)
POZO SOMERO DE 2000' HASTA BASAMENTO (1980)
FORMACION OFICINA
FAJA PETROLIFERA DEL ORINOCO**



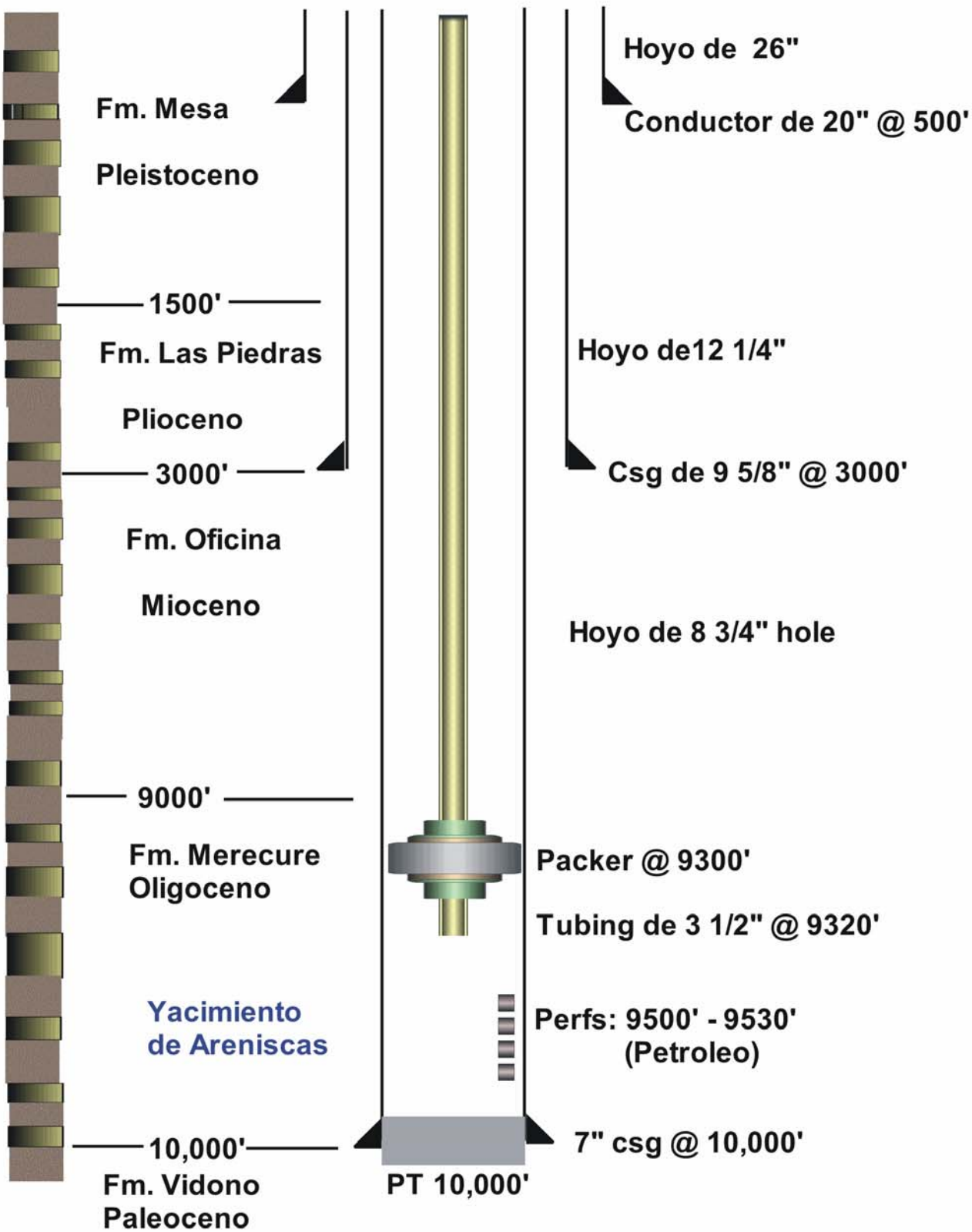
2B

**CUENCA DE ORIENTE (2005)
POZO SOMERO VERTICAL HASTA DE 2500'
Y HORIZONTAL HASTA 7500')
FORMACION OFICINA
FAJA PETROLIFERA DEL ORINOCO**

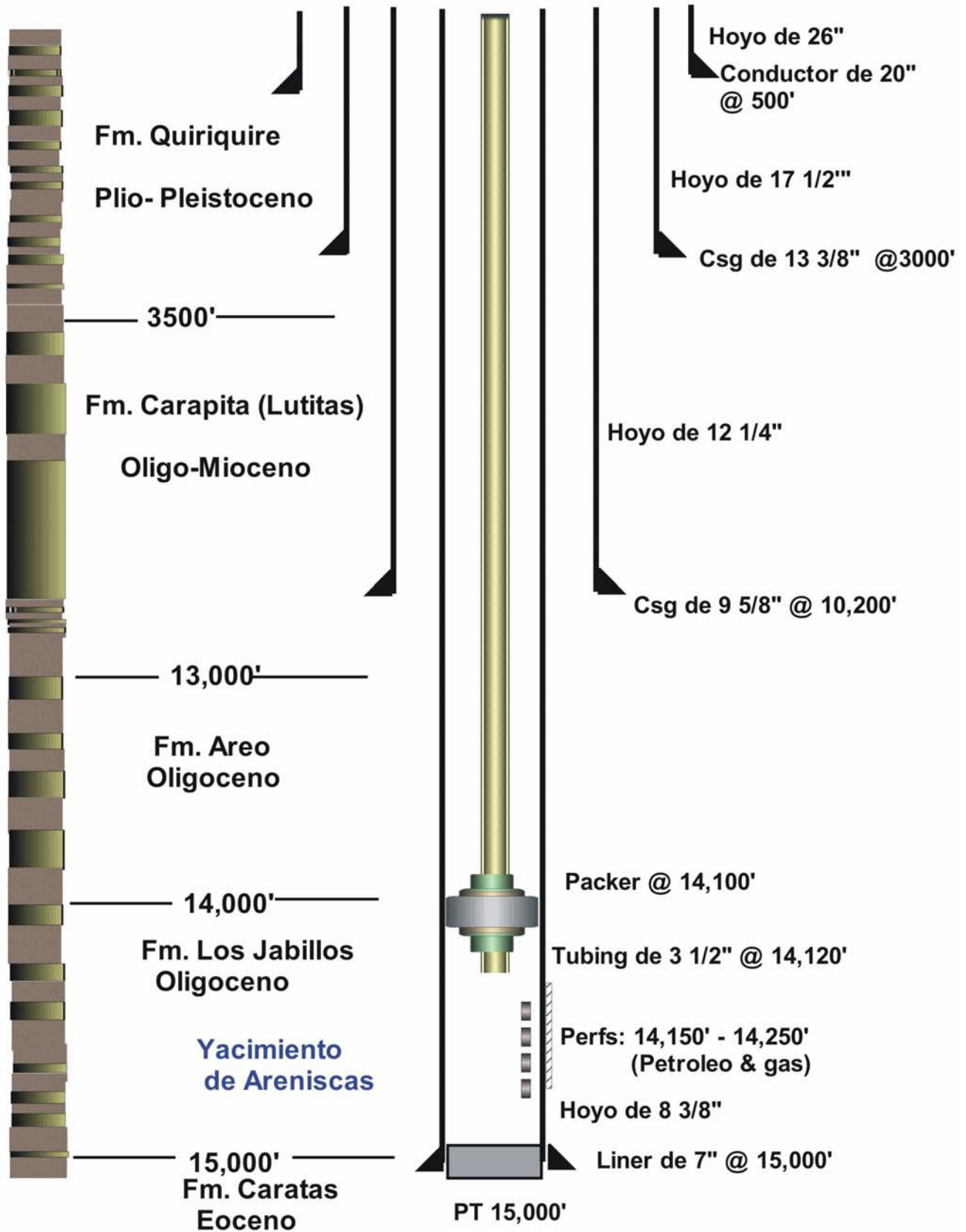


3

**CUENCA DE ORIENTE
POZO DE 10,000' HASTA FM. VIDONO
YACIMIENTO MEREKURE - CAMPO SANTA ROSA**

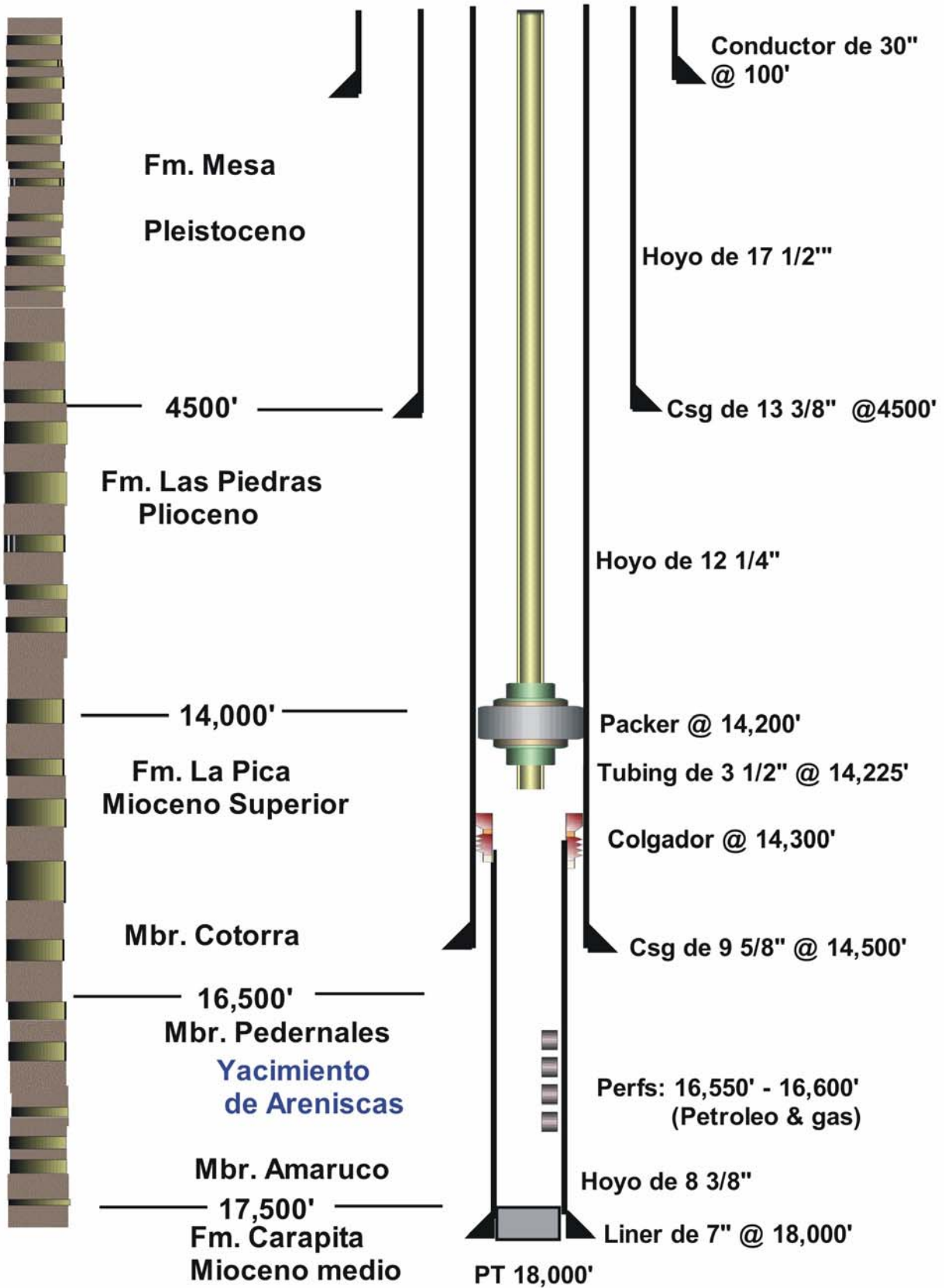


**4 CUENCA DE ORIENTE (QUIRIQUIRE)
POZO DE 15,000' HASTA FM. CARATAS
YACIMIENTO LOS JABILLOS**



5

**CUENCA DE ORIENTE (PUNTA PESCADOR)
POZO DE 18,000' HASTA FM. CARAPITA
YACIMIENTO MBR. PEDERNALES**



6

CUENCA DE ORIENTE
POZO DE 18,000' HASTA MEREURE
YACIMIENTO FM. OFICINA
AREA DELTA CENTRO

