Offshore Neogene Plays, Salina del Istmo Basin, Southeast of Mexico

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Abstract

Offshore exploratory drilling in the Salina del Istmo Basin began in 2002, after three decades of laying aside. Oil, condensates and dry gas was discovered in the Pliocene terrigenous rocks.

Based on sedimentary facies, *Play*s as used by The Mexican State Petroleum Company (PEMEX) and British Petroleum (BP), 1994, has undergone a modification of its original meaning. There have been defined seven (7) plays in the said Basin: Blasillo Turbiditas (25.2-16.4 Ma) and Blasillo Barras (16.4-12.5 Ma), within the Miocene compressive structures. Sands and sandstone pinch out against the aforementioned structures, known as Magallanes Play (12.5 – 5.2 Ma).

Early Pliocene sand deposits (5.2 – 3.0 Ma) pinch out and overlap allochthonous salt bodies that make up the Cinco Presidentes Turbiditas and Cinco Presidentes Barras plays. Shelf progradation, identified in Middle Pliocene (3.0 – 2.4 Ma), occurred in such a way, that coastal environment sands and sandstone are found in the Orca Barras play and, on the other hand, basin floor and slope fans are found in the Orca Turbiditas play.

1. Exploration Background

The study area is located on the Continental Shelf covering an area from the shorelines of Veracruz and Tabasco to the 500 m isobath. (Fig. 1)

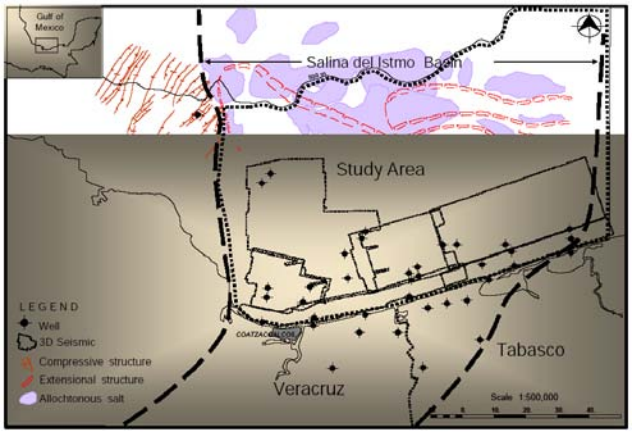

Fig. 1 *Study Area Map*

The first offshore oil and gas reservoirs were discovered in the 50s and 60s, however new exploratory studies were carried out in 1994, and in 1995, a 3D seismic was acquired.

Beginning with 2002, 17 exploratory wells were drilled and Neogene plays were tested to various depths, from 600 to 3750 m. Eight of the 17 wells tested, proved producers of oil, 15 to 28° API, of condensates and that of dry gas.

2. Structural Framework

The complex geology of the Salina del Istmo Basin structural framework, with its characteristic tectonic phases induced the formation of superimposed structural styles in the basin, during the Mesozoic and Tertiary, and is associated with compressive, extensive, and salt tectonic events. (Fig. 2)

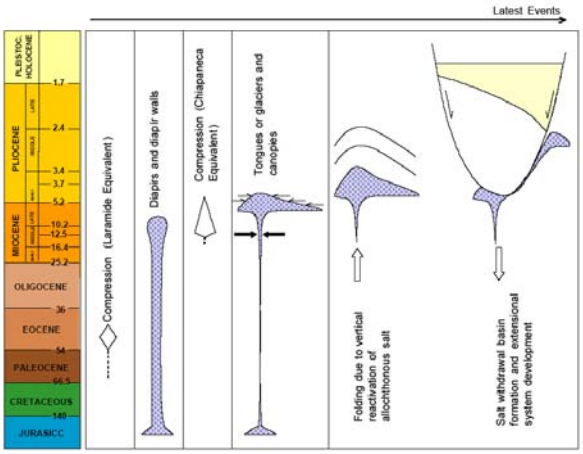

Fig. 2 *Structural Tectonic Events Identified in the Salina del Istmo Basin*

2.1 Compressive Structures

In the study area, there have been found compressive structures within sequences, of the Mesozoic and Paleocene-Miocene, that are related to two tectonic events. The first one, probably from the Eocene, can be found in small areas, with no allochthonous salt present (Fig. 3, central portion); the Middle-Late Miocene folds, with a NE-SW orientation, and the thrust faults were generated by the second and most important event (Fig. 3). Some of the compressive structures suffered from allochthonous salt intrusions, in either of the two extremes of the axial axis, tilting the hinges in a structural nose shape.

2.2 Salt Tectonics

The next tectonic event, responsible for the sedimentary fill in the basin, was salt tectonics, whose evolution began with Oligocene (?), taking advantage of thrust faulting related to compression events. Subsequently, salt continued its movement and evolved in the Miocene, in the shape of diapirs and diapir walls, and cropped up close to, or on the sea bed. Once in contact with seawater, salt got partially dissolved and the insoluble residue or cap-rock (anhydrites) remained on the salt dome crests, (Talbot, 1995.) Wells, in the area, have proved the presence of cap-rocks, which in seismic information is associated with a double reflector that can be seen on the top of allochthonous salt. At the end of the Miocene, the compressive event squeezed the diapirs and diapir walls forming vertical wedges, extruding salt outside in the shape of tongues or glaciers (Fig. 3.) The allochthonous salt bodies, in some cases, joined one another and formed canopies. Afterwards, sediments deposited in the later Early Pliocene and earlier Middle Pliocene overlapped these salt bodies, marking a relatively inactive salt tectonics stage.

2.3 Salt Withdrawal Extension

After the period of inactivity of salt tectonics, prograding systems originating in the South, reached the marine area of the central part of the basin during the later Middle Pliocene and earlier Late Pliocene, depositing and stacking great volumes of coarse grain siliciclastic rocks, that led to the displacement and northward migration of salt to shallow depths, with the development of great counter-regional faults, with an E-W and NW-SE orientation, forming salt-withdrawal basins.

Salt structures, related to sedimentary growth, are tongue or glacier shaped, and showed a vertical development that folded and faulted the sequences of Early Middle Pliocene on the top of salt structures.

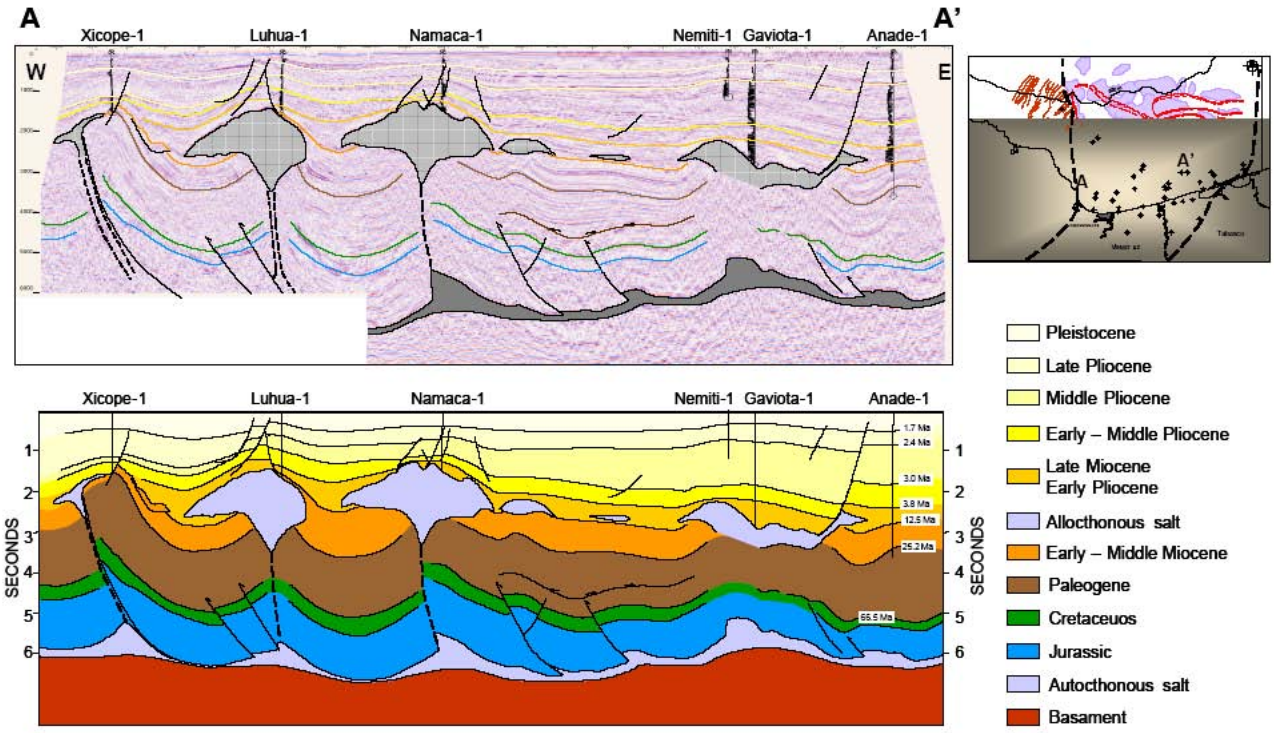

Fig. 3 Geological Section Showing Tectonic Structural Systems in the Salina del Istmo Basin

3. Stratigraphic Framework

Within the study area, the Miocene through Pliocene stratigraphic succession is made up of terrigenous sediments that include deep water, shallow marine and fluvial deltaic environments.

The oldest identified stratigraphic unit in this paper, is represented by Early Miocene pelagic and turbiditic sediments, truncated by an unconformity (D_1640), and covered by Middle Miocene coastal facies sandstone bars. The sequence limited by Middle Miocene unconformities D_1500 and D_ 1250, is represented by channel systems, covered by transgressive fine terrigenous rocks with small sandy rocks of an external shelf environment.

The stratigraphic succession, limited by Late Miocene and Early Pliocene unconformities, D_1250, D_520 and D_380, is made up of pelagic and hemipelagic sediments, and turbidites (channels, levee channels, overbank, basin floor and slope fans), that filled inter-salt mini-basins, as well as, piggy back basins, related to the Middle-Late Miocene compressive structures.

Three main sedimentary systems were identified in the Early Pliocene and earlier Middle Pliocene (D_380 – D_300) sequence: basin, shelf and a littoral shoreface. Lowstand slope fans, transgressive shale and high-stand coastal deposits can be found in the south central part of the study area. Pelagic, hemipelagic and turbiditic sediments, deposited in inter-salt minibasins, can be seen in the western portion of the area. Finally, in the eastern portion, a pelagic sediment shift can be appreciated, overlain by littoral shoreface deposits with a high shale content and even related to the deltaic system.

The best understood sequence is that of the Middle Pliocene (D_300 – D_240), as there is a clearly identifiable shelf progradation and a shelf-edge of same, that can be seen in the southwestern portion of the area studied.

In the south-central portion, the aforementioned sequence displays a greater development, because it corresponds to the main support entry of sediments, allowing for a littoral shelf system, with sand facies and thicknesses up to 1500 m. Basin floor fans prevailed in the north and west parts of the area. The Middle Pliocene sediments are overlain by a transgressive sequence of up to 300 m in thickness that functions as a regional seal.

Basin and shelf systems are found in the Late Pliocene sequence and are limited by unconformities D_240 y D_170. The basin system consists of basin floor fans and channels that were deposited by turbidity currents, controlled by the shelf edge and topographic heights due to the presence of salt.

4. Plays

The offshore Miocene and Pliocene plays of the Salina del Istmo Basin were redefined, based on the nomenclature as supported by PEMEX-BP, in 1994, (Fig. 4). The modifications were brought about according to the elements' characteristics as established in the stratigraphic and structural framework.

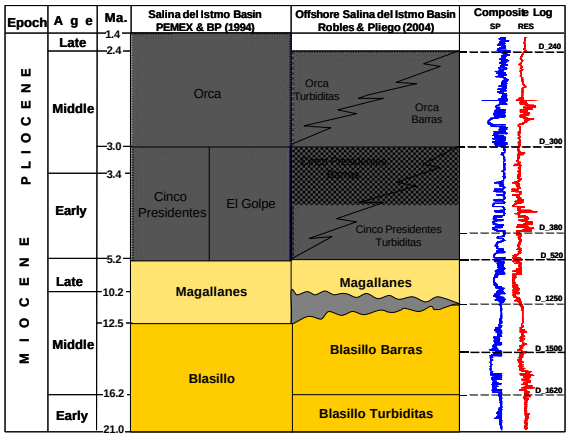

Fig. 4 *Table showing Miocene and Pliocene Plays in the Salina del Istmo Basin*

Geochemical analysis of the oil discovered, indicates that all of the plays are related and are part of the Tithonian-Tertiary Petroleum System (!), which according to geochemical modeling, the process of generation-migration started with 12 Ma until the present time. (Maldonado et al., 2004; (*in press*)

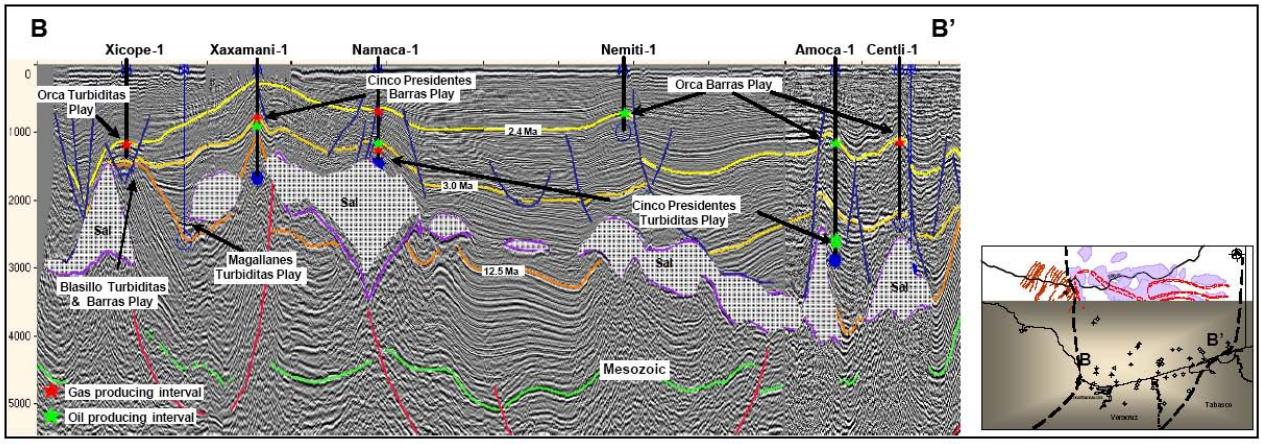

Fig. 5 *Geological Section Showing Plays Within the Tectonic-Structural Stratigraphic Framework*

4.1 Play Types

Early Miocene (25.2 – 16.4 Ma) Blasillo Turbiditas Play

The said play is made up of basin floor and slope fans sandstone, with thicknesses up to 20 m, typical lowstand deposits. The seal is formed by intra-formation shales.

Middle Miocene (16.4 – 12.5 Ma) Blasillo Barras Play

This play is made up of coastal and transitional environments: shoreface and delta-front sandstones. The net thickness of sandstone bars can reach 100 m, whereas deltaic deposit thicknesses are reduced in comparison to sandstone bars. Porosity varies from 12 to 24% and, permeability was found to be up to 50 md.

Blasillo Barras and Blasillo Turbiditas play trap types are formed by big anticlines with a NE-SW orientation, and a west vergency. (Fig. 5)

Late Miocene (12.5-5.2 Ma) Magallanes Play

This play is constituted by sandstones that fill and overflow submarine channels and fan tabular bodies. The seals are made up of intra-formation shales.

Early-Middle Pliocene (5.2-3.0 Ma) Cinco Presidentes Turbiditas Play

This play is formed by channel sands and fans, with thicknesses that vary from 5 to 20 m, pinch out or overlap salt bodies (Fig. 6). The seal is made up of intra-formation clay layers and fine transgressive sediments that regionally cover the sequence. Porosity varies from 14 to 37% and permeability from 6 md to 2.4 d.

Early-Middle Pliocene (5.2-3.0 Ma) Cinco Presidentes Barras Play

This play is formed by shoreface sand bars, with thicknesses that reach up to 30 m, that are structured by folding and faulting associated with salt pierce (Fig. 6). Porosity varies from 30 to 37 % and permeability, from 0.4 to 2.1 d.

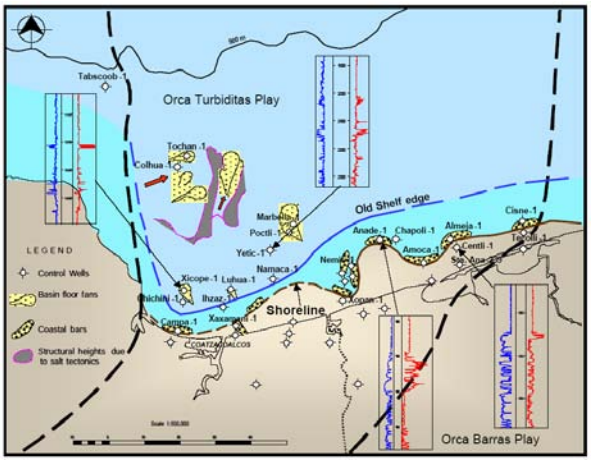

Fig. 6 *Sequence (5.2 - 3.0 Ma), Facies Map Showing Cinco Presidentes Turbiditas and Barras Plays*

Middle Pliocene (3.0 - 2.4Ma) Orca Turbiditas Play

This play is composed of basin-floor fan sands, with thicknesses from 10 to 20 m, structured and faulted by salt pierce and salt withdrawal (Fig. 7). Porosity range is from 26 to 36 % and permeability varies from 13 md to 5.8 d.

Middle Pliocene (3.0 - 2.4Ma) Orca Barras Play

This play is composed of shoreface bars, with thicknesses from 20 to 60 m, structured and faulted by salt pierce and salt withdrawal (Fig. 7). Porosity range is from 31 to 39 % and permeability varies from 310 md to 2.6 d.

4.2 Production Strategies and Risks

The main play risk factors are seal effectiveness, migration and timing, due to structural complexity and the presence of allochthonous salt. These factors require a new study for their better understanding.

Up to date, the Salina del Istmo Basin Miocene plays proved unsuccessful by way of exploratory wells, however, Pliocene plays proved to be producers.

Early Pliocene Cinco Presidentes Turbiditas and Cinco Presidente Barras plays, in their south portion of the study area, are the main oil producers, however, in the northern part, Cinco Presidentes Turbiditas play contains dry gas reservoirs.

Middle Pliocene Orca Barras play has got only recently discovered most important oil reserves, whereas Orca Turbiditas play holds the main condensate and gas fields.

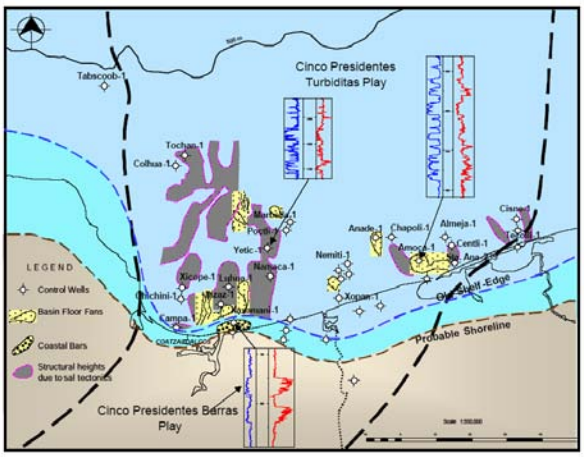

Fig. 7 *Sequence (3.0 – 2.4 Ma), Facies Map Showing Orca Turbiditas and Barras Plays*

The Tithonian hydrocarbon origin opens new exploratory possibilities in search of major accumulations in the Tertiary subsalt structures and even in the carbonated Mesozoic rocks. In order to perform this task it is necessary to get better imaging of 3D seismic applied to greater depth structures.

5. Conclusions

Seven plays have been defined in the sedimentary column, from Miocene through Pliocene.

Miocene plays, Blasillo Turbiditas and Blasillo Barras, have proved to be unsuccessful. Cinco Presidentes Turbiditas, Cinco Presidentes Barras and Orca Barras plays are the main producers of oil, of 15 to 28° API. The Orca Turbiditas play is the principal gas and condensate producer.

Finally, the economic benefits from this part of the Salina del Istmo Basin, especially, from Pliocene reservoirs, point at the need of a joint development strategy.

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