Present and Future of the Salina del Istmo Basin and its Offshore Extension into the Gulf of Mexico.
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Abstract

The Salina del Istmo Basin is a geographic region, which includes onshore and offshore prospects. The basin comprehends three main areas named: the Catemaco, Agua Dulce and Marbella folded belts; the Pescadores and Comalcalco withdrawal salt basins; and the “Sal Somera” area. Three generic play types have been identified: Neogene’s sandstones in structural and combined traps over salt bodies; Paleogene’s sandstones in structural and combined traps under the salt; and Mesozoic structured carbonates in compressional traps under the salt. In the first play (onshore) 50 fields were discovered in the last 50 years and have a cumulative production with over than 2 billions bbl of equivalent oil. In the offshore portion 6 oil and gas fields were discovered, with 106 millions of barrels of original reserves. The second and third plays are in the early exploration stage, and are expected to provide better geological conditions. Higher volumes and better hydrocarbons quality characterize these plays, however with a higher exploration risk due to prospects depth.

More than 300 exploration opportunities are identify, in the Salina del Itsmo Basin, with a considerable volume of hydrocarbons and an average exploration risk of 1:5. Therefore, these traps offer an attractive perspective in the short and medium term. The best short term development possibilities are on the coast, near the giant land fields, where oil production facilities currently exist.

1. – Study area

The Salina del Istmo Basin (SIB) is located in the south of Gulf of Mexico covering an area from Veracruz and Tabasco states to extending about 100,000 km² offshore towards the Gulf of Mexico center (Fig. 1).

Fig.1 Location map

2. – Background

The biggest three oil and gas fields, with 37 million bbl of oil accumulated production and 30 bcf of gas, were discovered in the 50s and 60s. However new exploration studies were carried out in the 90s. In 1998 the Tabscoob oil and gas field was discovered. Beginning with 2003, 12 exploration wells were drilled and 22 reservoirs were discovered: 12 of oil, 5 of associated gas and 5 of dry gas, distributed in 8 fields, with a 62% of geological successful. About 116 million bbl of equivalent oil, ranging from 8 to 28 degree API, had been certified. Low API
values are due to biodegradation of shallow reservoirs.

Currently, there are more than 300 exploration opportunities identified, where the main targets are concentrated in shallow tertiary, sub salt and Mesozoic plays. Seal and reservoir rock quality are the main risks in open marine facies. New discoveries results suggest that the best exploration strategy is to focus on sub salt and Mesozoic plays, with high possibilities to find bigger oil volume fields. Exploration in the SIB has been developed more widely onshore, and it has focused to the tertiary sands, while in offshore areas the exploration is just beginning. To date, the SIB has all the facilities for oil and gas production and export.

3. – Production history

The SIB has a long and prolific history of oil production and continues to provide exploration targets. The exploration initiated in 1902 with the drilling of the Amesquite-1 well. In 1906 the San Cristóbal-1 well discovered the first field, and the production began in 1910, with the discovery of the Ixhuatlán field. In the 60s the Cinco Presidentes field was discovered and the production reached 150 000 bbl/d.

Currently, Cinco Presidentes, Ogarrio, Cuichapa, Blasillo, Magallanes, El Plan and Bacal are the most important fields in the SIB. The production in the basin is 39, 000 bbl/d of oil and 56 million cfpd of gas. The historical exploration success of 35% allowed the discovery of 48 tertiary fields, with an accumulated production of 2.044 billion bbl and an average recovery factor of 22% (Fig. 2). The remnant reserves of these fields ascend to 788 million bbl of equivalent oil. From 1976 to 2002 reserves had not been incorporated in the basin.

Fig. 2 Exploration in the Salina del Istmo Basin.

The second stage of exploration in the SIB, initiates in 2003 with the discovery of 8 fields; 6 in the offshore and 2 in the onshore portion, with reserves of 116 million bbl of equivalent oil. Reached the 16% of the total reserves incorporated in Mexico during 2003. (Table 1).

Table 1.- Summary of reserves incorporated in the SIB during 2003.

<table>
<thead>
<tr>
<th>POZO</th>
<th>Aceite (mmb)</th>
<th>Gas Natural (mmmpc)</th>
<th>Aceite (mmb)</th>
<th>Gas Natural (mmmpc)</th>
<th>Aceite (mmb)</th>
<th>Gas Natural (mmmpc)</th>
<th>PCE (mmb)</th>
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<td></td>
<td></td>
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<tr>
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<td>13.6</td>
<td>4.3</td>
<td></td>
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<td>4.3</td>
</tr>
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<td>10.1</td>
<td>13.2</td>
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<td>18.9</td>
<td></td>
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<tr>
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<td>6.7</td>
<td>3</td>
<td></td>
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<td></td>
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<tr>
<td>Quiaucho-1</td>
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<td>5.4</td>
<td>8.8</td>
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<tr>
<td>Guadalupe-1</td>
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<td>1.2</td>
<td>0.7</td>
<td>1.2</td>
<td>0.7</td>
<td>1.2</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>30.4</td>
<td>31.9</td>
<td>45.7</td>
<td>50.7</td>
<td>56.7</td>
<td>76.8</td>
<td>115.6</td>
</tr>
</tbody>
</table>

4. – Geology

The SIB shares the geological history of the rest of the Gulf of Mexico that initiates with the rifting in the Middle Jurassic, evolving from oceanic opening to a passive margin basin (Fig.3). During the
first stage of the basin, thick packages of salt were deposited in an extensive area. Later, the drift of the Yucatan block towards the south allowed that great mass of salt was separated, remaining one part in the north of Gulf in USA and the second bordering the western side of the present Yucatan Platform. The mass of salt was buried by sediments from the Late Jurassic, and during the Mesozoic and the Tertiary; the salt has suffered episodes of mobility that deformed the sedimentary sequence in different ways.

During the Pliocene the clastic platform margin progrades towards the north over an extensive body of salt developing withdrawal basins, associated to the counter regional faults, such as the Comalcalco and Pescadores basins.

5. - Source and Petroleum Charge

Despite of 58 fields discovered, in Agua Dulce area, source rocks are unknown, and therefore their characteristics have been defined indirectly. Oil analyses indicate that the source rocks of this area are Upper Jurassic Tithonian (152-144 Ma) in age, constituted of shaly limestones and bituminous shales deposited in open marine conditions with regional distribution. Hydrocarbons geochemical analyses correlation and oceanic floor samples indicate that they have similarity with the oils from fields near the coast and the land fields neighbors. Both of them show a similar geological generation conditions. Based on the characteristics of heavy, light oils (27° to 43° API) and gas in this area, source rocks probably are currently in the generation window. In the onshore portion the SIB produces light oils and gas (Fig.4).

![Fig.3 Tectonosequences table](image)

The Catemaco, Agua Dulce and Marbella belts represent the effects of tectonic during the Middle Miocene to Late Miocene in the region. These folded belts are characterized by high depth decollement, and they are located over the autochthonous salt and involve also the Mesozoic’s basins and platforms. Seismic and well information suggest the structures have been formed around 12.5 million years ago and were accompanied by the emplacement of the canopy of “Sal Somera” towards the north.

![Fig.4.- Light oils (27° to 38° API) located in the SIB.](image)
6. Economic Play Analysis

Three generic types of plays are identified in the SIB Upper Jurassic–Tertiary Petroleum System: 1. Neogene’s Sandstones in structural and combined traps over salt bodies. 2. Paleogene’s Sandstones in structural and combined traps under the salt and 3. Mesozoic structured carbonates in compressional traps under the salt. In the first play (onshore) 50 fields were discovered in the last 50 years and have a cumulative production with over than 2 billions bbl of equivalent oil. In the offshore portion 6 oil and gas fields were discovered, with 106 millions of barrels of original reserves. The second and third plays are in the early exploration stage, and are expected to provide better geological conditions. Higher volumes and better hydrocarbons quality characterize these plays, however with a higher exploration risk due to prospects depth. Since economic point of view, these plays are important and they change the exploration strategy in the SIB. They offer attractive perspective to explore in the short and medium term.

The next definitions of plays were modified from Pemex-BP, 1994, and adapted here to be used in the SIB.

1. The Neogene’s Sandstones in structural and combined traps over salt bodies.

**Brujas Play** (Pleistocene–Recent 1.7 - 0 Ma). – This play has not yet been proven in the SIB. It is formed by a series of turbidite sandstones deposited in the slope and quickly overlapped by progradant deposits of platform. The intraformational shale provides vertical and horizontal seal. Anticline structures turtle type that contains this play, are rollovers related to growth faults and anticline structures made by withdrawal salt.

**Orca Play** (Pliocene Late 3.0 - 1.7 Ma).- It is associated to turbidity sands against normal faults. The seal is formed by intraformational shales. The trap is made by pinchouts of sands, or can appear against growth faults caused by salt withdrawal, the deposit is contemporary with the age of the structures.

This play is divided in Upper Orca Play (1.7 - 2.4 Ma) and Lower Orca Play (2.4 – 3.0 Ma); both have fluvial deltaic, shelf and basinal facies. In the offshore portion, the Upper Orca Play (1.7 - 2.4 Ma) was proven in the Tecolli-1 well. The oil discovered has less that 8º API. The Lower Orca Play (2.4 – 3.0 Ma) produces in the wells Tabscoob-1 (44º API), Amoca-1 (18º API); and Nemiti-1 (8º API) and is also producer of dry gas in Xicope-1, Centli-1 and Namaca-1 wells.

**Cinco Presidentes Play** (Pliocene Early 5.5 – 3.0 Ma). – Associated to “turbidite sands” pinching out against the salt or overlapping it. The play is divided in Upper Cinco Presidentes Play (3.0 – 3.8 Ma) and Lower Cinco Presidentes Play (3.8 - 5.5 Ma). The progradation of this clastic wedge caused great mobilization of the Miocene’s canopies and the development of extensive withdrawal salt basins with a Plio-Pleistocene thick fill. To the offshore there is a transition of fluvial deltaic and shelf facies including basinal turbidities.
The Cinco Presidentes Play has been proved in several wells. In this play were discovered 6 reservoirs with the follow distribution; In the Lower Cinco Presidentes Play (3.8-5.5 Ma) twice oil reservoirs in the Amoca-1 well (27-28° API). In the Santa Ana Field this play produces oil of 32° API, while in Marbella-1 well this oil is the 26° API. In the onshore portion the Guáricho-1 well produced oil of 39° API.

The Upper Cinco Presidentes Play (3.0–3.8 Ma) produces oil of 26° API and gas from Yetic-1 and Namaca-1 wells; 25° API from Xaxamani-1; 32° API from Santa Ana field, and dry gas in Campa-1 well.

**Magallanes Play.** (Middle-Late Miocene (12.5–5.5 m.y.). This play is constituted by pinchouts of turbidite sandstones against compressional structures. The Play is distributed in the different bands of the folded belts. The origin of the play is associated to "piggy back" basins. The turbidite sands were transported by the submarine canyons among compressional structures; these sands filled up the synclinals that generated conditions of pinchouts towards the top of the structures. Seal rocks are present in many intervals of the sequence.

The deformation of the SIB, begins during the Miocene (12.5 my), and stop in 5.5 m.y., which is also the age of this play. This play has just been proven onshore in the Gubicha-1 well, where 36° API oil was recovered.

**Blasillo Play.** Early Miocene-Middle Miocene (21–12.5 Ma). The Blasillo Play is composed of shallow marine and turbidite sands, later deformed into large anticlines. The sands were deposited in a shallow marine shelf and on the slope base as lobules of submarine fans. The seal is present as intraformational shales. In the 5.5 m.y. limit, when the compressive deformation finished, the area already structured was covered by the Sal Somera canopy. The Blasillo Play Sub salt varies from 21 to 12.5 Ma in age, and is composed by turbidite sands structured by folding under the salt canopy. This Play has been proved without success, in the marine area, by the wells Tascoob-1, Chichini-1, Xicope-1 and Xaxamani-1. Nevertheless, this play has good potential in the onshore portion.

2. Paleogene’s Sandstones in structural and combined traps under the salt

The Blasillo Play Subsalt had been drilled in the Salsomera-1 well and in land wells near of the coast such as Tonalá-902, Gurumal-2, Rabasa-1 and Palotada-1, and Yaxche-1 in offshore. This play is a target in a short and medium term in the SIB.

3. Mesozoic carbonates structured on compressional traps under the salt.

In the SIB, this play had not yet been proven. However, based on production from near fields, can be a potential target. Yagual-1 and Yaxche-1 oil and gas fields are example of oil accumulation in this type of play. Therefore, this carbonates are strategic targets in a short and medium term.

The plays described ahead, are important plays to be explored, and they are the...
result of data analyses made by PEMEX-BP (1994) and PEMEX (2002).

**Play Yum** (Late Cretaceous, 94-66.5 Ma). This play is composed by open marine fractured carbonates, in great thrusted structures underneath the tertiary fields. The prospects are in open marine fractured rocks, involved in compressional structures. Late Cretaceous shaly carbonates and Paleogene shales form the seal rocks.

**Nispero Play** (Early Cretaceous- Middle, 134-94 Ma). This play is formed by Middle Cretaceous local deposits of breccias, product of the erosion of the carbonated platforms. Potential methods and seismic information indicate basement high areas in the SIB, where carbonated platforms were developed. Compressional structures are the main type of traps. Late Cretaceous open marine facies constitute the seal for this play.

**Jujito Play** (Late Jurassic (144–134 Ma). It is a conceptual play, represented by oolitic deposits, Late Jurassic in age, in thrusted structures. The definition of this play is based on the identification of high basements areas, where isolated platforms were developed. Tithonian`s shales and Kimmeridgian open marine shaly facies form the seal for his play.

7.- Strategy and Results

1.- The exploratory wells were drilled in the crest of the salt cored anticline structures, were the sands are less developed and with low reservoir quality

2.- The best reservoir quality sands with better thickness are located in the flank of the structures such as was found in the Amoca-1 well.

3.- The volumes of hydrocarbons found are not indicative of the volumes that we expect in the structure.

4.- Directional and horizontal wells are the best technologies we have to use in the development of the reservoirs.

Conclusions

1.- The SIB is a geologic province with high hydrocarbon traps potential.

2.- Blasillo, Magallanes, Orca and Cinco Presidentes are plays already tested, while the Mesozoic, Blasillo Subsalt, and Brujas are hypothetical plays. From 2002 to the 2004, 25 reservoirs have been discovered: 15 of oil, 5 of humid gas and 5 of dry gas.

3.- The Cinco Presidentes Play is the best play discovered in the SIB.

4.- Shallow traps contained biodegrade hydrocarbons

5.- Historical records of the reservoirs in the SIB show us that the production is mainly light oil.

References
