Sureste Basin, México and Associated Sub-basins: An Update and Future Potential

José Alberto Aquino-López (PEMEX, México)

The Sureste Basin, with an extensión of approx. 65,100 Km2, has been the main hydrocarbon province of Mexico since the mid-1970´s. It consists of two main areas: The light oil-bearing onshore Mesozoic province, also known as Chiapas-Tabasco, and the prolific offshore oil province of the Sonda de Campeche with heavy and light crudes. The Southeast basin also contains two Tertiary subbasins – the Comalcalco to the north, and the Macuspana subbasin, producing oil and gas since the 1950´s (Fig.1).

Hydrocarbon reserve incorporated for the basin is 23,930 mmb of oil and 32,960.30 mmmpc of gas for the Mesozoic, and 311.8 mmb of oil and 361.8mmmpc of gas for the hydrocarbon column in the Tertiary sequence. Evidently production from the Mesozoic far exceeds that from the Tertiary section. Hydrocarbon quality varies from heavy to superlight oil in the Mesozoic, while the Tertiary produces oil and non-associated gas. Recent exploration activities have been very positive with the addition of considerable new reserves.

BASIN EVOLUTION

Multiple tectonic regimes left its imprint on the study area: a passive margin phase during the opening of the Gulf of Mexico, a prolonged Pacific-type convergent margin phase, and a transcurrent phase associated with the major Motagua-Polochic system. Any interpretation of the ancestral Southeast Basin should take into account the uniquely complex polyphasic deformation history of the basin.

In general terms the tectonic evolution of the ancestral Southeast Basin may be summarized in seven stages:

Stage 1-. Triassic-Jurassic Rifting (230-144m.a). The geometry as well as the location of the basins, including the Southeast basin, was established on the southern rim of the Gulf of Mexico during this period.
An important aspect of this stage is the precipitation of thick beds of Callovian salts in the lows of rifted grabens of large areal extension. Salt distribution strongly influenced the events which shaped the later traps. Equally, the salt acted as a detachment level, and was an important factor in later deformation through diapirism and salt evacuative processes.

The Southeast Basin formed as a wide but partly closed basin, bordered by basement highs, and includes: Fig.1.-The Chiapas Depression which formed as a pronounced NW trending basement low (presently designated as the Sierra de Chiapas). The Mesozoic Chiapas-Tabasco, and the Sonda de Campeche depocenters hosting the main fields and the most important petroleum system of the Southeast Mexico region.

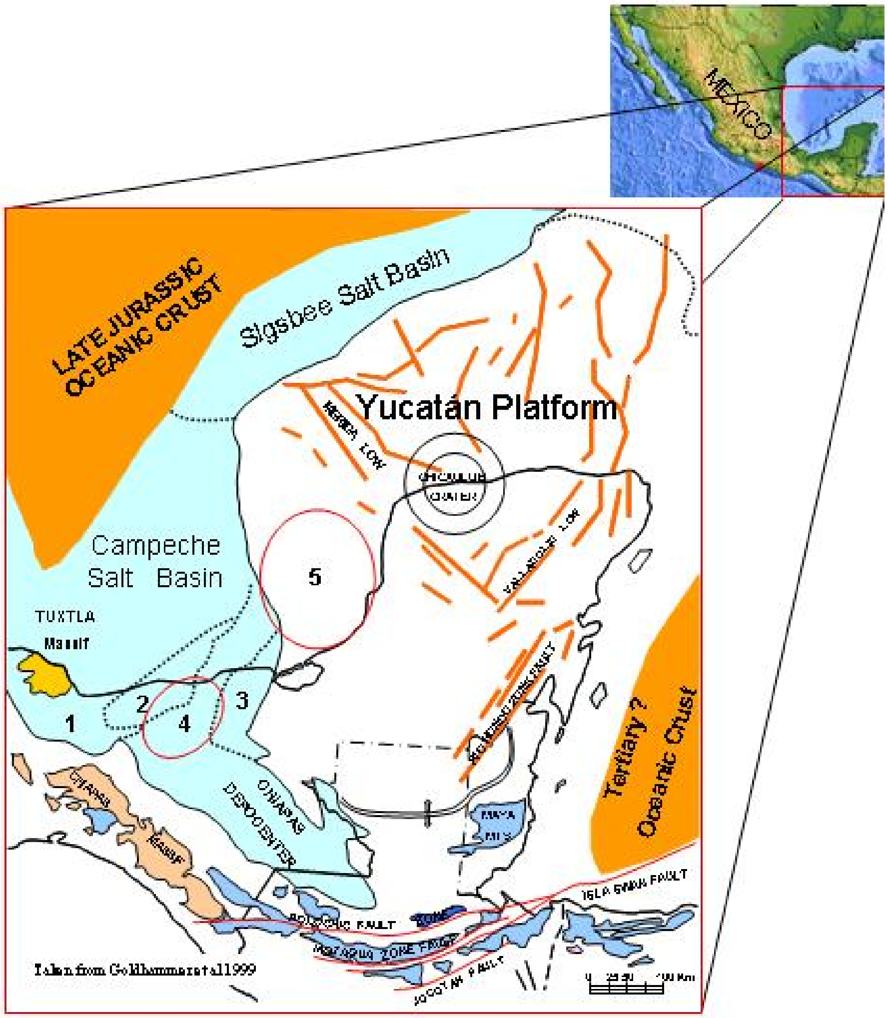

Fig.1 Location of the ancestral Cuenca del Sureste. This province include: The Tertiary Sub-basin of (1) Salina del Istmo, (2) Comalcalco and (3) Macuspana and the prolific Mesozoic provinces of (4) Chiapas Tabasco and (5) Sonda de Campeche. The total production from these basins it´s the 8,749.9 mmb and 24,628.1 mmmpc. In this province that which stands out, are the marine part of the basin which mainly produce oil and The Sub-basin of Macuspana with production of gas

Neogene Volcanics
Cretaceous Ophiolites
Exposed Paleozoic Basement
Pre Mesozoic intrusives
Oceanic Crust
Structural lineament

Stage 2-. Late Jurassic Passive Margin Phase (144-130m.a.). In the Late Jurassic the borders of the Gulf of Mexico acted as passive margins, while new oceanic crust was being created along the central Gulf oceanic ridge. The widely extensive marine Tithonian shaly lime mudstone were deposited during this time. The shaly mudstone forms the most important hydrocarbon source rocks of the southern border of the Gulf of Mexico.

Stage 3-. Early Cretaceous Thermal Subsidence (30-98m.a.). Following the cessation of the spreading of the Gulf of Mexico ocean floor and subsequent to the break-up with South America along the eastern and southern border of Yucatan, a period of passive subsidence ensued along the southern border of the Gulf. The phase of thermal subsidence lasted about 30m.a. (Early Cretaceous to Cenomanian).
At this time a series of wide carbonate platforms, bordered by rudist reefs, developed along the Gulf margins.

Stage 4-. Late Cretaceous Crustal Flexure and Island Arc Collision (98-66.5m.a.). In the Late Cretaceous the collision and subsequent suturing of the Greater Antilles Island Arc (Chortis Block) destroyed the southern passive margin of Yucatan. This caused loading, flexural uplift and erosion of older carbonates more to the north, enhancing the porosity of strata. The event also permitted the continuous growth of the Chiapas platform and Yucatan, and the drowning of other platforms. Stage 4 marks the end of the passive margin and the onset of the convergent phase.

Stage 5-. Paleocene-Eocene Oblique orogenesis and relaxation (66.5-49.5m.a.).The eastward movement of the Chortis Block during the Paleocene-Eocene destroyed the early passive margin; the convergence continued to the south of Yucatan causing deformation and erosion of folds and thrusts. Mainly siliciclastic sediments, characterized by thick argillaceous units were deposited in the Reforma area. Locally early maturation of source rock occurred. The Campeche area was marked by continuous carbonate sedimentation in a distal foreland setting.

Stage 6.- Eocene to Recent Transpression (49.5Ma. – Present). The Eocene-Recent eastward movement of the Caribbean plate caused left-lateral transpression along the southern edge of Yucatan (Motagua-Polochic System) with resultant uplift and continuous erosion. The influx of clastics, bypassing the distal shelf, gave rise to the producing Paleocene slope breccias in the Sonda de Campeche area and similar productive Eocene breccias in the Reforma area.

Stage 7.- Miocene Orogenesis (Chiapaneca Orogeny) (11.7 Ma.–Present). Finally, the Miocene development of Chiapas folded belt triggered a massive influx of Neogene clastics in the Reforma-Campeche area, causing movilization of salt, large volumes of argillaceous sediments, and formation of traps. Drastic changes took place in the Reforma area where clastic platforms developed during the Middle and Late Miocene, sourced by the ancestral Mezcalapa and Usumacinta –Grijalva fluvial systems.
The compressive deformation was responsible for the formation of traps in the subsurface in a foreland setting, while the uplifted folded belt lost its potential partially due to the uplift and erosion which interrupted source rock maturation, and breaching of the traps.

This event is particularly important, in as much as the compressive effects of the orogeny in the Chiapas folded belt triggered extensional effects in the foreland area, giving rise to the Comalcalco (Early Pliocene) and Macuspana sub-basins (Late Miocene), both being filled with thick columns of siliciclastic detritus.

The extensional phenomenon which gave rise to these basins, are related to large systems of listric faults. The faults, in addition to generating structural roll-over traps, and movilizing large volumes of argillaceous sediments, breached the seals of the Mesozoic fields, thus forming the migration route to the suprajacent Tertiary (including the Neogene) siliciclastic sedimentary column.

These tectonic events acted in such a way as to make the Southeast Basin a rich hydrocarbon province where each element of the petroleum system was in perfect synchrony. Hydrocarbon accumulation in this prolific basin was controlled first by the play elements created during the passive margin phase of the southern Gulf of Mexico, to be later complemented by play elements created, enhanced or catalyzed through the Pacific active margin phase, and the transcurrent systems.

The main productive areas in the Southeast Basin are:

CHIAPAS-TABASCO

The Mesozoic Chiapas-Tabasco province, discovered in 1972 with the Cactus 1 and Sitio Grande 1 wells, and developed during the mid-seventies, covers an area of 13,100 km2, and corresponds to the central onshore part of the Sureste Basin. Northward offshore extension of the basin is found in the Litoral de Tabasco and the Sonda de Campeche provinces. Total daily production of the province from different stratigraphic intervals is 576 mmb of mainly light oil, and 1835mmmpc of gas from 57 fields (out of a total of 75 discoveries). The deepest producing horizons are intensely dolomitized and fractured shelf, and slope/basinal limestones of U. Jurassic Kimmeridgian and Tithonian respectively. Cretaceous production comes from shelf to basinal facies.
Cumulative production from 11 fields exceeds 100 million barrels of oil, the most famous fields being the El Complejo Bermudez with 2,518mmb of oil and 3,380 mmmpc of gas, and the Jujo-Tecominoacan field with 968 mmb of oil and 1,061 mmmpc of gas. Total cumulative production is 7,123 mmb of oil and 32,960 mmmpc of gas, while the remnant reserve is 17,126mmbpce.

SONDA DE CAMPECHE

Discovered in 1976 at a shallow water depth of 50m, it includes 24 fields (of which 18 producing now). The province consists of two zones, the Marina Noreste and Marina Suroeste; together they have a cumulative production of 16,807 mmb of oil, 10,335 mmmpc of gas, and a reserve of 11,370mmpce. The reservoirs are in Oxfordian quartzose arenites of coastal dune origin, Late Jurassic Kimmeridgian oolitic limestones (similar to those in the Chiapas-Tabasco province), Late Cretaceous to Early Paleocene carbonate breccias, associated calcarenitic turbidite facies of Paleocene-Eocene, and associated Mio-Pliocene siliciclastic turbidite facies.

The region is by far the most prolific petroleum province in Mexico and includes the supergiant Cantarell Field which alone produces 1.34 mmb of oil and 532 mmmpc of gas daily, out of a total daily production of 2.4 mmb of oil and 1,500 mmmpc of gas for the entire province. The exploration discovery in early 1999 of a repeated section underneath the Cantarell field corroborrated the existence of a totally new, independent reservoir with lighter oil (30° vs. 24° API of the overlying reservoir) with a total reserve of about 1,136 mmbpce.

COMALCALCO SUB-BASIN

The sub-basin, located in the northwestern part of Sureste Basin, is bounded by the continental shelf of the Gulf of Mexico to the northeast, the Comalcalco Fault to the south, and the Salina del Istmo basin to the west. Since 1934 when exploration started, 11 oil and gas producing fields have been discovered in the sub-basin

The productive reservoirs occur in three play types: Middle to Late Miocene turbidite sands, Late Miocene-Pliocene deltaic sands, and Plio-Pleistocene fluvial sands. All are associated with anticlinal traps produced by normal faults of extensional tectonic regime. Cumulative production is 297mmb of oil and 269.5mmmpc of gas in the sub-basin.

MACUSPANA SUB-BASIN

The Macuspana sub-basin is located on the coastal plain of the Gulf of Mexico. Extending from the central part of the State of Tabasco to the extreme southwestern tip of the Campeche province, the sub-basin has an area of approx. 13,800 km2, (with one-sixth of its area being offshore), and is a producer of non-associated, shallow (less than 3000m depth) gas since the 1950's. The producing horizons are associated with fluvio-deltaic sandstones and shelf limestones of the Macuspana Formation. Traps are both stratigraphic and structural, the latter being mainly roll-over anticlines associated with an extensional regime and resultant deformation. As yet no production comes from the offshore part of the sub-basin. However, several potentially attractive structures have been identified, to be explored by drilling during the coming years. So far the sub-basin has registered a cumulative production of 5,184 mmmpc of gas from 13 fields (of a total 36 discoveries). The peak production of 720 mmmpc of gas was reached in the year 1975. The remnant reserve is about 166 mmpce.

THE FUTURE OF THE SOUTHEAST BASIN

The southern region is an important petroleum province in Mexico. It is crucial for the country that production is maintained and revitalized in this region. The Chiapas-Tabasco region produces light oil, while the Sonda de Campeche produces heavy oil in the northwest sector, thus the two regions having a complementary aspect toward obtaining the characteristic Mexican blend. Both regions are important in this sense. A remnant 3P reserve of 14,469 mmpce is estimated to be present in this part of the basin; Recovery of this reserve will require: a better knowledge of the subsurface, knowing well the stratal geometry of the sequence of interest, characterizing in detail the structural traps, and recognition of the stratigraphic traps. The knowledge gained will allow us to implement adequate secondary recovery programs, to identify yet unexplored traps, and enhance the development of fields, many of which still with appreciable recoverable reserves.

Exploration activities in the Sureste Basin already follow this approach; however, to bolster this strategy we should invest more resources in the acquisition of 3D seismics and study of plays, permitting us to reduce the uncertainty factor in geological risk evaluation, while at the same time augmenting our understanding of the petroleum system. This will equip us to launch an aggressive exploratory drilling campaign in known areas, while extrapolating our acquired knowledge to frontier areas with potential. Recent discoveries in the Early Pliocene paralic sands in the Saramako field, with a proven reserve of 8.44mmpce, and in the Middle Cretaceous basinal fractured carbonates in the Naranja field with 13.8mmpce of proven reserves, confirm the validity of this approach. Our regional exploration strategy contemplates the addition of 279 mmbpce of reserves during the period 2004-2006, in step-out areas of existing producing fields , mainly from the Mesozoic interval; also our strategy contemplates the evaluation of a potential P10 reserve of 728mmbpce in areas extending out of Mesozoic plays, the priority being the subjacent Mesozoic in the Macuspana and Salina basins. In the Sonda de Campeche marine region, as well as the Litoral region, an estimated 3P remnant reserve of 19,971 mmpce exists which undoubtedly makes this area the most important part of the basin. Nevertheless, a more active exploratory campaign will be necessary to obtain new 3D seismic information, to better define the outward extension of known plays in frontier marine areas at greater water depth.

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