SUPERPOSED STRUCTURAL STYLES OF THE MARACAIBO BASIN, VENEZUELA

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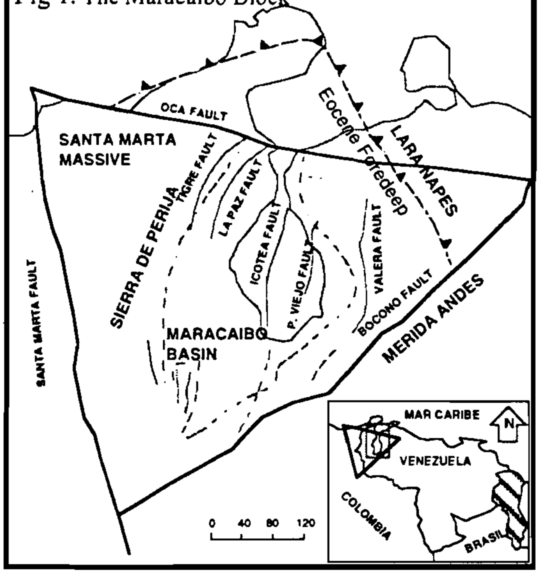
INTRODUCTION

The Maracaibo basin, which is located between two andean chains, the Merida Andes and the Sierra de Perija (fig. 1), has been subjected to several deformation styles during its geologic evolution.
The objective of this paper is the explanation of the different tectonic phases which deformed the sediments of the Maracaibo basin. This structural evolution was constructed from the interpretation of a transect of 2D and 3D seismic lines, which cross the basin from NW to SE (fig. 2).

Fig 1. The Maracaibo Block



STRUCTURAL FRAMEWORK

The actual Maracaibo basin is located inside a triangular tectonic block (fig.1), bounded by the Bocono fault, in the Merida Andes, the Santa Marta fault, located west of the Sierra de Perija in Colombia, and the E-W striking Oca fault, running parallel to the boundary with the Caribbean plate.
Before the uplift of the Merida Andes, the basin included the Barinas-Apure basin, located south of the Andes.
Inside the triangular tectonic block, one can differentiate two fault systems: a N to NE striking fault system, which experienced compressional deformation by episodic pulses, and an extensional W to NW striking fault system. The N to NE striking system consist of two main faults (fig. 3). A lower fault, which is a thrust propagated at basement and Cretaceous levels and generally absorbed by the Colon shales (Upper Cretaceous). This fault is converted into a drape fold structure at Paleocene levels. The upper fault is a normal growth fault at the Eocene level and strikes opposite to the overprinted thrust

STRUCTURAL EVOLUTION

During the breakup of Pangea (Triassic-Jurassic times), the North and South American plates separated from each other forming a belt of rift-grabens (Pindell, 1990), opening the space for the depositional history of the Maracaibo basin. The graben system extended from the Gulf of Venezuela to the south-

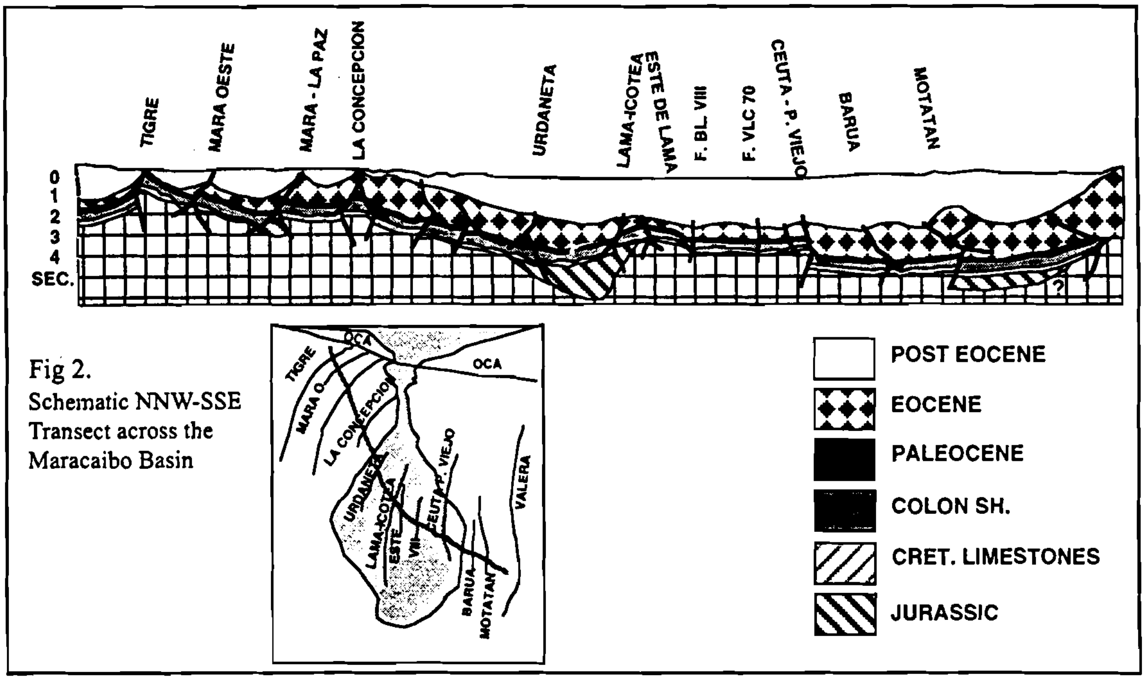


Fig 2.
Schematic NNW-SSE Transect across the Maracaibo Basin

reaching Ecuador (Bartok, Reijers and Juhasz, 1981).
The Jurassic La Quinta formation filled the grabens with volcano-sedimentary sequences. Some of these grabens are buried under the thick sediments of the Maracaibo basin and others are outcropping both in the Merida Andes and the Sierra de Perija

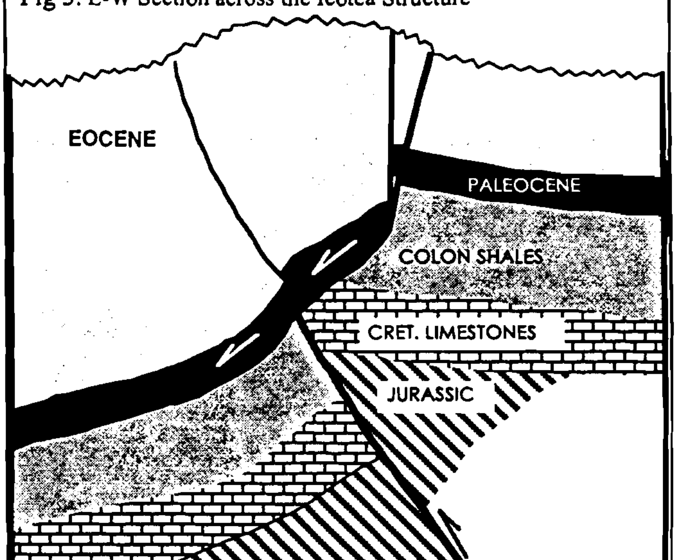
The graben system that developed from extension changed to a compressional phase presumably during Upper Jurassic to Lower Cretaceous times. Subsequently, the sediments were folded and faulted culminating in a partial to total erosion (Stephan, 1980).

During the Cretaceous , the sediments were deposited in a passive margin setting (Pindell, 1990) under broad subsidence . After the basal Rio Negro sands thick sequences of the Cogollo group carbonates were deposited (Lower Cretaceous). This was followed by the black bituminous limestones of La Luna formation, which is considered as the main source rock for oil in the basin. The Upper Cretaceous was characterized by the shaly Colon formation, set behind the arch environment (Bartok et al., 1981).

Up to the end of Paleocene and during Eocene the basin area faced an eastward moving Caribbean plate across its northern edge. The encounter with this Pacific-derived plate caused two different kinds of events. To the northwestern part of the basin ocurred a collision and subduction. But, the northeastern edge underwent an obduction.

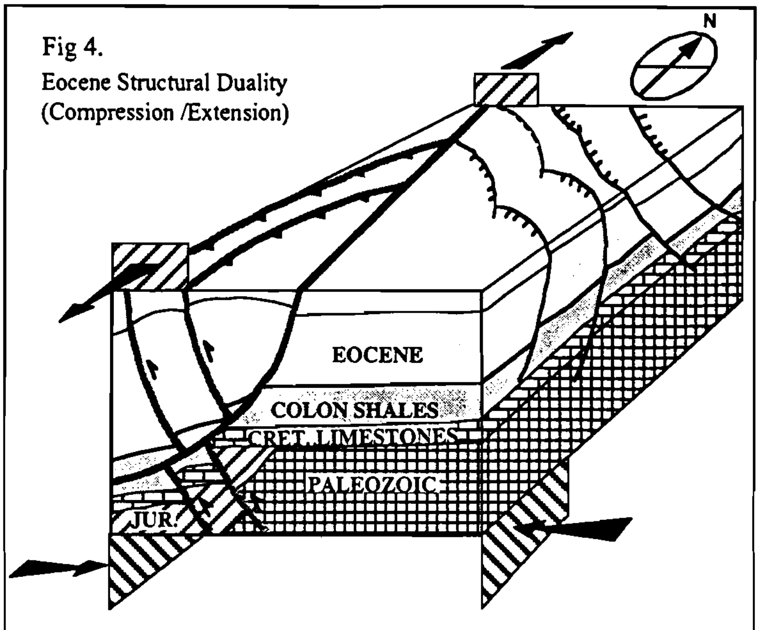
The oblique collision with the Caribbean plate caused a subduction under the Santa Marta Massive in Colombia, which

Fig 3. E-W Section across the Icotea Structure



extended under the Maracaibo basin (van der Hilst, 1993). The resulting compression created a thrust belt in the Sierra de Perija and a foreland tectonic province in the Maracaibo basin. The thrust belt is characterized by faults in a thin-skinned setting, while the foreland area developed basement-involved faults.
In the foreland tectonic province set in the Maracaibo basin, the compression caused thrust propagation along old N to NE oriented Jurassic grabens and related structures. The thrusts extended across the basement and Lower Cretaceous carbonates, but once reaching the Upper Cretaceous Colon shales, the reverse faulting detoured and was absorbed. At Paleocene levels, the thrusts were developed into drape fold structures. In the foreland province of the Rocky Mountains in Wyoming, one can observe similar drape fold structures (Lowell. 1985). The resulting high and low areas were filled by Eocene tectono-sedimentary sequences and bounded by normal growth faults dipping opposite to the overprinted thrusts. The compressional deformation took place though episodic pulses. Each tectono-sedimentary sequence began with a sediment deposition under extensional regime. After a compressional pulse the sediment wedges were shortened, slightly folded, inverted and sometimes slightly eroded. A new deposition began once the compresional pulse ended, began a new deposition. Seismic lines of the Mara field (in the western part of the basin) define three different tectono-sedimentary sequences for the Eocene and another three for post-Eocene times (fig. 5).

Fig 4.
Eocene Structural Duality
(Compression /Extension)



The compressional Eocene deformation involved only faults striking N to NE, while taking into account that the main shortening axis was oriented NW-SE (figs. 3 & 4).

The extensional deformation was opposite to the compressional forces (fig. 4). As the Caribbean plate appeared along the northern edge of the Maracaibo basin, its charge produced a flexural deformation, resulting in a foredeep located close to the allochtonous body. The foredeep advanced eastwards together with the Caribbean plate.
This event transformed the area of the Maracaibo basin into a foreland basin (Lugo and Mann, 1993). To accomodate to this new situation, the old sedimentary passive margin platform completed a lithospheric bend toward the foredeep. In this extensional environment were normal faults striking W to NW, allowing for a stepweise descent into the foredeep.
Towards the central part of the lake (during Lower Eocene times) was located a high, which was presumably a reactivation of the Merida High - active during the Paleozoic. Large normal growth faults bound the northern and southern edges of this high.
The eastward migration of the Caribbean plate lead to an obduction. The Lara nappes were pushed over part of the actual Falcon and Lara areas (Stephan, 1977,1980). The foredeep was located close to the obduction zone in the northeastern part of the basin.

The combination of NW oriented compression with the eastward foredeep migration which merged with the Caribbean plate) resulted in a clockwise rotation of the main blocks of the Maracaibo basin. This action caused sinistral strike-slips along the main faults striking N to NE.

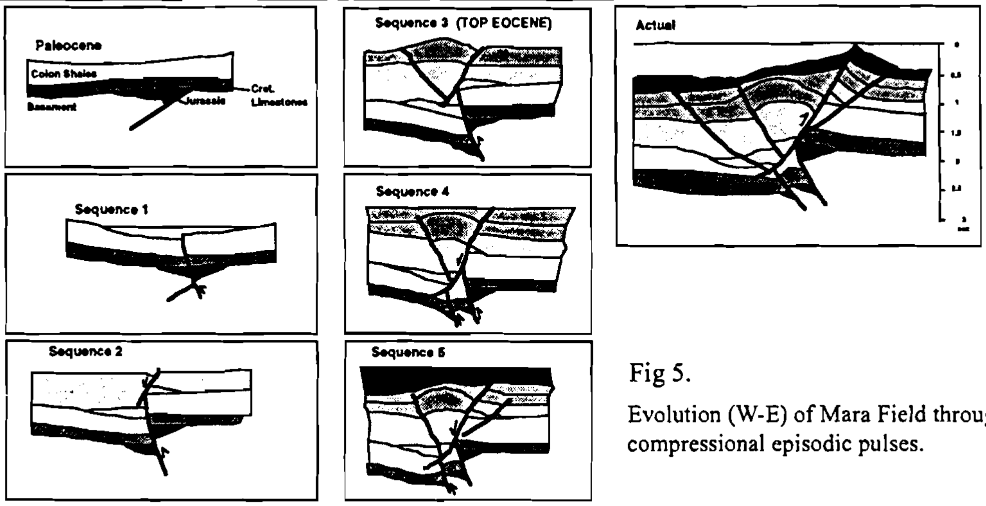


Fig 5.
Evolution (W-E) of Mara Field through compressional episodic pulses.

CONCLUSIONS

The structural styles that have ocurred in the Maracaibo basin were heavily influenced by plate tectonics. The breakup of Pangea opened the space for Jurassic sediment deposition, followed by a quiet Cretaceous passive margin. Once the Caribbean plate appeared in the northern edge of the area during the Upper Paleocene, the environment changed to a foreland tectonic province. During the Eocene, the oblique collision with the Caribbean plate in the northwestern edge of the basin (and the following subduction) produced a NW-SE compression. This caused thrust propagation at the border of old jurassic grabens. While in the opposite quadrant a foredeep produced by the charge of the allochton and later, by the obduction produced in the northeastern basin edge, gave place to an extensional deformation in a foreland basin setting. The resulting normal faults strike E-W to NW-SE.
Additionally, the combination of the NW oriented compression with the eastwards foredeep migration (which merged with the Caribbean plate) resulted in a clockwise block rotation. Thus causing sinistral strike-slips along the main faults striking NNE.

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