STRUCTURAL INTERPRETATION OF CEUTA FIELD, LAKE MARACAIBO, VENEZUELA

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RESUMEN: La interpretación estructural del levantamiento tridimensional del Campo Ceuta , en la Cuenca de Maracaibo, fué realizada considerando los diferentes estilos de deformación a los cuales estuvo expuesta la cuenca desde el Triásico-Jurásico hasta el Neógeno. La deformación tuvo lugar alternando fases tensionales y compresionales.

KEY WORDS: Ceuta Field, Pueblo Viejo Fault, Maracaibo Basin, Structural Inversion

INTRODUCTION

This interpretation, achieved in an interactive workstation, is centered around an area covered by a 3D seismic survey acquired over most of the Ceuta Field, located in the Maracaibo Basin, which is situated between two Andean chains, on the northern edge of the South American Plate.

GEOLOGICAL SETTING

The stratigraphic column shows over a paleozoic basement, the volcano-sedimentary complex of Triassic-Jurassic La Quinta Formation, which fills deep basement depressions, and is uncomformably covered by Cretaceous and Paleocene platform sediments, followed by passive margin Eocene sediments and finally, the continental Neogene embankment.

The structural deformation took place under alternating extensional and compressional tectonics. The major structural features of the field are the Pueblo Viejo and the VLG-3693 faults.
During Eocene and Miocene times, the Ceuta Field was located in a regional high structure, which gradually has been inverted during the Upper Neogene reaching the deep today situation (Roberto, Cramez and Duval, 1993).

The Ceuta Graben
The North-South oriented Pueblo Viejo fault is interpreted as the border fault of a Triassic-Jurassic graben, which western part is situated in the Ceuta Field, in Lake Maracaibo. The eastern border-fault, the Valera Fault, is outcropping in the Trujillo Andes and the Lara-Trujillo Mountains, in the eastern coast of Lake Maracaibo.

Lower Eocene Extensional Deformation
The graben was covered by Cretaceous and Paleocene platform sediments, and was reactivated under extension during Early Eocene times.
During the same time, and due probably to the forebulge originated by the emplacement of the Lara nappes in the northeastern part of the Maracaibo Basin (Rodriguez, Bueno and Ostos, 1993), a series of listric faults were developed.
To the South of the field exists a remanent of a Mesozoic structural high, "the Merida Arch", which is bounded by the big listric VLG-3693 growth-fault, dipping to the North.

Structural Inversion
During Upper Eocene times, and as a result of collision of the Caribbean and the South American Plates, followed by the oblique subduction of the Caribbean crust under the Maracaibo Block (Van der Hilst, Rob and Mann, 1993), the sediments of the Maracaibo Basin were deformed under compression, which gave place to the structural inversion of the Ceuta graben.
The main stress deformation axis was oriented in a NW-SE direction (Willemse, Van de Graaff and Sancevic, 1990).
During this phase, the normal border-faults of the graben were converted in reverse faults, particularly at Eocene levels. Due to the high angle of the Pueblo Viejo fault at Cretaceous and Basement levels, the inversion was of little significance there.
Antithetic faults situated in the East flank of the Pueblo Viejo fault were also converted in reverse faults, giving place to the formation of wedge shaped blocks, which, locally are squeezed up as pop up structures.
Due to its orientation almost parallel to the main deformation stress, the big VLG-3693 fault has not been inverted, excepted in its Northwesten edge, where the Pueblo Viejo fault overprints the VLG-3693 fault.

Strike slip Faulting
This analysis of the Ceuta graben leds to dynamic and cinematic processes, which are different to the traditionally used for the structural interpretation of the area, until now considered as a result of strike slip tectonics only (VST, 1986). The present interpretation considers the strike slip deformation of the Pueblo Viejo fault as an event associated to the structural inversion, and due to block rotations.

Post-Eocene Deformation
An extensional deformation took place in Early Miocene, which was followed during Late Miocene, by a new phase of compressional deformation. This deformation took place during the uplift of the Merida Andes, which also involved the eastern eastern part of the graben, which is now outcropping. During this phase, the Maracaibo Block escaped northward from its Colombian Eastern Cordillera convergence (Pindell, 1993).
The main stress deformation axis had an East-West orientation (Willemse et al. 1990). During this phase occurred also a conjugated shear-fault system, which cut the Ceuta High with 45 degrees angles to the Pueblo Viejo fault.

Hydrocarbon Traps
The tectonic processes were very important for the development of different types of hydrocarbon traps recognised in the Ceuta Field.
Four different kinds of plays can be distinguished, the Miocene-, Upper Eocene-, Lower Eocene- and Cretaceous-plays, which are related to specific deformation phases.
The Miocene plays are related to the entrampment caused by the Pueblo Viejo fault.
The Upper Eocene play consists also in traps developed next to the Pueblo Viejo reverse fault and its antithetic faults.
The Lower Eocene plays are situated against the normal faults oriented NW-SE, and developed during the extensional deformation.
The Cretaceous plays are related to the highs, which existed in the upthrown flank of the Pueblo Viejo fault, during the extensional Lower Eocene deformation phase, assuming a migration previous to the structural inversion.

CONCLUSIONS

Ceuta Field is located in the western half of a graben originated during Triassic-Jurassic times, which after being eroded was covered by Cretaceous and Paleocene platform sediments. During Lower Eocene times the graben was reactivated under extension. During the Upper Eocene, and as a result of subduction of the Caribbean crust under the Maracaibo Block, the sediments were deformed under compression, which gave place to the structural inversion of the graben. Finally, an extensional deformation phase took place during Early Miocene, which was followed by Late Miocene, by a new phase of compressional deformation during the uplift of the Merida Andes.

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