



Seismic evidences of Cretaceous duplex structures in the Tuy-Cariaco Basin - Venezuela

Maria Gabriela Castillo Vincentelli, Universidade Estadual Paulista - UNESP

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Abstract

The sub_basin focus of this study is located on the Eastern Venezuelan basin between Araya Peninsula and Margarita, Cubagua and Coche islands. Until now, this sub-basin is considered as marginal because it hasn't find high hydrocarbon potential on the drilled wells; but not wells have drilled the plays proposed here.

The main objective is to understand the kind of geological structures present on the Tuy-Cariaco Basin, based on seismic observation/interpretation and surface geology calibration.

On this order of ideas, the complementation of the traditional seismic interpretation with compressive geological interpretation techniques (dip panels analyses, Dhalstrom-Suppe geometries among others) and lateral correlation of the geological models, would show us the presence of important structural traps for hydrocarbon

Even with few seismic data on the region and low stratigraphic control, the preliminary analysis indicates the presence of prospective structures like folds divided on two kinds of play, the first one related to duplex structures showing Barranquin Formation as the main reservoir and the second one is the mentioned reservoir sealed by a big Pliocene-Pleistocene erosion.

The author based on the previous observation recommend to perform a petroleum system study in order to verify the timing of it, and in case of get a good timing, it is recommended a 2D/3D seismic acquisition that will show a new exploratory frontier on Venezuelan basins.

Resumo

A sub-bacia foco deste estudo é localizada na Bacia Oriental da Venezuela entre a península de Araya e as Ilhas de Margarita, Coche e Cubagua. Até agora esta Bacia é considerada marginal porque nenhum poço perfurado tem apresentado grandes volumes de

hidrocarboneto, mas também o play perfurado é diferente ao proposto neste estudo.

O principal objetivo consiste em compreender o tipo de estrutura geológica presente na Sub-Bacia Tuy-Cariaco, isto baseado em observação e interpretação do dado sísmico assim como calibração com geologia de superfície.

Nesta ordem de idéias, complementar o estudo sísmico tradicional com técnicas de interpretação de estruturas compressivas (análises de painéis de mergulho, geometrias Dhalstrom-Suppe, entre outros), e correlação lateral de modelos geológicos, poderiam apresentar a presença de importantes armadilhas estruturais capazes de conter hidrocarboneto.

Mesmo com poucos dados sísmicos e baixo controle estratigráfico, análises preliminar indicam a presença de estruturas prospectivas como são as dobras as quais são divididas em dois tipos de play, o primeiro relacionado a estruturas tipo duplex apresentado a Formação Barranquin como reservatório principal e o segundo é constituído pela mesmo reservatório mencionado selado pela discordância do Plioceno-Pleistoceno.

O autor baseado nas observações prévias recomenda realizar uma análise de sistema petrolífero com o objetivo de testar o timing to mesmo, e no caso de obter um bom timing é indicado que uma aquisição sísmica 2D/3D poderia apresentar uma nova fronteira exploratória nas bacias venezuelanas.

Introduction

The Tuy-Cariaco sub basin is located on the Eastern Venezuelan basin between Araya Peninsula and Margarita, Cubagua and Coche islands (Figure 1). This region was considered as a marginal basin because no wells drilled the stratigraphic column below the Upper Miocene, and until now just few seismic lines indicate the actual prospective situation for this sub_basin.

Structurally the Tuy Cariaco sub-basin was submitted to the same compressive, extensive and transtensive effects that the Eastern Venezuela basin, at the same time; on this hand, the sub_basin was exposed to the Caribbean tectonics.

For its genesis is accepted that a volcanic arc collided with the continent and formed a narrow foreland basin with posterior extensional features formed by flexure and subsidence of the continental crust.

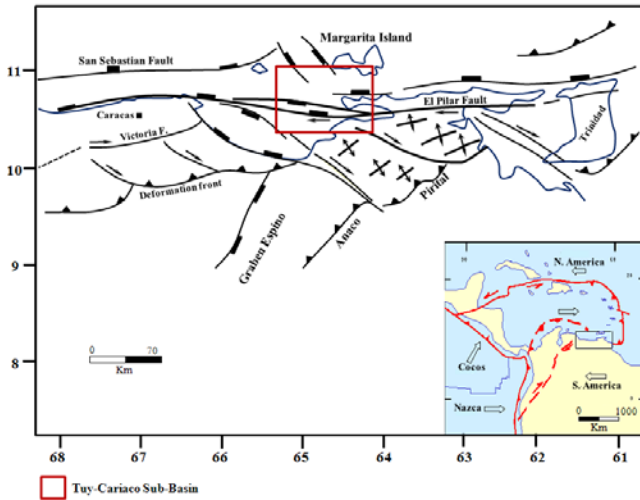


Figure 1.- Tuy Cariaco Sub_basin location.

Pindell (1988) indicates that this collision was happened 50 my ago, and it would be difficult to understand its paleoconfiguration because the Caribbean tectonics influenced its recent configuration.

The stratigraphy of the Tuy-Cariaco Sub_basin is not well described, as show on the figure 2. There are only five recognized units (Alluvium, Castillo de Araya Fm., Cumaná Fm., Cerro Verde Fm., and Guinimita Fm.), from the Lower Cretaceous until the Recent ages.

Guinimita Formation (Barremian – Albian): this formation was recognized on the Araya Peninsula area and it dips below the sea level on the West direction. It is formed by quartz conglomerates with a high iron content on its basal part; conglomerated interbedded with calcite on the middle; and on the upper section dark and compact limestone with fossils are found; this section observed on Chimana Grande Island contains a lot of white calcite veins (as show on the figure 3). The depositional environment is an open platform with the Caribbean plate to the north

Cerro Verde Formation (Upper Miocene): This formation was described at the first time by Vignaly (1965) on Araya’s outcrops. It is a metamorphic conglomerate with sandstone as a matrix, this sandstone changes, from the base to the top, to limonite and fossiliferous limestone.

Cumana Formation (Pliocene): The paleoenvironment was recognized as shallow tropical waters with reef presence (Castro and Mederos, 1985); and its sediments contain a high percentage of molluscs, coral, micrite calcite, and grey mudstone interbedded by blue-grey claystone.

Castillo de Araya Formation (Pleistocene): formed by shells with bioclastic material (molluscs and algae). This unit is the base for the recent coral reef of the Mochima

National Park, that lies on angular unconformity on the Cumana Formation.

IDADE	FORMAÇÃO	ESPESSURA	ATIVIDADE			
	Região Leste	(m)	TECTONICA			
C E N O Z Ó I C O	HOLOCENO	Aluvião	Transgressão			
	PLEISTOCENO	Castillo de Araya		450-3650		
	PLIOCENO	Cumana		50-2150		
	NEOGENO	MIOCENO	SUPERIOR	Cerro Verde	35-920	Inversão
			MEDIO	Não Reconhecido		
			INFERIOR	Não Reconhecido		
	PALEOGENO	OLIGOCENO	Não Reconhecido		Extensão	
		EOCENO	Não Reconhecido			
		PALEOCENO	Não Reconhecido		?	
	M E S O Z Ó I C O	CRETACEO	MAASTRICHTIANO	Não Reconhecido		Colisão de um arco-volcânico e a margem passiva
CAMPANIANO						
SANTONIANO						
CONIACIANO						
TURONIANO						
CENOMANIANO						
ALBIANO		Guinimita	369	Limite nor-ocidental da Margem passiva da Sul-América		
APTIANO						
BARREMIANO						

Figure 2.- Stratigraphic chart from Tuy-Cariaco Sub_Basin



Figure 3.- White Calcite Veins on Chimana Grande Outcrops.

Objectives

The main objective is to understand the kind of geological structures present on the Tuy-Cariaco Basin, based on seismic observation/interpretation and surface geology calibration.

Method

The used database is formed by two composite seismic lines on the Tuy-Cariaco sub-basin (2D and 3D seismic images) and outcrop measures obtained along the continent and over Mochima Islands.

Because there aren't wells to stratigraphic calibration a method to project laterally the stratigraphic sequence was applied, using calibrated geological models from onshore regions (Castillo, 2008).

The main problem on the offshore Tuy-Cariaco region is that the seismic is not regional; there is a small 3D acquisition on the north and 2D seismic lines on the proximal areas.

The seismic lines were interpreted based on its geological features (unconformities, dip panels, main faults, etc), and the regions where the seismic image doesn't exist, the converted time into depth seismic and/or geological model was complemented using Dahlstrom-Suppe techniques for compressive models.

Results

Two seismic profiles were interpreted, but the available data is very limited on both profiles, there are at least 6 km of gap between the seismic data recorded on the proximal areas and the offshore region.

Over each seismic line the main unconformities were interpreted, and a lateral correlation of San Antonio and Barranquin formation were obtained. In this sense, the Lower Cretaceous is present on the Tuy-Cariaco Basin.

When interpreted the line 301 (Figure 4), the presence of a duplex structure is justified by the identification of flat horizons below 3000 ms and dip layers above this depth at the northeast of the first seismic line from the south to the north. This kind of duplex reproduces the same structural style observed on the onshore regions, with repetition of the Lower and Upper Cretaceous sequence.

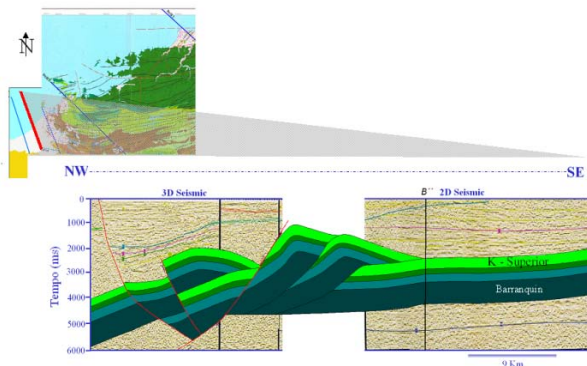


Figure 4.- Interpreted seismic line (301)

When the model is converted from time into depth, the cutoff ramp indicates the presence of at least four folds.

On this hand, on the gap's region is possible to interpret two folds and on the last portion of the seismic profile more two folds were observed. It is important to mention that these last two folds were deformed by recent extensional faults.

The observed fault, on the north of the seismic section with dip to the south, was identified by Giraldo (1996) as Coastal fault. The second extensional fault observed to the south doesn't show lateral expression and it was formed by reactivation of the compressive system.

This kind of structure is associated with a positive inversion, as defined by Powell & Cooper (1993), on this model the extensive faults cut deepest levels, most of the times, these levels are the same that the decollement level or it uses pre-existent faults.

On the section 302 (Figure 5) was interpreted a duplex structure with repetition of the Cretaceous Sequence, the cutoff ramp is 18 degrees and the decollement level is 10 km depth.

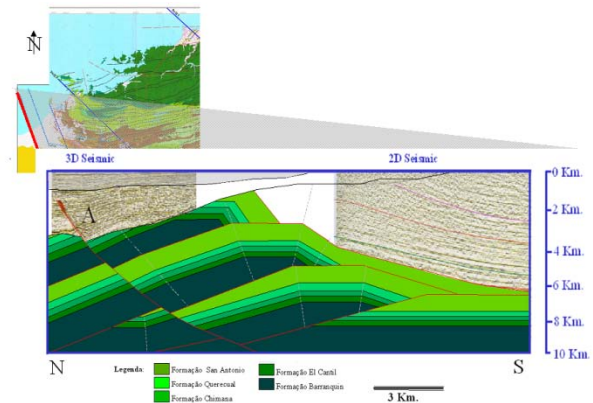


Figure 5.- Interpreted seismic line (302)

On this seismic section (302) the upper fold represents an exploratory play formed by a structural fold sealed by an unconformity like the Manrresa oil field on the Eastern Venezuelan Basin. On this case, the reservoir is recognized as Barranquin and it is sealed by the Pliocene-Pleistocene unconformity.

Conclusions

Based on this analysis is possible to identify prospective structures on the un-explored Tuy-Cariaco Sub-basin. The presence these prospective structures like folds will be considered as two kinds of play, the first one related to duplex structures that involves Barranquin Formation as the main reservoir and the second one is the mentioned reservoir sealed by a big Pliocene-Pleistocene erosion.

The author based on the previous observation recommend to perform a petroleum system study in order to verify the timing of it, and in case of get a good timing,

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