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Petrophysical trend analysis, a useful tool to understand reservoir geometry and quality in Santa Barbara Field, Norte de Monagas, Venezuela

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Abstract

New techniques making use of petrophysical data were introduced in a full blown integrated study in order to decipher the sedimentological and structural complexity of the Santa Barbara Field. Understanding and validating the sedimentology proved difficult because of local folding invoking high angle dips and because of the existence of numerous thrusts and detachment faults. Isochore maps are thus highly disturbed by the structural complexity of the area. Three newly defined methodologies, based on a statistical analysis of petrophysical averages have shed a new light on the Santa Barbara Field. These are based on a semi-quantitative quick-look dip evaluation using net-to-gross derived decompacted isochores and on 3-D visualization of porosity and water saturation depth trends.

Net-to-Gross maps are very useful to understand and review sedimentary environments, morever, N/G values can also be used as a decompaction factor in order to control the quality of a stratigraphic correlation. A quick-look dip evaluation method has been devised using the ratio between the decompacted thickness of a unit and the equivalent decompacted thickness in a reference well. In the Santa Barbara Field, the quick-look dip evaluation has corroborated the existence of large folds and of local detachment planes that have altered the apparent thickness of the unit and dramatically reduced the reservoir quality. Cores have confirmed the proposed hypotheses.

The traditional but very powerful Porosity Depth Trend Analysis gave new insight into the structural complexity of the area and confirmed that local reservoir quality deterioration is not linked to lateral facies changes but is due to tectonically derived processes.

In the complex Santa Barbara Field, one of the petrophysical problems encountered is the evaluation of water saturation, due to uncertainties in the estimation of true formation resistivity. Exploratory statistics (3D) complemented by a depth trend analysis has clearly shown that the exaggerated saturation values are due to higher dip in thinner bed intervals. The maps of water saturation anomalies are in total agreement with the structure of the field and can be used to predict zone with highly dipping beds and to correct saturation maps.

Introduction

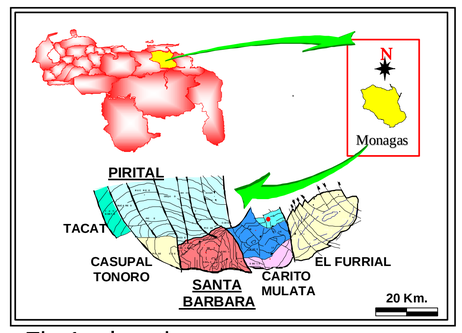

Fig.1 location map

In order to understand the sedimentological and structural complexity of the Santa Barbara Field (Norte Monagas, Venezuela - Fig. 1) a few new techniques were introduced in a full blown integrated study. This field is a large compressional structure producing from Oligocene and Cretaceous sands, with more than 150 wells to date. The hydrocarbon column is complex and of the order of 2500 to 3000 feet and produces about 240,000 BOPD (Embid et al., 2001). The following paragraphs summarize the use of petrophysical trend analysis as a tool to better define the stratigraphy, the sedimentology and the structure.

Understanding and validating the sedimentology has proved difficult because of local folding invoking high angle dips. Isochore maps are thus highly disturbed by the structural complexity of the area. Three newly defined methodologies based on a geostatistical analysis of petrophysical averages have shed a new light on the Santa Barbara Field. These are based on a visualization of porosity and of a qualitative Quick-Look Dip Evaluation using net-to-gross derived decompacted isochores.

An example for each of the three methods is shown below (Figs. 2 to 4) , the description and results are found in the following parts of the poster.

Quick-look petrophysical dip evaluation:

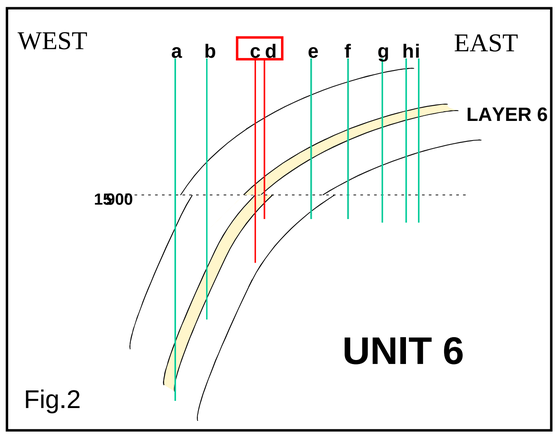

Fig.2

Porosity depth trend analysis:

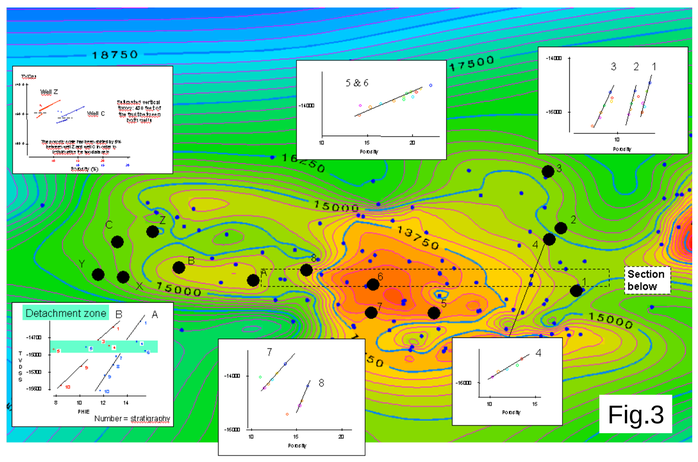

Fig.3

Water saturation depth trend analysis:

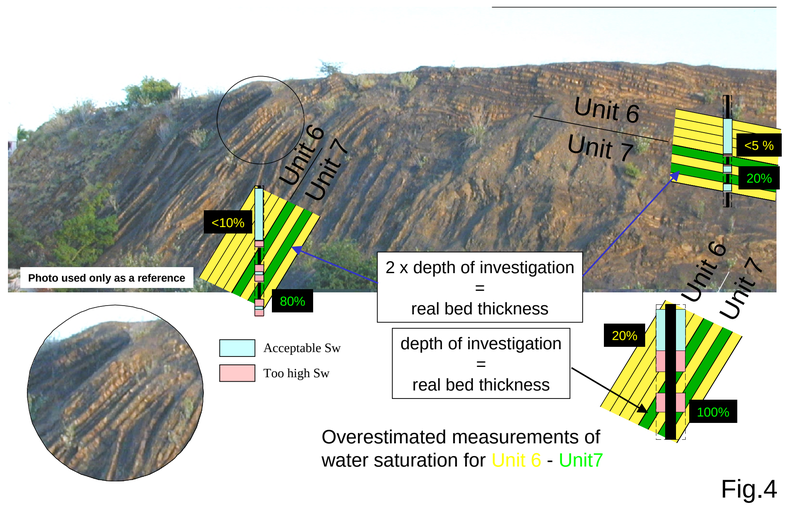

Fig.4

A simple analogue to summarize the apparent change in water saturation as a function of dip and of bed thickness

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