UR18

Rock Physics and Seismic Inversion Modeling Guided by its Detailed Geological Model

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Summary

From the structural-stratigraphic patterns in the study area, it's possible to identify main deposits distribution and behavior of the carbonates, unite to seismic inversion and rock physics for unconventional reservoirs enabled to establish sweet spots areas.
Identify the best prospective in the sweet spot areas, using seismic, petrophysical and rock physics information for the unconventional plays of the Upper Jurassic.
The deepest structural events play an important role in the carbonate basins formation, especially for the producer's plays in the geological objective. Among them, highlight Upper Jurassic Tithoniano and Oxfordiano plays as the best unconventional to explore in this kind of reservoirs.
The present project corresponds to the Upper Jurassic Characterization in the Tampico Misantla Basin
Establish prospective areas using the sweet spot methodology
Obtain iso-properties cubes, as elastic impedances (P & S), density, effective porosity, TOC and brittleness among them

Introduction

This study is focused on the three-dimensional propagation of rock properties in the subsurface through the seismic inversion and rock physics in order to evaluate an area of exploratory interest for unconventional hydrocarbon resources within a Mexican basin. The work flow designed and applied in this project includes the seismic calibration with well data as well as with the guidance of the detailed stratigraphic and structural model stablished for obtaining better results in the definition of sweet spot areas.

Objective

The main goal of this project is to support the identification, delimitation and hierarchization of prospective sweet spots in an area of unconventional hydrocarbon shale plays of Upper Jurassic age.

Theory/Method

Methodologically speaking, this project was undertaken under an integrative approach that included biostratigraphic analysis, stratigraphic and structural seismic interpretation, petrophysic evaluation, geochemical analysis, rock physics and seismic inversion. Firstly, high-resolution biostratigraphic analysis provided the chronostratigraphic framework and the basis for the subdivision into units of these Jurassic formations under study.
Secondly, the stratigraphic and structural seismic interpretation allowed the identification and delimitation of ancient depocenters and potential structural highs. Then, petrophysics and rock physics were undertaken with the support of the mineralogical and geochemical data. Complementarily, for the seismic inversion it was used the offsets in order to generate the volumes of P-wave impedance, S-wave impedance and density. From these volumes it was obtained the Vp/Vs ratio as well as the volumes of elastic parameters such as Lamda and mhu-ro. Finally, it was obtained the three-dimensional distribution of each parameter of interest for evaluating these unconventional shale plays such as total organic carbon (TOC), water saturation (SW), effective porosity (ø) acoustic and elastic impedances, density and brittleness for the reservoir fracking.

Conclusions

1.- In general, there was a good fit between the sweet spot areas obtained from this seismic inversion and those sweet spots resultant from the application of other kind of methods previously used in this area.
2.- It was tested that the elastic properties of these rocks can be used for identifying, delimiting and ranking prospective areas for unconventional shale hydrocarbon resources.
3.- Based on the results of this seismic inversion the most prospective stratigraphic horizons and areas within these formations were identified and delimited.

Acknowledgements

We want to express our gratitude to Pemex for this opportunity to present part of the results of this project in this important seminar.

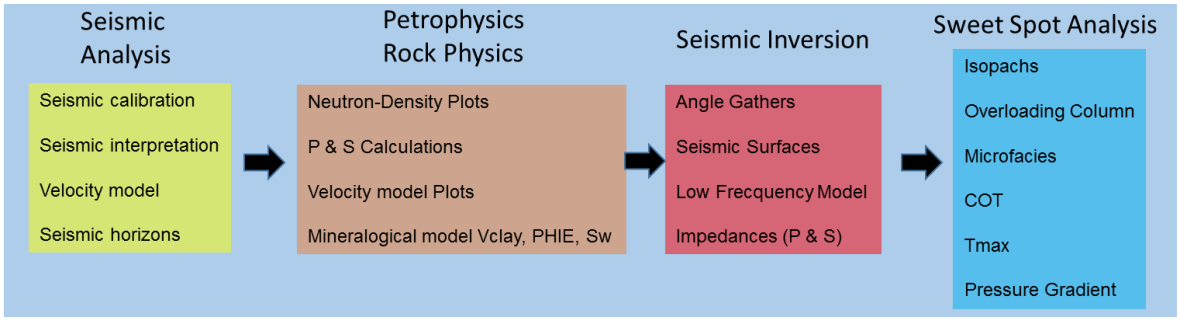

Figure 1 *Workflow applied in this project that includes seismic analysis, rock physics and seismic inversion for defining the sweet spot in the subsurface of the study area.*