AVO analysis for lithology prediction

Yoryenys Del Moro and Kurt Marfurt
The University of Oklahoma

Abstract

Elastic rock properties are associated to the variation of local geology and they can change drastically within the same geologic basin. Depositional events that take place on a basin could affect the elastic properties of the rocks and knowing their response on seismic data, could enhance the reservoir characterization and then the ability to predict the location of hydrocarbons accumulations.

To approach this issue, Amplitude versus Offset (AVO) has proven to be an effective hydrocarbon indicator technique for Miocene and Pliocene gas exploration, especially in the Gulf of Mexico. Careful processing and calibration of pre-stack seismic data with petrophysical properties along with detailed petrophysical modeling has made AVO an important tool for lowering drilling risks and increasing the drilling rate success. In spite of this value, little or no research has been published on the implementation of this technique for the well-consolidated Paleozoic rocks of the Anadarko Basin. In this sense the goal of this project is to give the lecturer the basic understanding of the AVO analysis and also some study cases in which it has been applied to lead them to the future work that is going to be done for well-consolidated rocks.

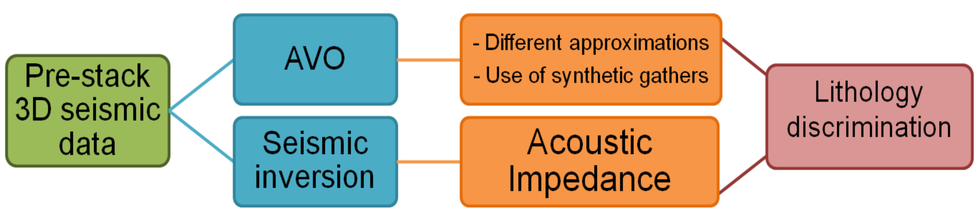
Geological Background

The Red Fork Formation is Mid Pennsylvanian in age and is considered to be an incised valley fill sequence composed with limestone, shale and sandstones.

Recognition of sandstone channels within the Red Fork could be challenging in sandy shaly intervals due to variation of deposition duration and overlapping deposition.

An incised valley system is characterized by a major fluvial erosion that cuts deep enough the bank causing erosional features.

Workflow



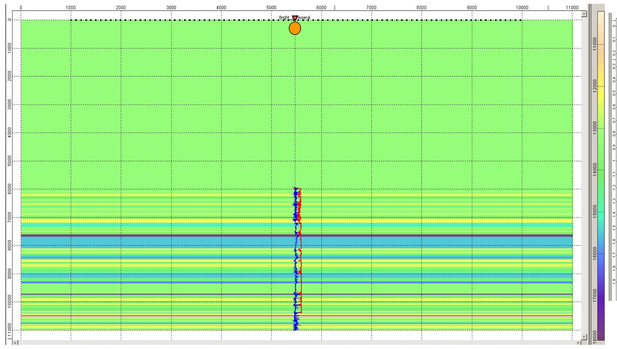
Conclusions

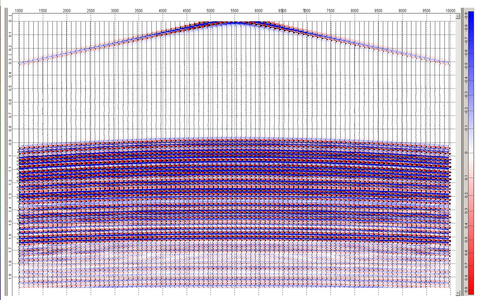
- AVO analysis is going to be used more less as a lithology discriminator tool than a fluid prediction tool.

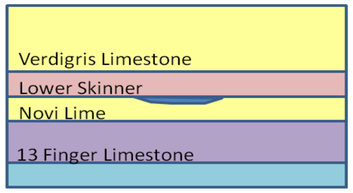
- Seismic modeling is a powerful procedure that can improve the understanding of the real seismic and the possible seismic artifacts that might mislead the geologic and geophysical interpretation of the data.

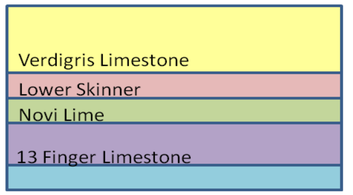
Seismic Modeling

Several models are going to be created in order to obtain gathers that could be a representation of the real seismic data. Therefore by knowing the input parameters such as V_p and ρ, we could predict by doing AVO where sandstones could differentiated from shales.





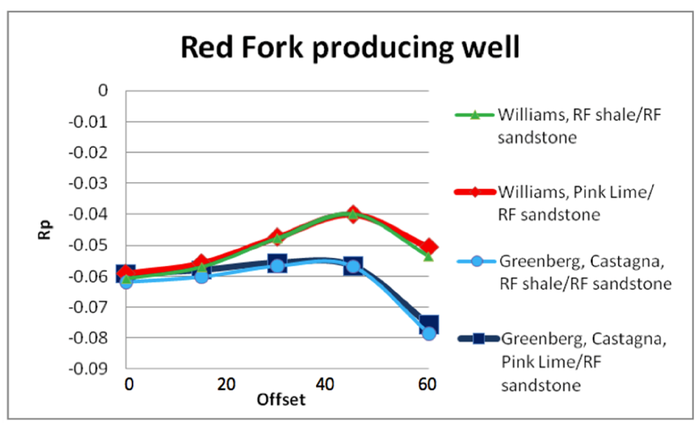




Different models are going to be helpful to prove the hypothesis that AVO for lithified and well compacted Pennsylvanian rocks can be beneficial to discriminate lithologies.

Study cases

(a)



(a)Foster et al. (2010) discriminated depending on the class of AVO anomaly sands with good porosity (Well A) normally AVO class III represented by red and yellow colors from lower values of porosity (Well B) with AVO class II represented with blue color.

(b)Barber (2010) compared AVO responses from a non– and a producing well within the Red Fork Formation, obtaining a class I AVO anomaly with the strongest reflection coefficient at near offsets (≤ 15°). Producing well displays a class III AVO with highest reflection coefficient at far offsets (30°- 45°).

Acknowledgements

To Chesapeake Energy for providing the data for this project. We also would like to recognize the software donation and support obtained from Tesseral inc and Hampson and Rusell as well as the sponsors of the Attribute Assisted Seismic Processing and Interpretation (AASPI) Consortium and The University of Oklahoma.