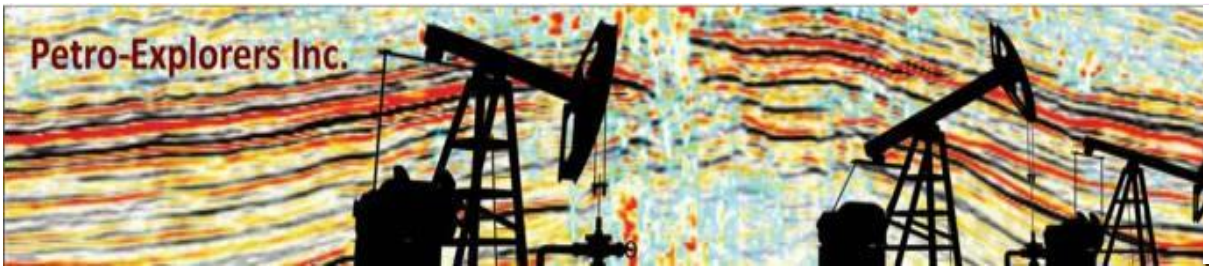


PETROEXPLORERS

Rock Physics Analysis and AVO Modeling

Rock Physics and Elastic AVO modeling is the key to unravel almost every play in the exploration playbook. It is integral part of all reservoir characterization work

Considerable time is put toward well data QC and conditioning in order to ensure that there is "Quality In, Quality Out". This preliminary stage of the workflow is considered to be so crucial to the success of the project, Petro-Explorers Inc. will perform a full review of all data prior to commencing analysis.

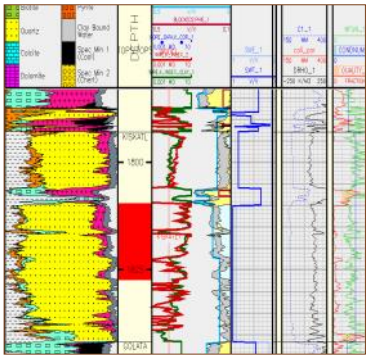
Well Data Loading and QC

Well Logs will be read from LAS files which will be reviewed, QC'd and edited as appropriate. The tops, strip logs and other related data will be reviewed and loaded. For unconventional shale plays, mineral composition log can help define the elastic and anisotropic properties of the shale units. Directional core analysis and/or FMI logs are used to evaluate the fracture density etc.

LAS log data to be compared with the raster data to make sure the validity of the digital information.

Petrophysical Analysis

Primary goal of the petrophysical log analysis is to depth match the logs, apply check shot corrections, and predict the best representative lithology to prepare the logs for rock physics input. For carbonates this would also mean separating bound porosity and predicting permeability.

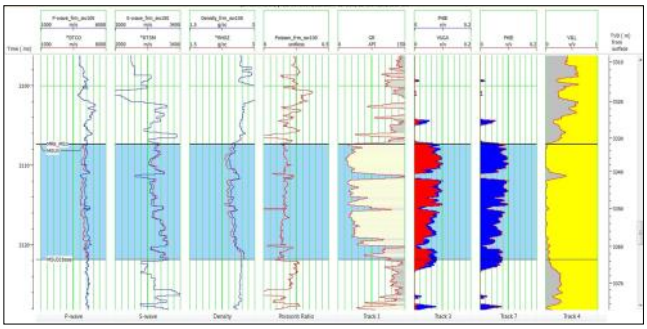


Multi-min petrophysical analysis of the log data using Quartz, Calcite, Dolomite and Biotite with 4 other minerals.

The log analysis will be focused to geophysical well log analysis while honouring and applying the petrophysical rules. In the presence of existing volumetric logs, this step can be optional

Generation of Shear Sonic, Saturation and Porosity Logs

If it is deemed necessary to generate additional Vs, Sw and porosity logs, these will be done using industry-standard empirical equations providing that the existing log data is suitable. Minor editing and log splicing may be required at this point to reduce existing log problems.

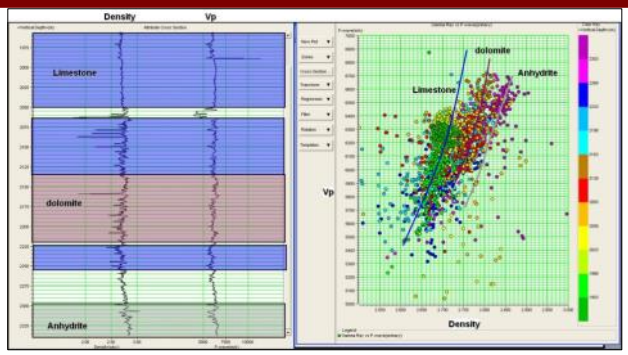


Investigate Log Based Rock Physics Relationships

Using cross plot tools, determine relationship between Zp, Zs, PR, Vp, Vs and rock properties such as N:G, Porosity, saturation, shale content, brittleness.

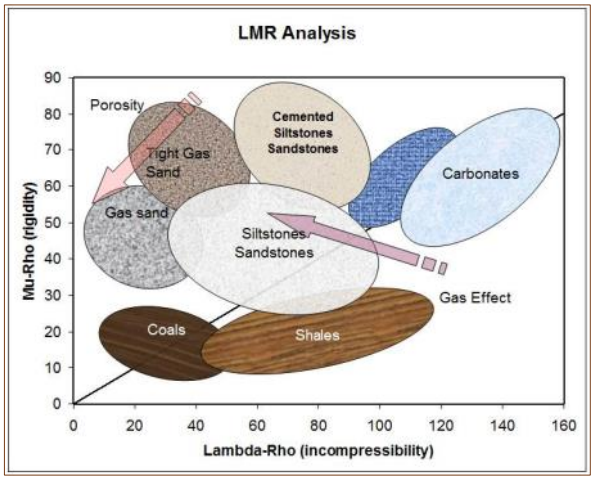
- Log Cross-Plotting: Depth v Attribute, Attribute v Attribute.
- Upscale logs to seismic scale (bandwidth) – Backus Averaging.
- Repeat Cross-Plotting: Depth v Attribute, Attribute v Attribute.
- Generate stack and offset synthetics and observe affects on well to seismic ties (time-depth relationship, wavelet extractions).
- Generate transformed attributes: Ip, Is, Ir, mr, EI, fluid factor, pseudo Poisson's ratio.
- Determine all required empirical relationships between measured petrophysical (rock) properties (e.g. Vshale, porosity, Sw, etc) and acoustic and elastic log properties (attributes) for each prospect interval. The results are then calibrated against core analysis.
- Carry out fluid replacement modelling (FRM) using various end member scenario.
- Repeat previous four steps with FRM - before and after Backus upscaling
- Produce final set of logs for tuning analysis and generate geomechanical log sets

ROCK PHYSICS ANALYSES AND AVO MODELING



Differentiation between limestone, dolomite and anhydrite to allow separate parameter selection for Gassman fluid substitution

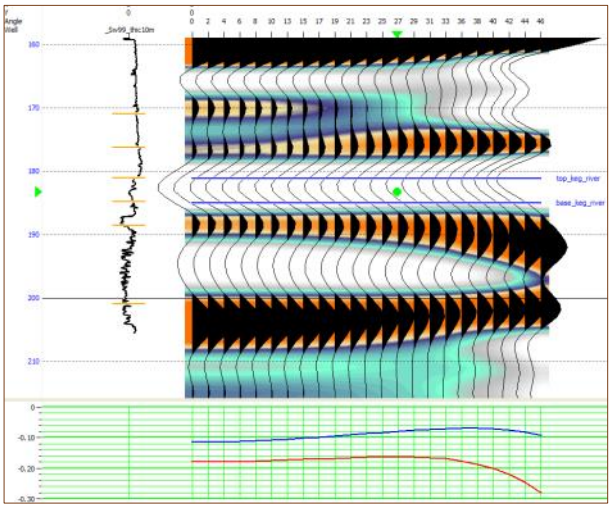
Young's modulus and Poisson's Ratio cross-plots provide a direct relationship to the brittleness of the shales. These shale properties and zones are then used for the understanding of the seismic response. It has been shown in the recent studies that lower Poisson's ratio calibrates to the zones of high brittleness, hence is good for fracture simulation.



LMR characterization of lithology to create Probability Density Functions (PDFs) in LMR space

AVO Synthetic Modeling

Pre-stack synthetic generation and scenario modelling to understand the nature of the play and its AVO attributes is very important part of the whole work. End member of the porosity and thicknesses are used to create 3D pre-stack synthetic seismogram. Various frequency options will be used to understand the nature of the play.

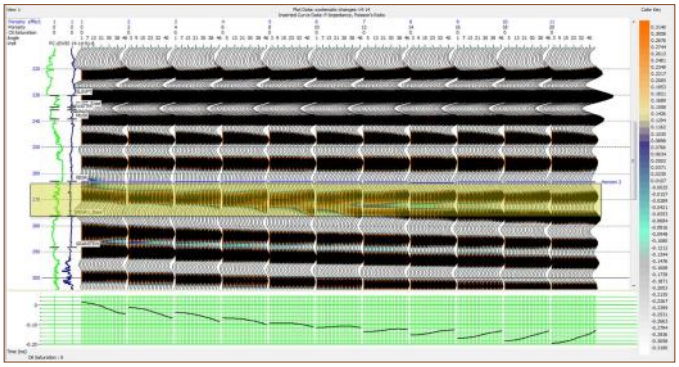


A typical AVO synthetic model to understand the amplitude variation using well data and seismic frequencies

Lithological information from the existing wells is very important at this point such as strip logs, core and geomechanical analysis etc. Various models will be used to control better lithological substitution parameters. Lithology substitution allows the change of shale type by changing the Poisson's ration and various elastic moduli.

Creating Porosity, Lithology and Fluid Scenario

3D synthetic gathers are generated by changing two properties at the same time. In these scenario we change Porosity on X direction and Water Saturation on Y direction while keeping the thickness of unit as the same. Following are gathers from in-line extracted from the modelled 3D showing the effect of porosity variation while the fluid is kept as wet. By using such scenario modelling the actual seismic gather response can be compared and calibrated. It is also important to understand the effect of porosity alone in wet or hydrocarbon zone. For the shale gas plays the clay mineral substitution uses the elastic moduli of different lithology types to create base rocks. The method can also be called as lithology substitution to create synthetic scenario.



Gathers of inline from modelled 3D with a change from Class II to Class IV AVO with only change in the porosity

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