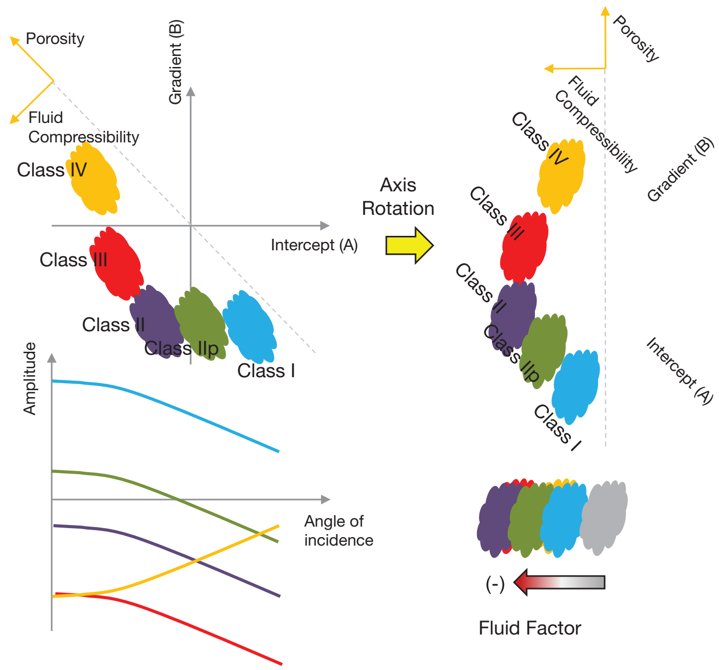
Reservoir Characterization Through AVO Inversion

FUNDAMENTALS OF FLUID FACTOR

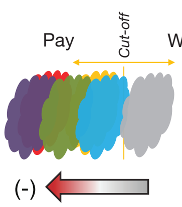
From a simple perspective, AVO response depends on the character of the matrix, or structure of the porous space, and the fluid contained in the pore space of the rock

Understanding the link between amplitude vs angle/offset and the rock makes it possible to isolate the responses of prospective pay sands.

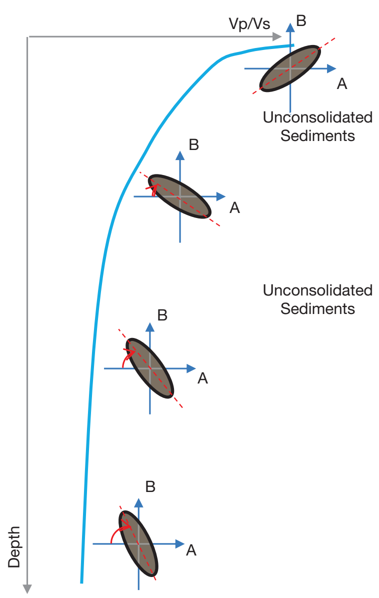
Under a variety of reasonable assumptions, shales and brine- saturated sandstones follow a background trend, or Fluid Line, in the Intercept/Gradient (AB) plane. The deviation of coordinates from this Fluid Line is the Fluid Factor. After rotating the Fluid Line axis to align it with the y-axis, the largest negative values on the x-axis will represent those AVO/ AVA responses related to the top of reservoir rocks with higher compressibility (mid to high porous rock with the more compressible gas or oil).



The Fluid Factor cut-off between wet and pay sands can be determined by comparing cross-plot outlier points to known producing and wet wells. This can be further quantified by testing various fluid and/or rock models using the fluid substitution method.



Compaction Trend: Reduction of Porosity



This is a global trend assuming normal compaction

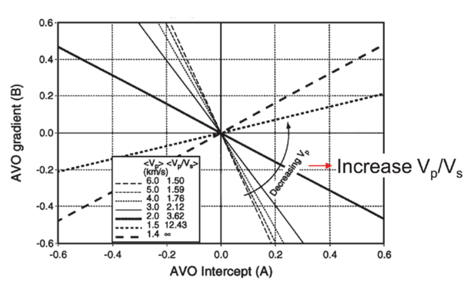
Possible pitfalls and issues:

Noise: Low signal to noise ratio in the seismic data may cause false AVO anomalies, such as high background AVO intercept/gradient values.

Non-uniqueness: the AVO response is a non-unique reflectivity attribute. A high porosity wet sand may have the same AVO intercept/gradient as a shale-like pay sand, or an identical reservoir may exhibit completely different AVO/AVA responses, depending upon variations in the rocks which encase the reservoir.

Amplitude Calibration: Comparison of AVO/AVA responses to rock property models is done through synthetic seismograms. If the dynamic range and background AVO/AVA response of the synthetic seismogram is not calibrated properly, the cut-off will be meaningless.

Dynamic Fluid Line Trend: The Fluid Line trend is directly related to Vp/Vs. Therefore, changes in depth due to compaction, or preservation of porosity due to overpressure, will alter the Fluid Line axis both spatially and in depth. These factors should be accounted for during the calculation and calibration of attributes.



Castagna and Swan (1997)

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TRICON'S DYNAMIC FLUID FACTOR

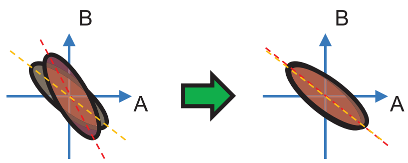
Step 1
Well Calibration

State of Art
seismic processing and imaging

Seismic Well – Tie

Actual vs. Synthetic AVO
response comparison

AVO trend calibration
(if needed)



Wet fluid substitution: the synthetic must match the background, or fluid line trend of the seismic data

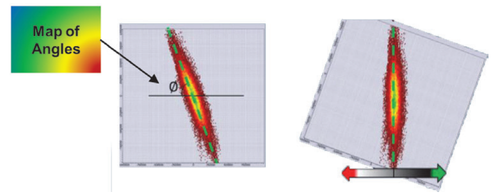
Step 2
Later/Vertical Variation

Calibrated AVO attributes
at well location(s)

Vp/Vs trend from AVO
crossplot trends

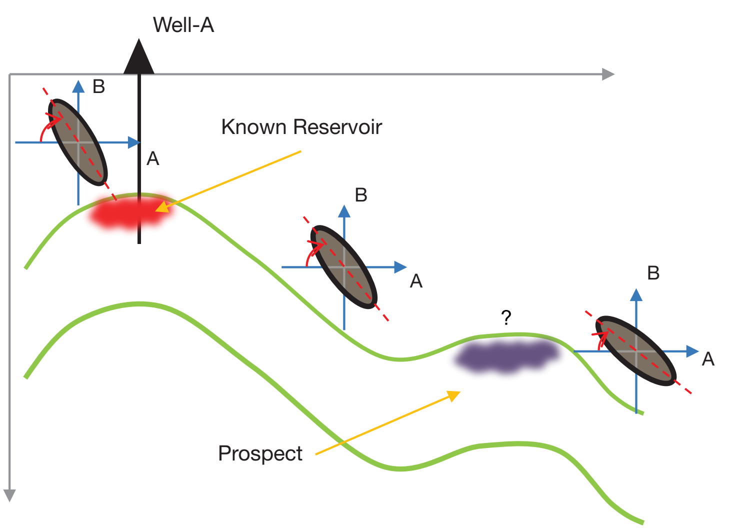
Mapping of background trends*
(map of angle of rotation)

Dynamic Fluid Factor



After Smith and Gidlow (2003)

* We highly recommend using an external, or secondary variable, like time maps of the seismic velocity volume, when mapping the control points of the angle of the Fluid Line axis.



Although Dynamic Fluid Factor will be valid for different depths positions, the selection of cutoff during the interpretation may change.

The compaction trend must be considered during the interpretation of the AVO/AVA inversion results if the calibration point (well) is located at a different vertical and spatial position than the prospect.