

**PS Incorporation of Geology, Wells, Rock Physics into Anisotropy Estimation for Seismic Depth Imaging
Enables “True Earth Model”***

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Abstract

Subsequent to our previous paper on how to indicate anisotropy from well-seismic mistie analyses (Bui et al, 2010), we continue to present our currently practical workflow of how to incorporate geology, well, and rock physics in anisotropy estimation for seismic depth imaging. As we all know, that the seismic velocity is an important variable that can result in the lateral and vertical mis-positioning of the reservoir targets. Likely, it was always thought that if the depth migrated velocity was wrong, seismic anisotropic functions (Thomsen’s delta and epsilon) were wrong in a vertical transverse isotropic (VTI) case. In fact, the Thomsen’s delta and epsilon functions help to flatten the gathers, but the depth still may be wrong at zero offset. In fact, the most important parameter that results in wrong depth is the vertical seismic velocity used in seismic migration. In order to create the right migrated seismic velocity model, we need to understand the effect of geological constraints on anisotropy as well as on anisotropic seismic velocity in the study area.

There are a variety of methods to estimate anisotropy for seismic depth imaging. The global function of anisotropy is no longer valid, especially in the complex areas. In this paper we present our practical workflow to incorporate the rock physics from the well and geological information, such as checkshot, calibrated sonic, and geological markers to estimate anisotropy from surface seismic data at well location by using the 1D ray tracing method. This step is very important to tie the seismic events with the well markers into correct depth as well as flatten the common image point (CIP) gathers.

Subsequently, we performed local well tomography to upscale into 3D at the well location. Then anisotropic functions have been propagated along the interpreted seismic horizons using WesternGeco steering filter tool. Finally, the updated seismic velocity field

and anisotropic field have been incorporated with estimated dips and azimuths to generate geologically driven anisotropic velocity for seismic depth imaging. This approach has been applied to a study area, in the Green Canyon, in the Gulf of Mexico showing very promising results of seismic images consistent with the well information and geology.

References

- Bakulin, A., M. Woodward, D. Nichols, K. Osypov, and O. Zdraveva, 2009, Localized anisotropic tomography with well information in VTI media: 79th Annual International Meeting, SEG, Expanded Abstracts, p. 221-225.
- Bui, H., P. Haw, D. Ng, J. Durrani, D. Becker, and M. Smith, 2010, Well-Seismic Tie in the Sub-Salt Wells, Deep-water Area in the Gulf of Mexico: A Valuable Indicator of Anisotropy: AAPG International Convention and Exhibition, 12-15 Sept. 2010, Calgary, AB, Canada. AAPG Search and Discovery Article #90108. Web accessed 20 December 2011, http://www.searchanddiscovery.com/abstracts/pdf/2010/intl/abstracts/ndx_bui.pdf
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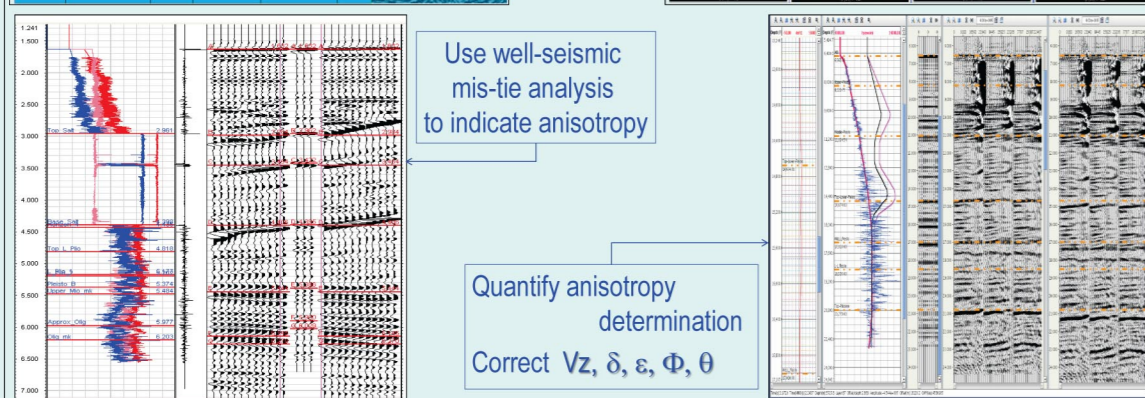
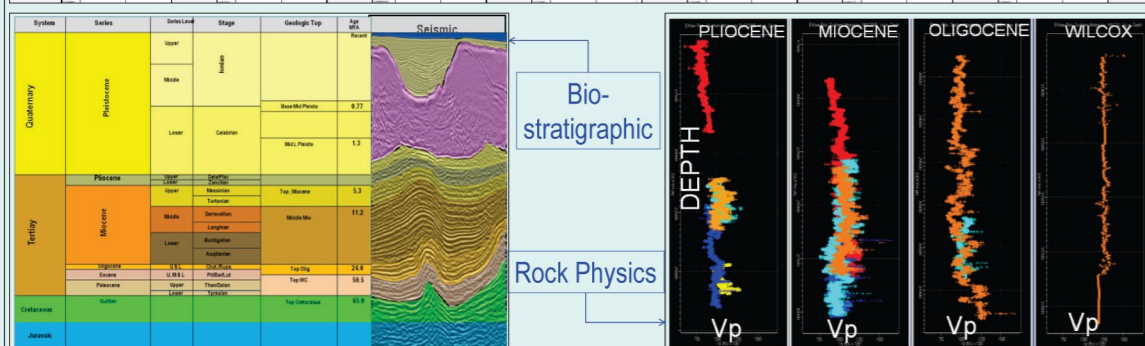
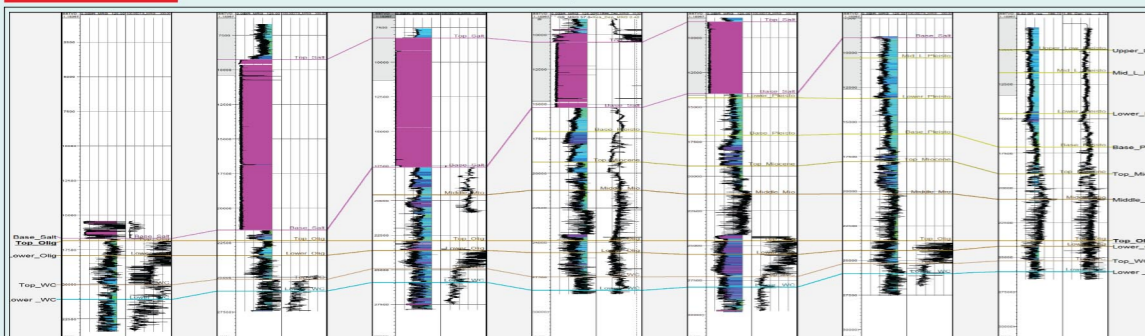
Abstract

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There are a variety of methods to estimate anisotropy for seismic depth imaging. The global function of anisotropy is no longer valid, especially in the complex areas. Our practical workflow is to incorporate the rock physics from the well and geological information, such as checkshot, calibrated sonic, and geological markers to estimate anisotropy from surface seismic data at well location by using the 1D ray tracing method. This step is very important to tie the seismic events with the well markers into correct depth as well as flatten the common image point (CIP) gathers. Subsequently, we performed local well tomography to upscale into 3D at the well location. Then anisotropic functions have been propagated along the interpreted seismic horizons using WesternGeco steering filter tool. Finally, the updated seismic velocity field and anisotropic field has been incorporated with estimated dips and azimuths to generate geologically driven anisotropic velocity for seismic depth imaging. This approach has been applied to a study area, in the Green Canyon, in the Gulf of Mexico showing very promising results of seismic images consistent with the well information and geology.

Concepts

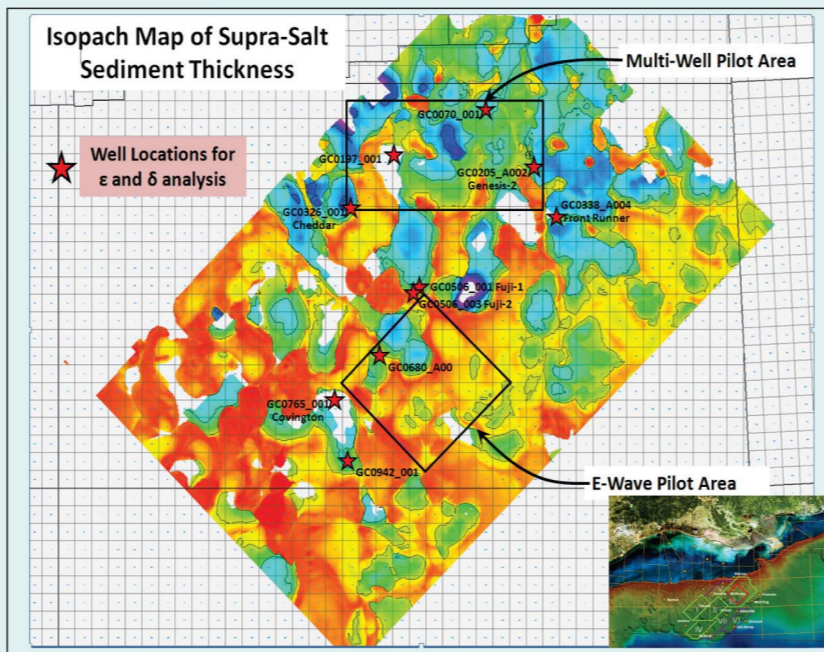
Paleos data, well correlation



Use well-seismic mis-tie analysis to indicate anisotropy

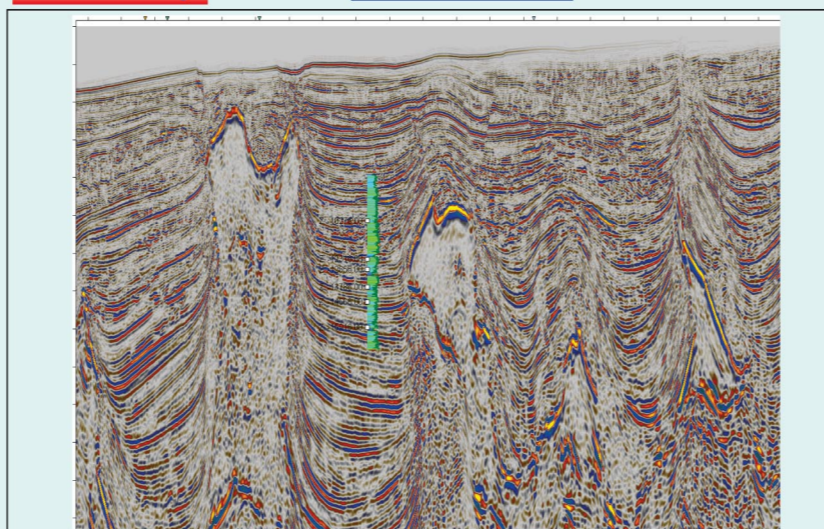
Quantify anisotropy determination
Correct V_z , δ , ϵ , Φ , θ

Study Area

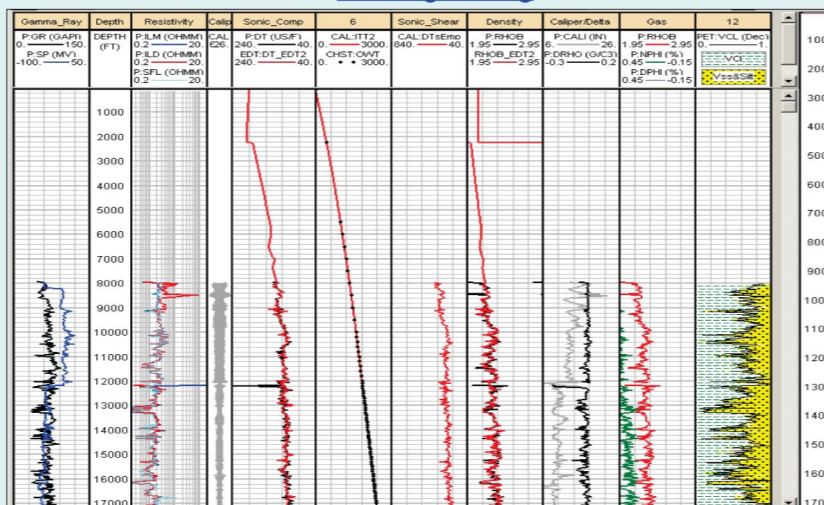


Case Study

Well 1 on seismic

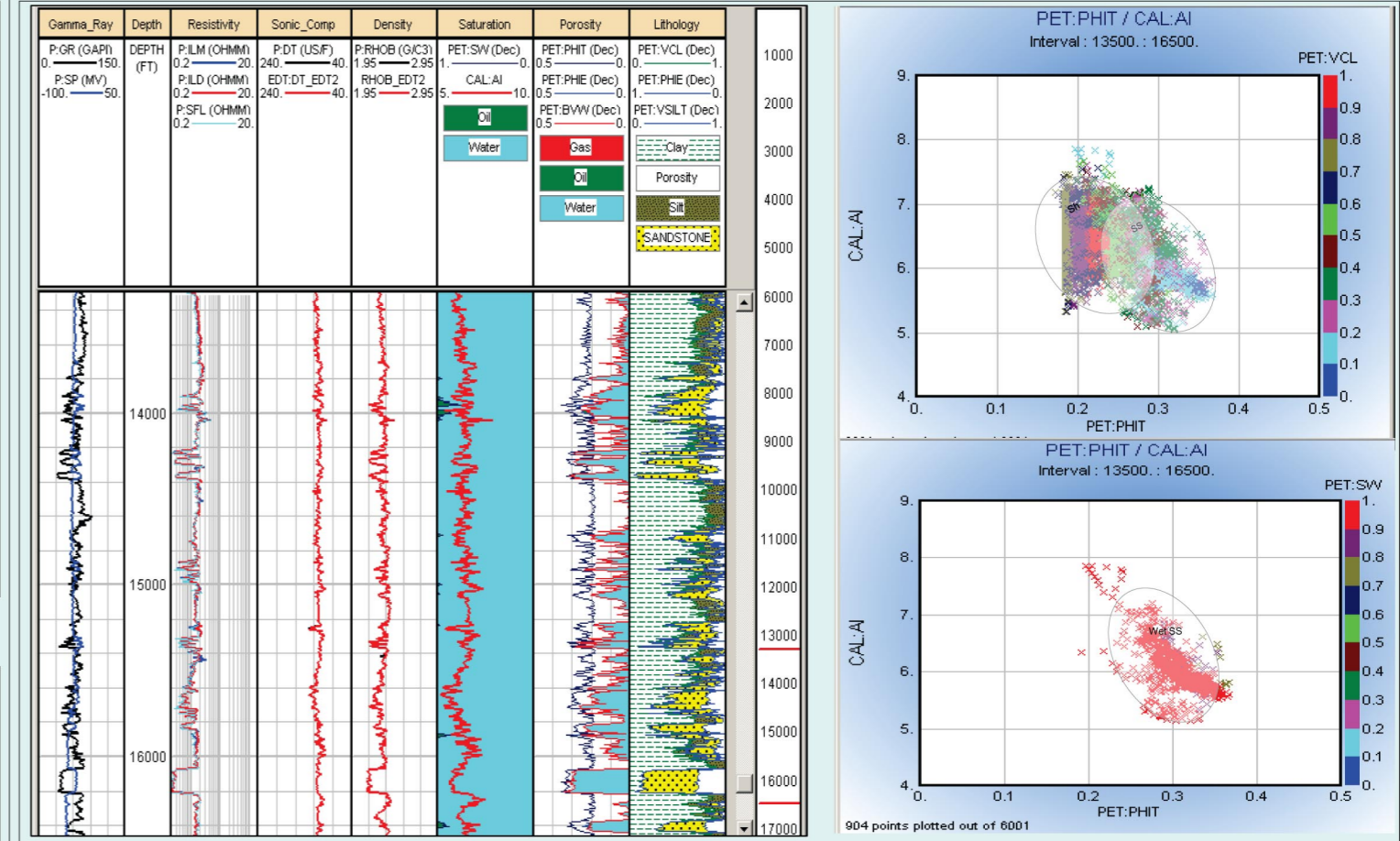


Well log editing

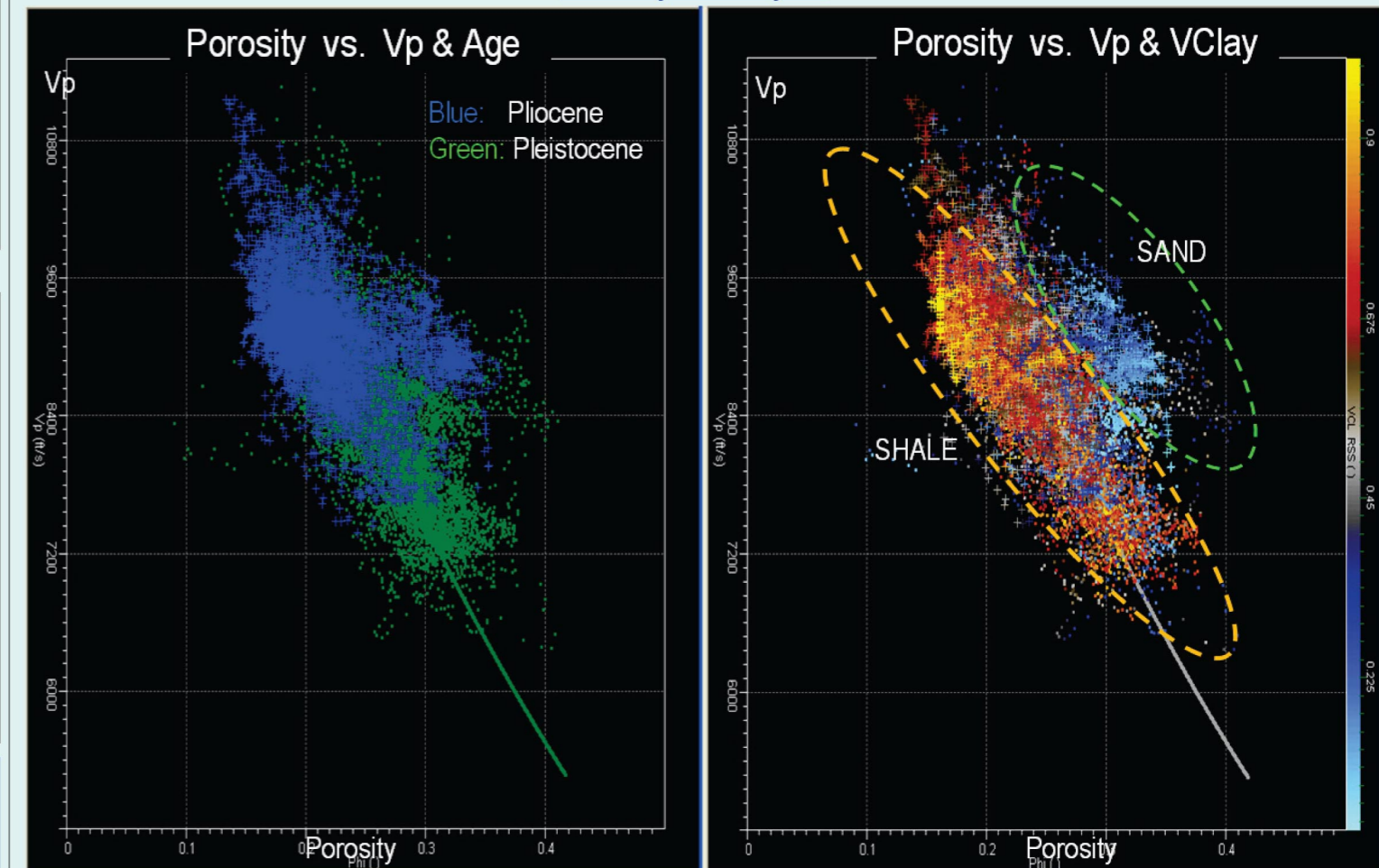


- Complete vertical velocity from MSL
- OWT trend from checkshot used to reconstruct shallow velocity
- Water layer velocity from seismic
- With edited density, VCI, GR, caliper, lithology, ...etc to support later works

Petrophysical analyses



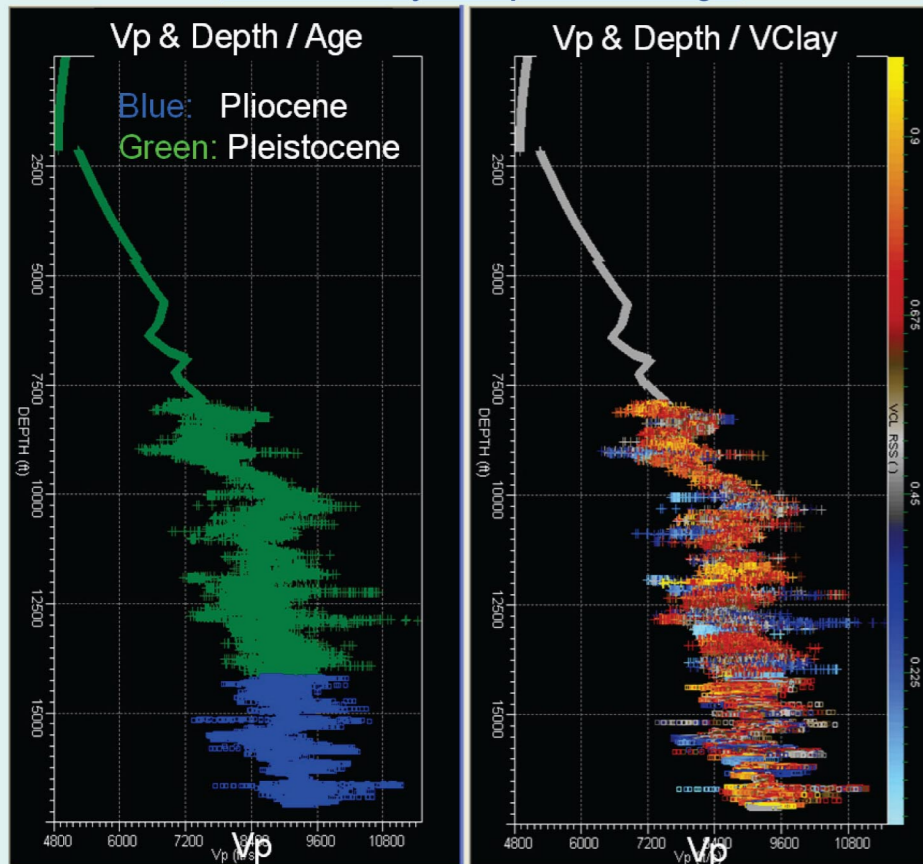
Rock Physics analyses



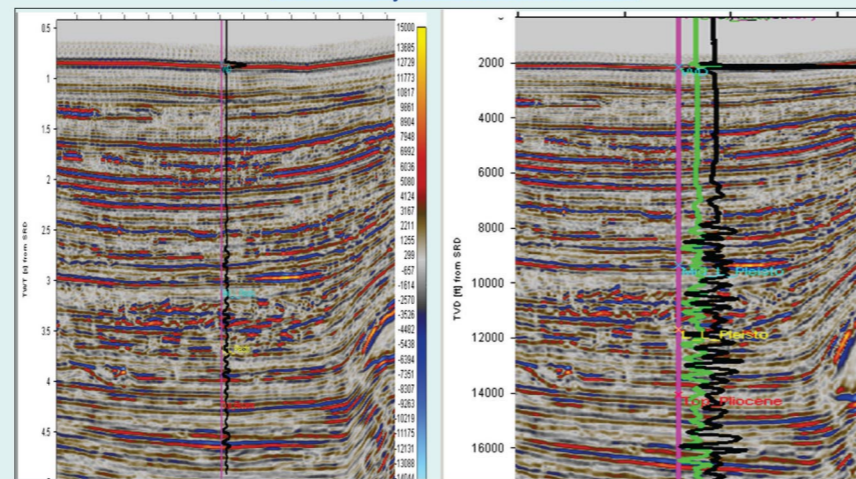
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Case Study (continued)

Well 1 – Velocity vs. depth - VCI and ages



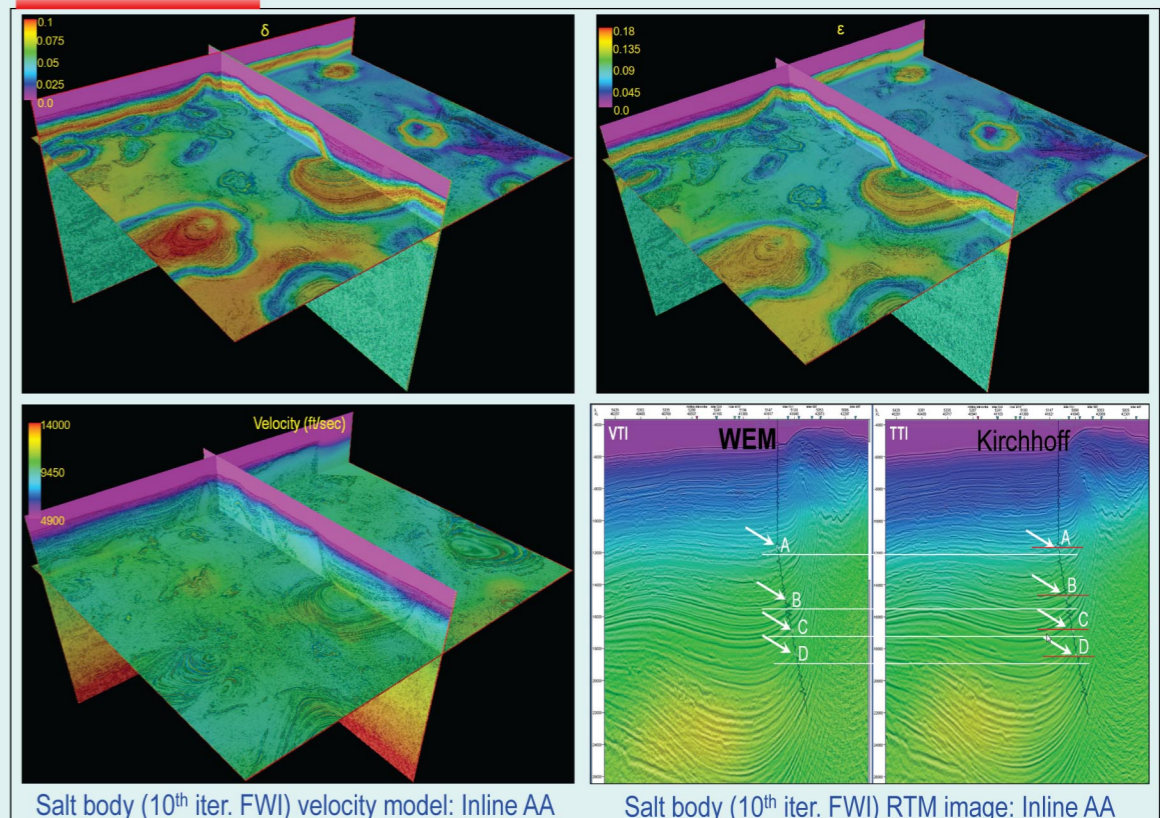
Well 1 – Synthetics on seismic



Conclusions

1. Proper incorporation of geology, rock physics and well information, help to update seismic velocity and derive appropriate δ & ϵ functions at well location (1D).
2. Seismic velocity correction using well velocity is the most critical and should be done before δ , ϵ estimation.
3. The correctness of 1D anisotropic model (at well locations) is very critical for the accuracy of entire 3D anisotropy and velocity model.
4. The geological horizons, dips, azimuths should be always used in 3D anisotropic models (TTI) building.

Some Results

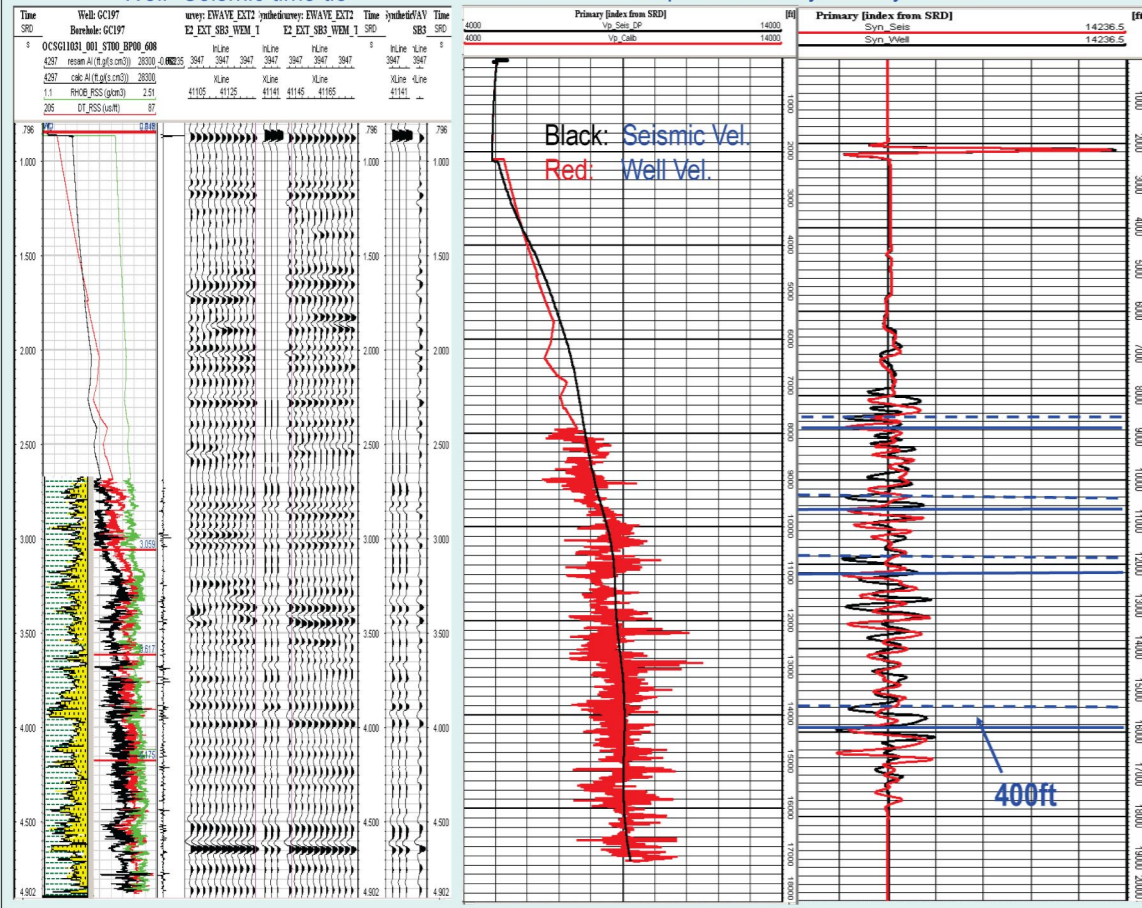


Critical depth synthetic generation for anisotropy

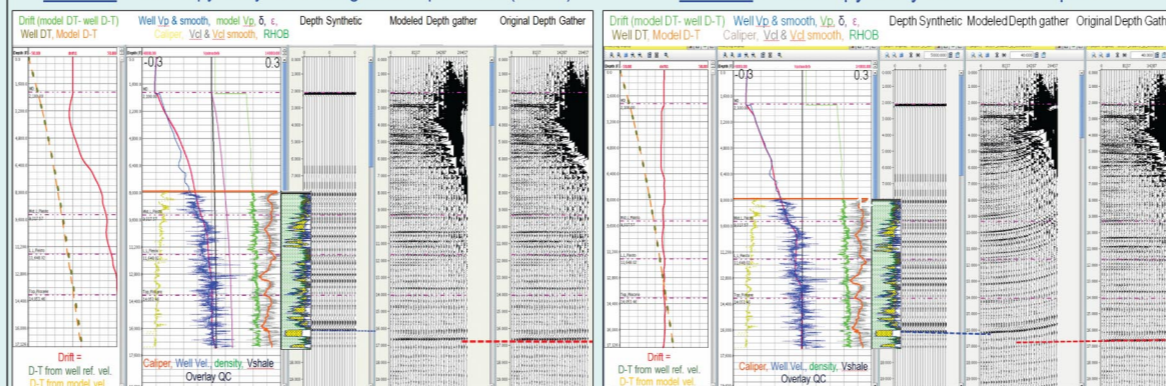
Use as reference for model building, and depth error analysis

Depth error analysis in synthetic

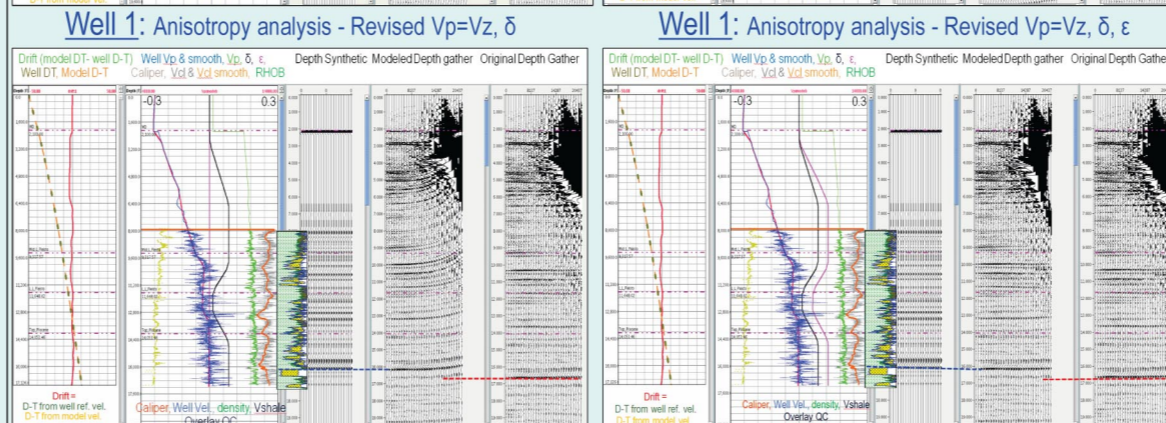
Well- Seismic time tie



Well 1: Anisotropy analysis - starting anisotropic model (WAZ's)



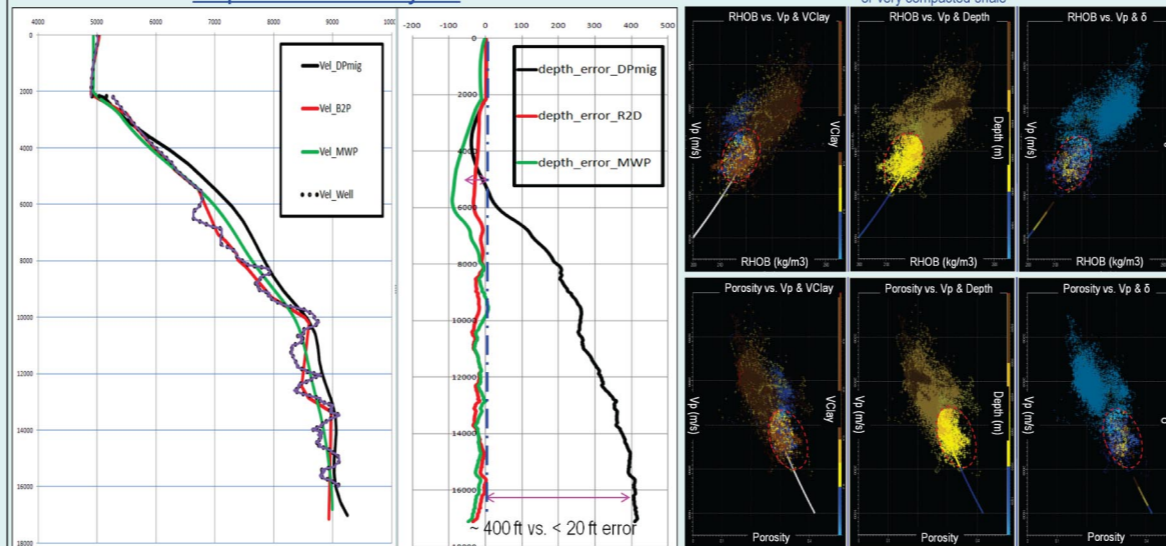
Well 1: Anisotropy analysis - Revised Vp=Vz



Well 1: Anisotropy analysis - Revised Vp=Vz, delta

Well 1: Anisotropy analysis - Revised Vp=Vz, delta, epsilon

Depth mis-tie analysis



References

- Bakulin, A., M. Woodward, D. Nichols, K. Osypov, and O. Zdraveva, 2009. Localized anisotropic tomography with well information in VTI media: 79th Annual International Meeting, SEG, Expanded Abstracts, 221-225.
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Acknowledgements

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