Chasing Not-so-Bright spots in the Lithic Glauc: Reservoir Sands or shale?

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Summary

Conventional seismic analysis techniques typically involve the extraction of amplitude information at a specified target interval to identify spatial variations in the seismic response. These varying signals can represent changes in subsurface conditions including structure, lithological variations, fluid content and many other rock properties. If well control is available to discern the difference between a positive and negative outcome, a pattern recognition exercise is usually undertaken to identify like areas corresponding to good and bad locations. For example, if a channel feature has been identified, and amplitude variations are observed within the channel, one would be inclined to think that the changing amplitudes are the result of changing lithology. If this statement holds, one would also be inclined to think that similar amplitudes are the result of a similar lithology. However, in many instances similar amplitude anomalies are the result of very different lithologies.

In this study, we investigate the phenomenon of similar amplitude anomalies resulting from different lithologies in the Lithic Glauconite. The Economic driver for the project was to improve confidence levels, and reduce risk in the identification of reservoir quality as measured by porosity and sand cleanliness. The discrimination of sand from shales within the Lithic system and from the Bantry shales which it can incise, became the objective. We accomplish this by investigating the relationship between elastic and petrophysical parameters using rock physics and ultimately, performing a rock physics inversion to directly estimate total porosity and clay content in our zone of interest. These seismic rock properties were then used to estimate reservoir quality by calculating zone specific effective porosities in the same manner done in petrophysical analysis.

Figure 1 shows a well cross-section illustrating sand and shale facies within the Lithic system, where reservoir sands are encountered at Well 1 (vshale of 21% and effective porosity of 9.6%) and an argillaceous section is encountered at Well 2 (vshale at 100%). Figure 2 shows the seismic inversion results for vshale, total porosity and effective porosity at Wells 1 and 2. The vshale estimate successfully images the position of the sand above the Bantry shale in Well 1 and its absence at Well 2. The total porosity shows the familiar challenge where it includes both hydrocarbon filled effective porosity in the reservoir as well as the bound water found in the clay minerals of the shale lithologies. In fact, Well 2 shows an apparent total porosity that is higher than Well 1. By removing the porosity contribution from the underlying Bantry shale, the calculated effective porosity successfully maps the presence of sand at Well 1 and no sand at Well 2. Importantly, proper determination of the clay correction factor in the effective porosity calculation is aided by a best-fit using petrophysical logs. This workflow demonstrates the transparency and advantage of working with seismically derived properties of effective porosity and vshale. Figure 3 shows a conventional stack of the seismic line between Well 1 and Well 2, which fails to discriminate between sands and shales. This provides another example of the importance of working with the elastic properties observable in seismic data applied to the exploitation of reservoir in Lithic systems.

Transformation of the seismic signal into total porosity and shale content leads to better integration of seismic and petrophysical data. This seismic determination of effective porosity by discriminating sand from shale leads to a higher confidence level when drilling the not-so-bright spots.

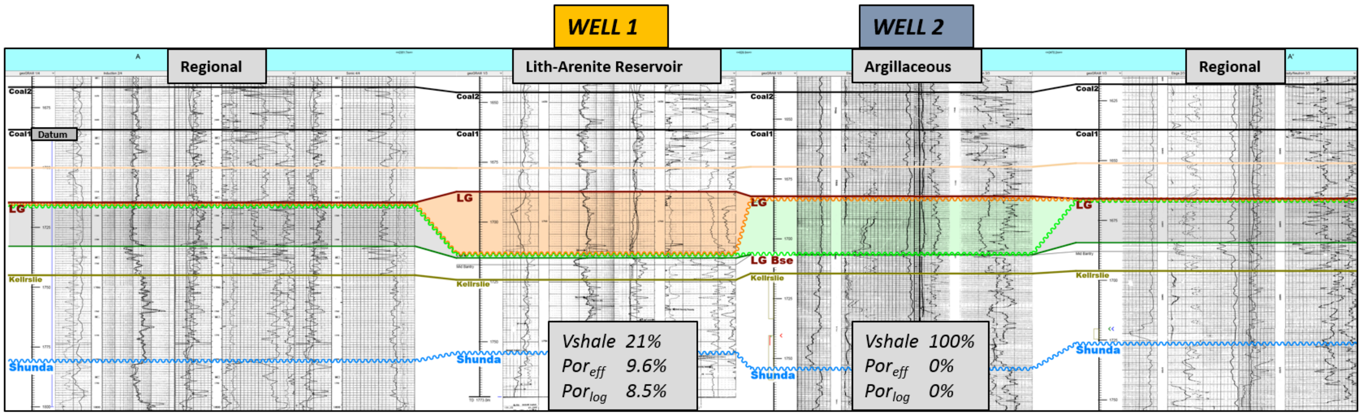

Figure 1. Well cross-section going through Well 1, which has 15m of reservoir quality sand and Well 2, which has no reservoir.

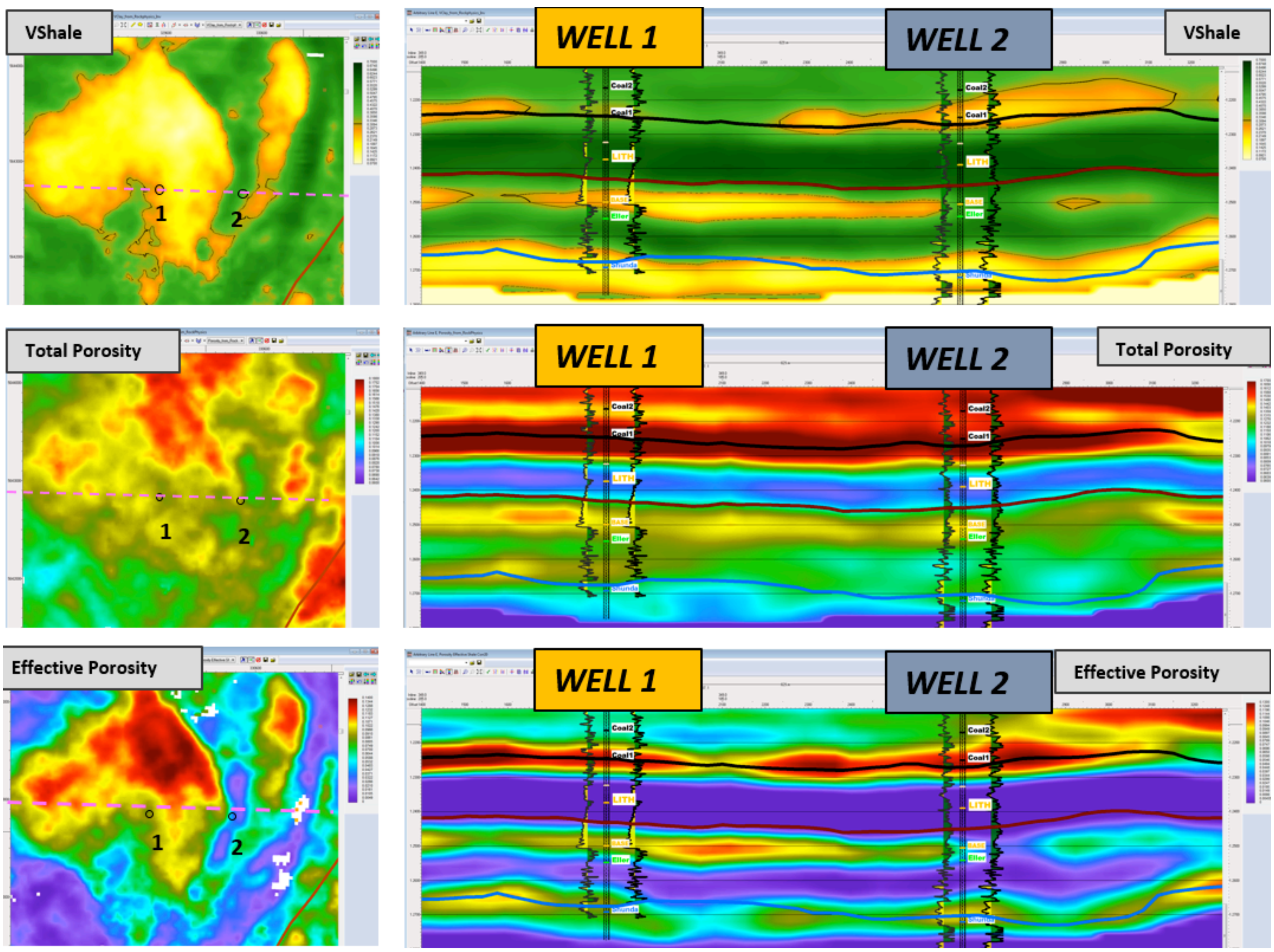

Figure 2. Seismic line in pink across the two wells shown in Figure 1. The gamma ray curve is shown on either side of the wellbore. The vshale successfully maps reservoir quality cleanliness in Well 1, and non-reservoir in Well 2. The effective porosity calculated from total porosity and vshale successfully maps porosity values within 0.5%.

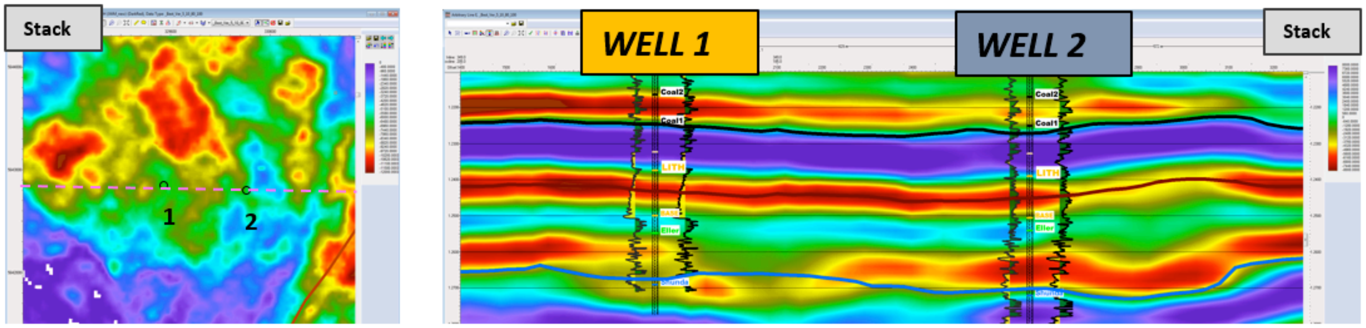

Figure 3. Conventional stack does not discriminate between reservoir and non-reservoir at Wells 1 and 2.