Understanding a Seismic Response from a Petrophysical Perspective

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EXTENDED ABSTRACT

Log editing and interpretation are two critical components of any petrophysical evaluation. Petrophysics is also an important tool which allows the geophysical interpreter to establish a link between reservoir properties (such as fluid content and reservoir quality) and an observed seismic response. Indeed, the seismic response (pre- or post-stack) of any given reservoir or prospect cannot be understood without the examination of the *in-situ* rock properties from nearby wells (Fig. 1). In addition to understanding the *in-situ* response at a nearby well location, most AVO studies also utilize forward models (*e.g.*, fluid and porosity substitutions) in an effort to understand the possible range of fluid and lithology combinations that might give rise to an observed response over a prospect (Fig. 2). This combination of petrophysics and seismic modeling is frequently referred to as "seismic petrophysics," and is a necessary part of any amplitude-versus-offset (AVO) analysis (Fig. 3). From this type of analysis, we gain an understanding of the information that can be extracted from seismic data, along with information on how the seismic data should vary with lithology, porosity, and fluid type.

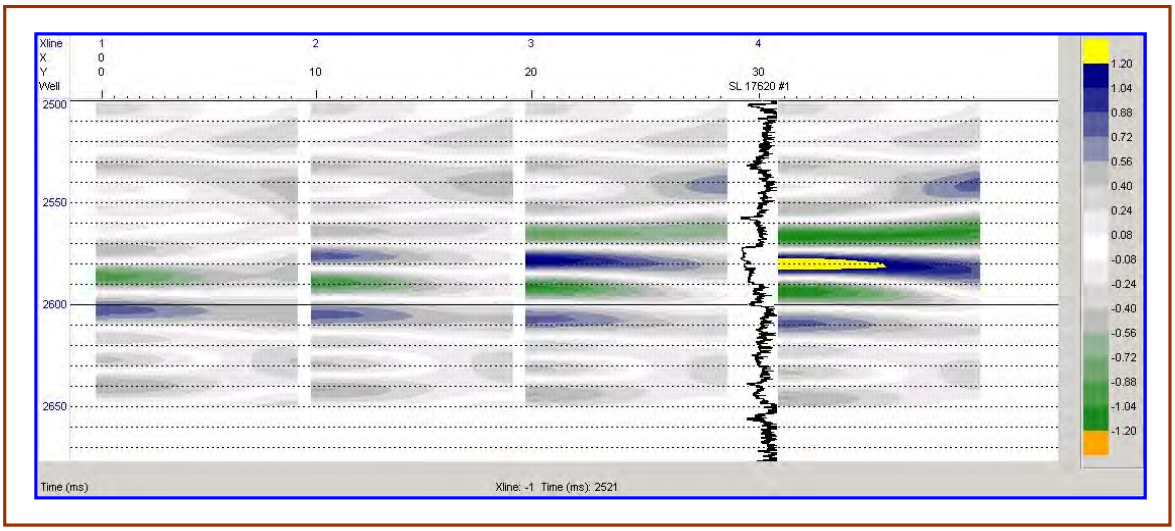

Figure 1. Seismic gathers show a Class-IV AVO response at the target location. At this point, it is impossible to determine whether this is a discovery well or a dry hole. Additional information is required.

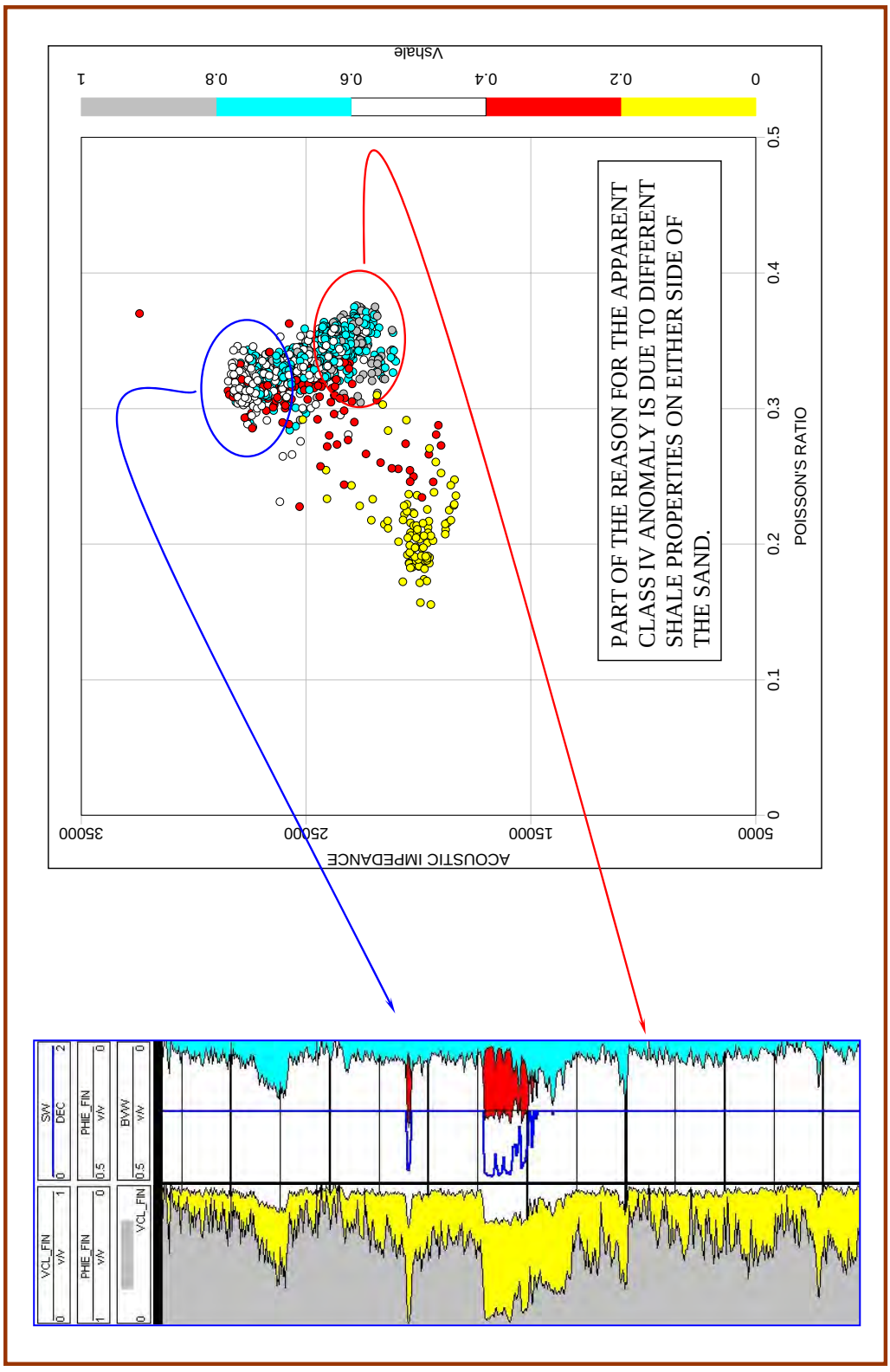

Figure 2. Rock properties analysis at a nearby wells shows the following: 1) there is a large contrast in acoustic impedance (AI) and Poisson's Ratio (PR) between the background shale and the gas sand, and 2) the elastic properties of the shale are asymmetric on either side of the sand. Additional modeling can be accomplished via Gassmann theory, which will allow for additional fluid scenarios to be modeled (*e.g.*, low saturation gas).

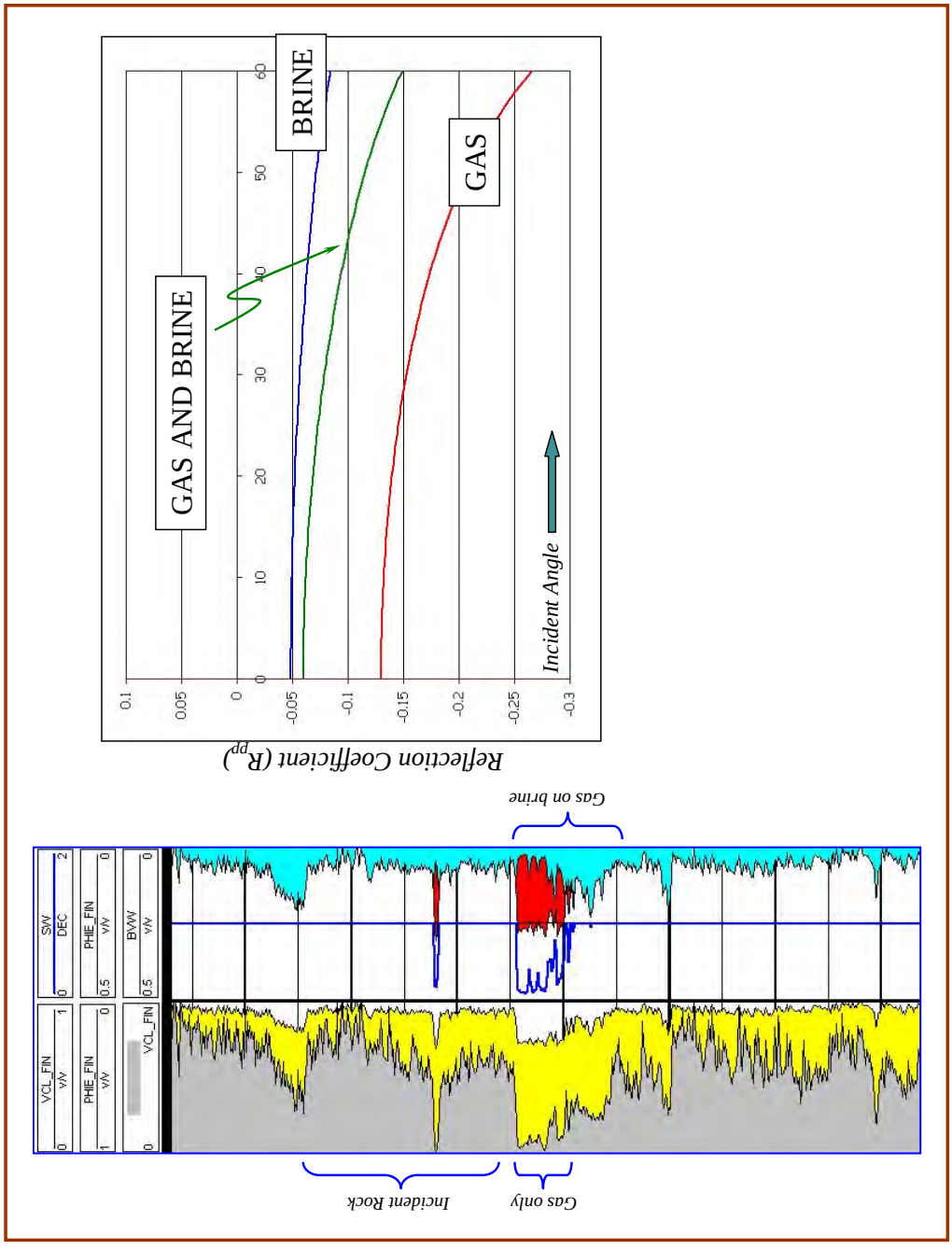

Figure 3. Simple half-space modeling shows that these sands and shales are capable of generating a Class-III AVO response. The Class IV AVO response observed in Figure 1 is interpreted to be due to the thinness of the reservoir, and asymmetric shale properties on either side of the sand. The outcome of this analysis is that the observed Class-IV AVO response is not due to the intrinsic rock properties, but rather is due to tuning effects related to reservoir thickness and the bounding shale properties.