Quick-Look Technique for Quantifying Shale Distribution Types using Total Porosity versus Shale Volume Crossplots

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EXTENDED ABSTRACT

Shale distribution in a sandstone reservoir can be broadly described in terms of three components: shale laminations interlayered within the overall sandstone interval, dispersed shale within the overall sandstone pore network, and structural shale comprised of sand-sized particles of shale composition (e.g., Thomas and Stieber, 1975; Juhasz, 1986) (Fig. 1). Total porosity versus shale volume crossplots offer a tool for quantifying shale distribution components (Fig. 2). We expand upon previous work by describing a full three-component equation of total porosity based on the individual partial porosity contributions of each potential component—we plan to publish the full mathematical derivations in a separate publication and instead show here graphical representations of analysis. Due primarily to limitations of traditional triple-combination log data, previous studies focused on two-component models (either laminar-dispersed [Fig. 3] or laminar-structural [Fig. 4]), assuming the third component is entirely absent, and we ourselves describe an additional two-component model (dispersed-structural) [Fig. 5], which appears to be an especially relevant model in the cleanest reservoirs. Because the dispersed shale component plays a critical role in calculating effective sandstone porosity, a crucial parametric of reservoir quality, we considered the influence on dispersed shale volumetric calculations from two-component models when considering the potential presence of all three components in a reservoir sandstone. Importantly, we found that considering the potential occurrence of the third component in the previous dispersed-laminar or structural-laminar models resulted in an increase in the calculated dispersed shale volume (Figs. 6–8). Thus, previous studies, especially focused on the dispersed-laminar model, likely underestimated dispersed shale volume and therefore overestimated effective sandstone porosity—an optimistic rather than conservative result (Fig. 9). Rather, our methodology constrains the actual range in dispersed shale volume and thus the range in effective porosity when using triple-combination log data. Additional datasets (e.g., 3D resistivity, core, image logs, etc.) can help more fully quanti-

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