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Integrated Reservoir Sedimentology: Unlocking Insights into Coeval Depositional Interaction Between Aeolian-Fluvial-Marine Deposits, Using Advanced Characterization and Ai-Assisted Tools

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Abstract

Objectives/Scope:

The coeval interaction between aeolian, fluvial, and marine depositional systems creates complex sets of succession and architectural elements, yielding heterogeneous reservoirs. This study integrates reservoir geology studies with technological applications to address these complexities, improve the accuracy of reservoir modeling, and gain a deeper understanding of actual reservoir behavior. This multidisciplinary approach ultimately leads to more accurate well placement and optimized reservoir development.

Methods, Procedures, Process:

This study utilizes a total of 1,000 ft of subsurface core data. Detailed core descriptions were combined with detailed petrographic analyses of over 80 thin sections, representative of diverse facies, to reconstruct depositional processes. Core-calibrated with image logs enabled sedimentary observations in uncored wells, while also determining paleocurrent orientations. To assess facies spatial variability, cross-sections were created along depositional dip and strike directions. Finally, these results were leveraged to populate facies across the field using AI-assisted tools, which employ a multidisciplinary approach integrating different data types and scales to produce robust reservoir facies distribution across the field with increased confidence.

Results, Observations, Conclusions:

Seven distinct lithofacies were identified, comprising: (F1) Well-sorted, high-angle cross-laminated sandstone, (F2) Fine-grained, crinkly laminated sandstone, (F3) Parallel laminated, moderately sorted sandstone, (F4) Bioturbated heterolithic sediments, (F5) Normally graded sandstone, (F6) Moderately sorted subarkosic to sublitharenitic sandstone, and (F7) Faintly laminated siltstone. Analysis of the stacking patterns, contacts, and relative proportions of these lithofacies facilitated determination of the depositional environment. Notably, close associations existed between (F1), (F2), and (F3), indicative of deposition under arid conditions dominated by aeolian processes. Conversely, marine influences were inferred from bioturbation in (F4), often truncated by (F5), characteristic of tidally deposited sediments. Relationships between (F6) and (F7) suggested fluvial channel and floodplain settings, respectively. Up-dip margins exhibited localized channel-fill deposits composed of immature lithic-feldspathic, coarse-grained sandstones, reflecting strong fluvial control. Down-dip margins displayed evidence of tidal processes through bioturbated

heterolithics accompanied by silty, fine-to-medium grained sandstones. The resultant detailed architectural element analysis and AI-assisted approach have collectively enabled a deeper understanding of the interactions between these competing systems, thereby facilitating the generation of conceptual models that capture both spatial and temporal complexities.

Novel/Additive Information:

This pioneering reservoir sedimentology study integrates advanced characterization approaches with AI-assisted tools, revealing the complexities of reservoirs formed through coeval aeolian, fluvial, and marine interactions processes. By employing the power of AI-driven analytics and detailed core analysis, outputs reveal internal reservoir architectures, facilitating the development of highly accurate predictive models. This innovative approach enhances reservoir characterization best practices, especially in interacting settings, delivering crucial insights for improved decision-making and optimized field development.