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Lithofacies, Depositional Environment and Diagenetic Evolution of the Paleocene Patala Formation, Potwar Basin, Pakistan: Implication for Shale Gas Potential

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Abstract: Reservoir assessment of unconventional reservoirs poses numerous exploration challenges. These challenges relate to their fine-grained and heterogeneous nature, which are ultimately controlled by depositional and diagenetic processes. To illustrate such constraints on shale gas reservoirs, this study focuses on lithofacies analysis, paleo-depositional and diagenetic evolution of the Paleocene Patala Formation at Potwar Basin of Pakistan. Integrated sedimentologic, petrographic, X-ray diffraction and TOC (total organic carbon) analyses showed that the formation contained mostly fine-grained carbonaceous, siliceous, calcareous and argilaceous siliciclastic-lithofacies, whereas carbonate microfacies included mudstone, wackestone and packstone. The silicious and carbonaceous lithofacies are considered a potential shale-gas system. The clastic lithofacies are dominated by detrital and calcareous assemblage including quartz, feldspar, calcite, organic matter and clay minerals with auxiliary pyrites and siderites. Fluctuations in depositional and diagenetic conditions caused lateral and vertical variability in lithofacies. Superimposed on the depositional heterogeneity are spatially variable diagenetic modifications such as dissolution, compaction, cementation and stylolitization. The $\delta^{13}C$ and $\delta^{15}N$ stable isotopes elucidated that the formation has been deposited under anoxic conditions, which relatively enhanced the preservation of mixed marine and terrigenous organic matter. Overall, the Patala Formation exemplifies deposition in a shallow marine (shelfal) environment with episodic anoxic conditions.

Keywords: Lithofacies, Organic Matter, Paleocene, Potwar Basin, Shale Gas, Shallow Marine.