Integrated Facies Analysis, LiDAR-enhanced Architectural Analysis, and Petrography of a Potential Paleocene Reservoir: The Prince Creek Formation at Sagwon Bluffs, North Slope, Alaska

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An extensive river-cut along the Sagavanirktok River adjacent to the Dalton Highway (mile 359) exposes 40-120 m-high bluffs (Sagwon Bluffs) that contain the most complete and laterally continuous succession of the Paleocene Prince Creek Formation (PC) found on the North Slope of Alaska. Rare North Slope outcrops such as this located near known oil and gas accumulations offer a glimpse into facies, alluvial architecture, sandbody interconnectivity, and stacking pattern that is difficult to resolve from seismic and core alone. The succession at Sagwon Bluffs includes numerous oil stained intervals making this outcrop belt a probable analogue for nearby oil and gas reservoirs. An integrated facies-architectural-petrographic analysis is used to (1) reconstruct Paleocene depositional environments and (2) determine the reservoir potential of the succession. A ground based LiDAR survey is incorporated into our study to enhance quantitative measurements and improve net-to-gross calculations.

The PC records alluviation on a series of clastic wedges that filled the east-west trending Colville Basin from the west along the axis of the basin and transversely from the south in the direction of the evolving Brooks Range orogenic belt. Fine-to coarse-grained conglomeratic sandstones, organic-rich siltstones, carbonaceous shale, organic mudstone, coal, and bentonite were deposited at Sagwon Bluffs on a Paleocene coastal plain containing meandering streams, levees, crevasse splays, lakes, swamps, organic-rich floodplains, and soil-forming environments. Sagwon Bluffs are comprised of isolated medium-to coarse-grained meandering sheet sandstones up to 6 m thick and thousands(?) of meters wide and ribbon-form sandbodies up to 15 m thick and 600 m wide. Paleoflow measurements recorded from trough cross-stratification in channel thalwegs (n=40) indicate paleoflow to the northeast (74°). Sandbodies are encased in organic-rich floodplain facies that include thick lacustrine deposits (some > 12 m thick) and thick coals (up to 5 m thick). This alluvial architecture dominated by isolated sandbodies encased in thick organic-rich floodplain facies suggests a high subsidence rate and high accommodation during the Paleocene, possibly resulting from lithospheric response to orogenic loading and proximity to the basin access.

Quartz and chert rich PC sandstones are saturated with biodegraded hydrocarbons in many horizons along the outcrop belt. High gravity low sulfur oils are typed to the Pebble Shale/Hue Shale/HRZ. Porosities (n=10) range from 19% to 29% averaging 22%. Permeabilities (n=9) range from 4 millidarcies (md) to 3650 md averaging 715 md. These porosity and permeability values imply that most sandbodies could function as excellent reservoirs. Thick packages of fine-grained facies encasing these sandbodies could serve as seals for sedimentary traps. The combination of facies analysis, LiDAR enhanced architectural analysis, and petrography is a highly effective method to reconstruct

ancient paleoenvironments and determine the reservoir potential of laterally extensive North Slope outcrop belts that may serve as outcrop analogues for oil and gas reservoirs.