Implications of Tectonic Reorganization for Cretaceous Turbidite-Reservoir Architecture in the Brookian Sequence, North Slope, AK

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The sequence boundary separating Lower and Upper Cretaceous depositional sequences of the Alaskan North Slope marks an abrupt transition in paleo-sediment supply and sandstone framework grain composition. We infer that these changes reflect tectonic reorganization of the hinterland sediment source area, and are manifested in contrasts in key elements of Brookian reservoirs of the North Slope.

Early Cretaceous sediment supply to the Coleville foreland basin is estimated to be at least three times larger than during the Late Cretaceous. Sandstone composition is predominantly lithic to sublithic arenite throughout the Cretaceous succession, but Upper Cretaceous sandstone is significantly more lithic-rich than Lower Cretaceous sandstone. Moreover, lithic components in Lower Cretaceous sandstone are mostly sedimentary and metamorphic grains whereas Upper Cretaceous sandstone contains more volcanic grains.

Reconstructed sediment-routing and depositional patterns from integrated seismic-reflection and sandstone compositional analysis suggest that the Chukotka orogenic belt was the predominant provenance terrane during Early Cretaceous foreland basin development in Arctic Alaska. The ancestral Brooks Range also contributed sediment that was mostly accommodated by rapid subsidence along the southern foredeep margin. Heightened Early Cretaceous sediment supply and the predominance of metamorphic and sedimentary lithics are consistent with interpretations of convergent tectonism along the South Anyui suture, which represents the plate boundary of Arctic Alaska and northern Asia. The abrupt decrease in sediment influx near the beginning of the Late Cretaceous, together with the increased proportion of volcanic lithics in sandstone and widespread tephra beds, are consistent with volcanic activity along the Okhotsk-Chukotka volcanic belt. Thus, we propose that significant and abrupt changes in the character of strata within the Colville foreland basin reflect these fundamental tectonic shifts in the Chukotka region.

Differences between Lower and Upper Cretaceous turbidite reservoirs are highlighted from seismic-stratigraphic, wireline-log, and drill-core analyses. Lower Cretaceous deep-water depositional systems include large basin-floor fans (<250 km^2 in area; >100 m thick) predominantly composed of fine-grained lithic arenite. Oil saturated depositional lobes have been discovered in the Lower Cretaceous succession, but development is inhibited by diminished permeability related to compaction of lithic grains. In contrast, a “bajada” of slope-apron deep-water depositional systems were deposited basinward of the Upper Cretaceous shelf edge. These systems are small (generally <20 km^2 in area and >70 m thick) and include a breadth of deep-water depositional lithofacies, from sand-rich turbidites to relatively heterolithic deposits from slurry and debris flows. The breadth of deep-water depositional facies and heterogeneity inherent to the slope aprons is at least partially a

result of the Late Cretaceous influx of relatively fine-grained volcanic sediment. Sand-rich lobate and channelized deposits of high-density turbidity currents represent exceptional reservoirs in the slope aprons.