Interplay between Sequence Stratigraphy and Structure in the Eastern Colville Basin, North Slope, Alaska

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Interpretation of seismic reflection and well data between central National Petroleum Reserve in Alaska (NPRA) and the Canning River reveals multiple Lower Cretaceous shelf-margins trending north-south that wrap around to a more west-east orientation beneath the south-central North Slope and Brooks Range foothills. This shelf-margin geometry was controlled by patterns of Early Cretaceous foreland-basin accommodation and sediment dispersal. The resulting Lower Cretaceous succession includes clinoform depositional sequences whose foreset dip, which indicates direction of progradation, is perpendicular to the shelf margins. In the lower part of the Lower Cretaceous succession, a wedge of strata displays northward thinning and pinch-out by onlap against the northern flank of the foredeep.

The boundary between Lower and Upper Cretaceous strata in the study area is marked by a pronounced backstepping and subsequent progradation of depositional sequences above the final Lower Cretaceous shelf-margin. Upper Cretaceous sequences thicken dramatically across that shelf margin, filling the accommodation space inherited from the terminal Lower Cretaceous strata geometry. Upper Cretaceous sequences display a range of slope-failure slumps and slides across the accommodation step. The extent of progradation of the Upper Cretaceous clinoforms within the Seabee Formation appears to be truncated by the Mid-Campanian Unconformity (MCU).

The study area shows evidence of significant interplay between structure and stratigraphy at regional to local scales. On a regional scale, the structural front of the foothills fold-thrust belt coincides in location with the northward pinchout of the Lower Cretaceous foredeep wedge. Because this pinchout occurs near the same location as the modern thrust front, we propose that the foredeep wedge geometry influenced the formation of the later developed frontal folds and associated thrusts.
Other folds in the area show a distinct decoupling from deeper structural features. Within the foothills of the fold-thrust belt, the Seabee Formation thickens significantly in the cores of tight anticlines from the primary thickness of the formation. We suggest that this may be due to the flow of the Seabee into the cores during deformation. In the west of the study area, a lateral ramp is interpreted to step up from east to west within the Seabee along a clinoform boundary. Displacement over this lateral ramp forms a subtle, open fold that trends perpendicular to the previously mentioned anticlines.

Further interplay between stratigraphy and structure is suggested where we observed normal faulting that is confined to the Seabee and the Tuluvak stratigraphic intervals. The offset increases and the strata are more chaotic just below the slump features where the MCU incises. This minor extension in the Seabee and Tuluvak formations may have caused collapse across a distinct paleoshelf margin where the MCU steps down.