Laramide Deformation and Flexural Effects in the Upper Cretaceous: A Basin in Transition

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Abstract

The nature of subsidence in the Western Interior evolved in the Late Cretaceous from a contiguous (Sevier) foreland to partitioned (Laramide) basins coeval with an increase in long-wavelength “dynamic” subsidence. This evolution is interpreted by many as indicators of flat slab subduction. However, the timing and geographic location of changing subsidence mechanisms remains poorly documented. To better assess the geodynamic mechanisms responsible for this transition, we have mapped active elements versus time, including classic foredeeps, intra-basinal uplifts, long-wavelength subsidence, and local flexural wedges adjacent to rising Laramide structures. Criteria include isopachs, paleogeography, geohistory analysis, unconformities/exhumation, and sediment dispersal patterns.

The analysis identifies a continuous foredeep along the Sevier Thrust Front through the Santonian, but not subsequently. Long-wavelength “dynamic” subsidence in the basin commences in the Coniacian, but is spatially and temporally quite variable. Short-wavelength Laramide structures first begin growing in the Ceno-Turonian. The influence of Laramide uplifts increases over time, with associated flexures becoming a dominant subsidence mechanism by the Maastrichtian.

Thirteen flexural stratigraphic wedges, associated with both Sevier and Laramide uplifts, have been used to quantitatively model loads (uplift height/width) and effective elastic thicknesses (EET). EET is a measure of the integrated strength of the lithosphere. Results indicate that EET decreases over time, enhancing Laramide basin partitioning. The decrease in effective elastic thickness of the lithosphere is consistent with lithospheric weakening by the introduction of volatiles during flat slab subduction. Calculated Maastrichtian EET’s are consistent with modern EET, supporting the hypothesis that flat slab subduction preconditioned the lithosphere for subsequent Cenozoic tectonic and magmatic events. Large-scale petroleum system play elements are correlated with the distribution of these tectonic elements and associated subsidence. Examples include the Lance reservoir at Pinedale Field, Lewis source/seal in the Washakie Basin and the Niobrara source/reservoir in the Sand Wash, eastern Piceance and Denver Basins.

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