

Stratigraphic Framework For Basin-Margin, Sub-Unconformity Diagenesis Below The Acadian Unconformity In The Southern Williston Basin

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ABSTRACT

The Acadian discontinuity is represented by a late Devonian (Famennian) unconformity that lies on top of the Famennian Three Forks Formation in the central portion of the Williston basin and on truncated Devonian through Cambrian formations in basin-margin areas. Bakken-Pronghorn sediments were deposited in the basin-center and onlap the Acadian unconformity. A maximum flooding surface overlies the Bakken-Pronghorn system in the basin-center but this surface overlies the Acadian unconformity in basin-margin areas. The maximum flooding surface is overlain regionally by open-marine carbonate strata of the basal Lodgepole. Sub-unconformity diagenesis was an important process in basin-margin areas around the southern Williston basin; however, the diagenetic analysis in this study focuses on a portion of the southwest Williston basin where good core data and numerous GR-neutron-density logs are present. Basin-margin, shallow-burial diagenesis beneath the Acadian unconformity formed a paleokarst characterized by evaporite dissolution and massive dolomitization. This diagenesis is illustrated in the Duperow and Birdbear formations, which consist of stratiform limestone, dolostone and anhydrite beds in the basin-center. These layered lithologies transition to massive dolostone in subcrop areas beneath the Acadian unconformity. A sub-unconformity paleo-dissolution front extends as much as 50 m below the unconformity and former anhydrite beds are now represented by solution-breccia beds within the dissolution area. Massive dolostone cuts across stratigraphic units and extends as much as 70 m below the Acadian unconformity. While they overlapped in basin-margin areas, massive dolomitization was not related to the fresh-water processes that produced evaporite dissolution during paleokarst formation. Since the massive dolomitization front is sub-parallel to the unconformity over large areas and there is no massive dolostone in overlying basal Lodgepole beds, it is likely that dolomitization occurred after unconformity development and before Lodgepole deposition. This indicates that basin-margin dolomitization took place while Bakken-Pronghorn sediments were being deposited, 10-20 million years after deposition of the Birdbear and Duperow. Basin-margin massive dolomitization probably occurred during one or more evaporative events that caused regional dolomitization within carbonates of the Middle Bakken. The "massive" characteristics, defined by the absence of a stratiform geometry, relate to dolomitization that occurred after mineral stabilization and initial lithification within the Duperow and Birdbear.