

Thickness Trends and Sequence Stratigraphy of the Middle Devonian Marcellus Shale, Appalachian Basin: Evidence of the Influence of Basement Structures on Sedimentation Patterns

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Analysis of more than 900 wireline logs indicates that the Middle Devonian Marcellus Shale comprises two third order depositional sequences, MSS1 and MSS2, in ascending order. Thickness trends of the sequences reflect the interplay of temporal and spatial variations in accommodation space, the influence of recurrent basement structures, eustatic fluctuations, and proximity to Middle Devonian clastic sources. Thickening of both sequences toward the eastern region of the basin preserves a record of greater accommodation space and proximity to clastic sources at this early stage of the Acadian Orogeny. Moreover, organic-lean late MSS2 highstand systems tract deposits prograded to the west. Local variations in the thickness of MSS1 and MSS2 reflect the reactivation of extensional basement structures, including the Rome Trough, most evident in thickness trends of MSS1 highstand systems tract deposits. Lithostratigraphic units and depositional sequences of the Marcellus Shale reveal variable degrees of erosion in western New York and northwestern Pennsylvania, a consequence of intermittent vertical displacement of crustal blocks bounded by both Eocambrian extensional structures and northwest-striking cross-structural discontinuities, including the Tyrone - Mt. Union, Lawrenceville - Attica, Home - Gallitzen, and Pittsburgh - Washington faults. Episodes of block movement induced by Acadian plate convergence gave rise to northeast-southwest-trending regions of starved sedimentation and /or erosion bounded by cross-structural discontinuities. Block movement appears to have initiated in late Early Devonian time resulting first in local erosion of the Oriskany Sandstone in northwest Pennsylvania. Similarly, depositional and erosional patterns of the Marcellus Shale and the overlying organic-rich Levanna Member of the Skaneateles Formation in New York and western Pennsylvania were controlled by block movement.