Appalachian hingeline: platform margin control on the Taconic orogenic front, and implications for hydrocarbon exploration

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The Appalachian Hingeline is defined as the facies transition from carbonate platformal facies to slope and deep basinal carbonate facies along the Early Paleozoic continental margin of Laurentia, western Iapetus ocean. Various Cambrian-Ordovician breccias in slope facies extending from western Newfoundland to southern Quebec, together with basinward thickening of reworked carbonate deposits, indicate likely early normal fault control of the platform edge and hingeline. However, the distribution of these facies relative to later thrust faults (including Logan's Line) suggests that the main Taconic deformation front was also controlled by the hingeline through continental margin deep-basin inversion; slope and basin deposits are restricted to allochthonous thrust panels, whereas platform units occur in the footwall and remain largely authochthonous.

The style of deformation in the Taconic foreland is typical of orogenic fronts, and varies along strike. Three main styles are recognized: (1) In Gaspésie, shortening dissipates into large-scale fault propagation folds above blind or emergent thrust tips in syn-orogenic Ordovician flysch, (2) similar features are observed in Western Newfoundland, however younger opposite facing thrusts define a large triangle zone, and (3) in southeastern Quebec, imbricate thrusts define duplex structures. A further complication of the Taconic foreland in the Gaspésie segment is recorded by the late extensional reactivation of the orogenic front; here immediately beneath the foreland flysch a thick zone of penetrative brittle-ductile extensional shear overprints earlier thrust structures. The net excision of a substantial portion of the Ordovician stratigraphy along this fault is interpreted to indicate that a significant period of extension and tectonic back-sliding occurred late in the evolution of the Taconic orogen within the foreland, which may be linked with late- to post-orogenic extension recorded elsewhere within the hinterland, and from Silurian sedimentation.

The Appalachian Hingeline apparently exercised a fundamental control on foreland ramp geometry. Because of the nature of the platform to slope transition, the hingeline likely produced a steep frontal ramp resulting in a strongly tapered wedge. Such a geometry is substantiated by the relatively narrow width of the foreland and orogen, the close telescoping of basement and cover, and late extension which reached into the foreland as a result of the close kinematic link between the foreland and hinterland allowed by a steep underlying ramp.

Timing of hydrocarbon generation is asynchronous across the Appalachian Hingeline. In the deep-basin of the continental margin, early hydrocarbon generation is due to sedimentary burial, and was complete previous to Taconic deformation. Subsequent burial of the slope and deep basin deposits resulted from tectonic thickening, and hydrocarbons were generated over a shorter time period, during Taconic deformation. On the platform, thermal maturation resulted from burial beneath late- and post- tectonics flysches, molasses, and successor basin deposits. In this late stage, hydrocarbon generation extended over a much longer period of time, and maturation levels reached are not as high as along the hingeline and deformation front.

The implications for hydrocarbon exploration are that platform rocks likely remain buried beneath overthrust panels of slope and deep basin units, isolating potential reservoir rocks at depth. Furthermore, hydrocarbons generated and driven from over-mature tectonically stacked slope and deep basin shales may have migrated to known porous units further up on the platform, where maturation levels may be within the oil window. The structural style has close similarities to that surrounding the western US Cordilleran Hingeline, where significant hydrocarbon accumulations occur.

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