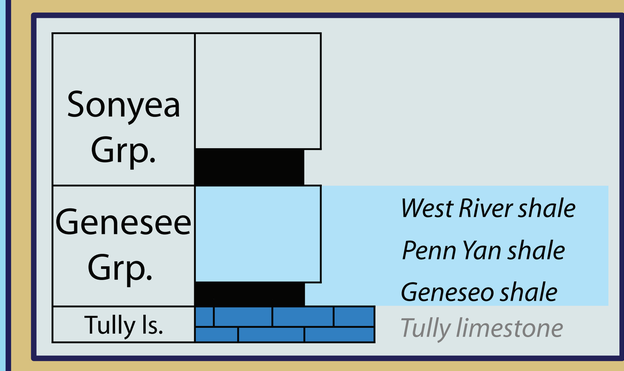
GENESEO - PENN YAN - WEST RIVER SHALE INTERVAL



Deposition of the Geneseo shale reflects rapid subsidence to a depth of perhaps 200 m (Ettensohn, 1985) induced by crustal loading in response to Acadian plate convergence in tandem with major global transgression (Dennison and Head, 1975). The organic-rich deposits, which mark the start of Ettensohn's (1985) third tectophase, onlapped the eroded Tully limestone and Moscow shale (the Tagahanic unconformity; Johnson, 1970) extending over the topographically positive area responsible for erosion of the Moscow shale and, subsequently, the Tully limestone. The Geneseo was onlapped by the Penn Yan - West River shale interval, which appears to have entered the basin from the southeast as the rate of subsidence diminshed. These units can be differentiated in the field, the Penn Yan comprising laminated dark gray shale and the West River being dominated by gray organic-lean shale. However, no attempt was made to make this distinction in the subsurface. Still, correlation of thin calcareous intervals in the Penn Yan - West River succession demonstrate onlapping of these deposits over the Geneseo shale and older strata.

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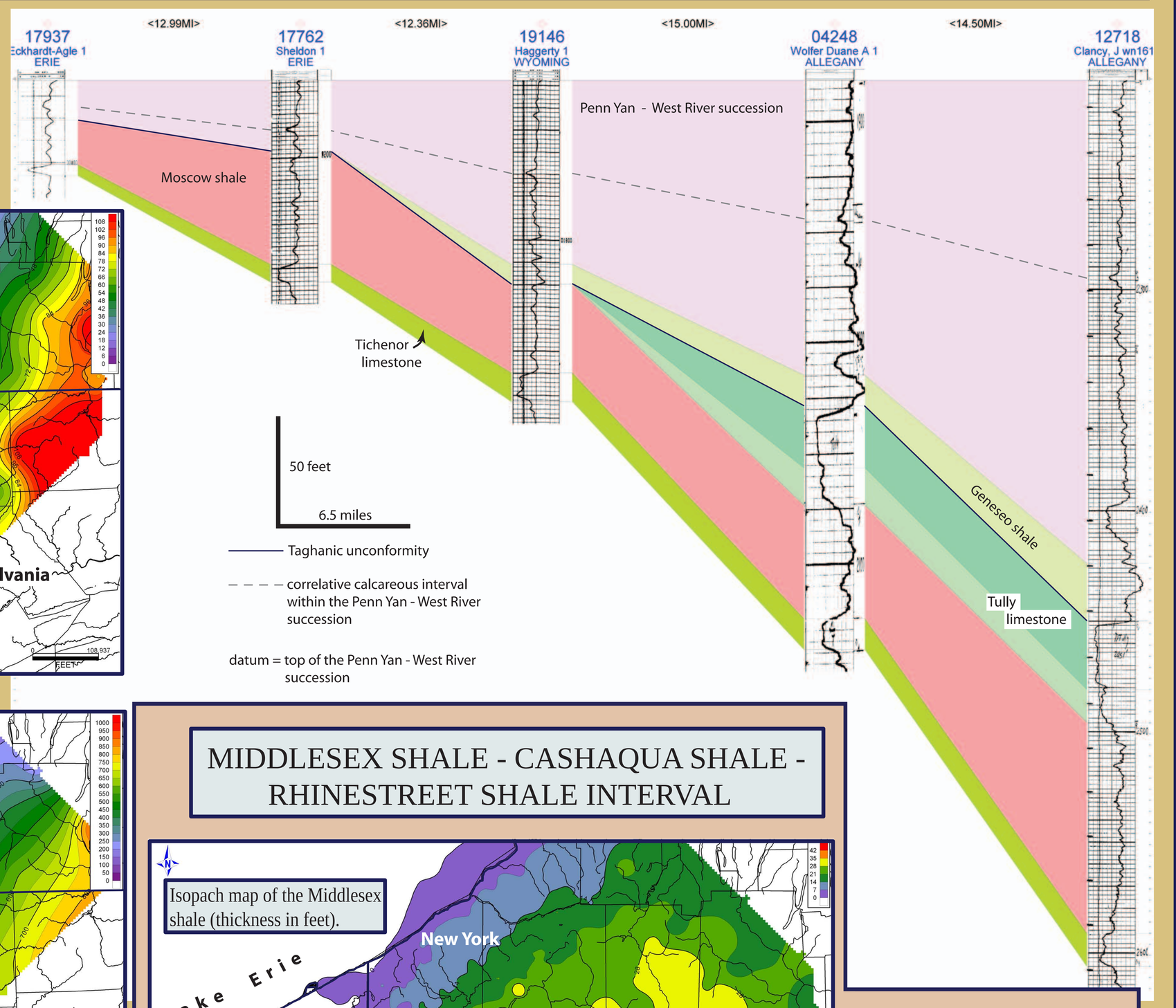
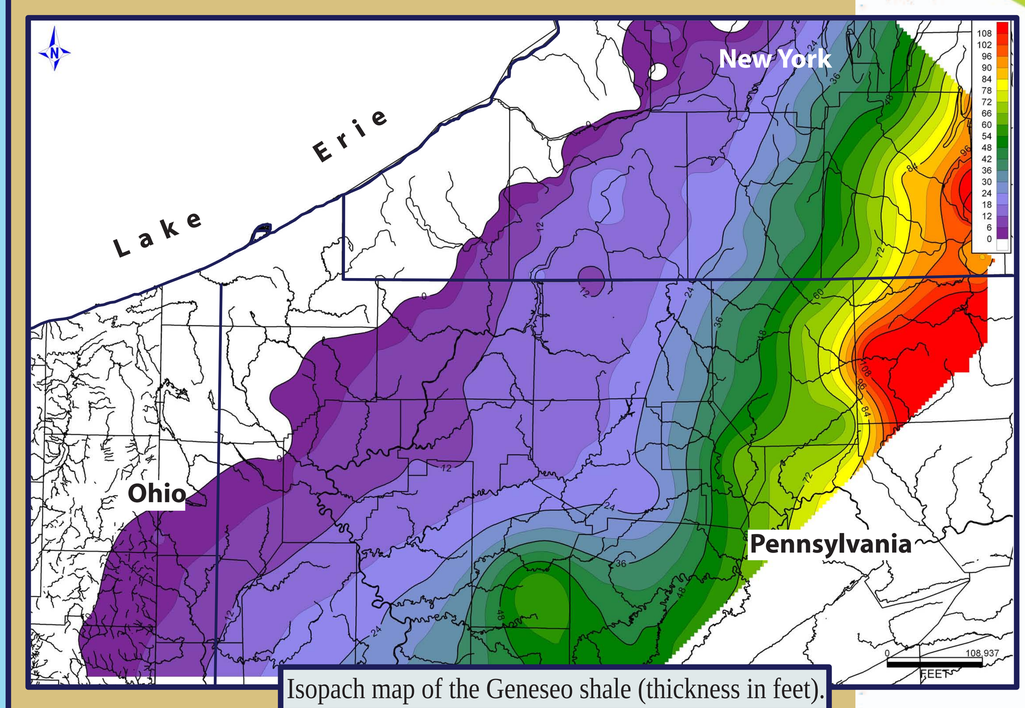
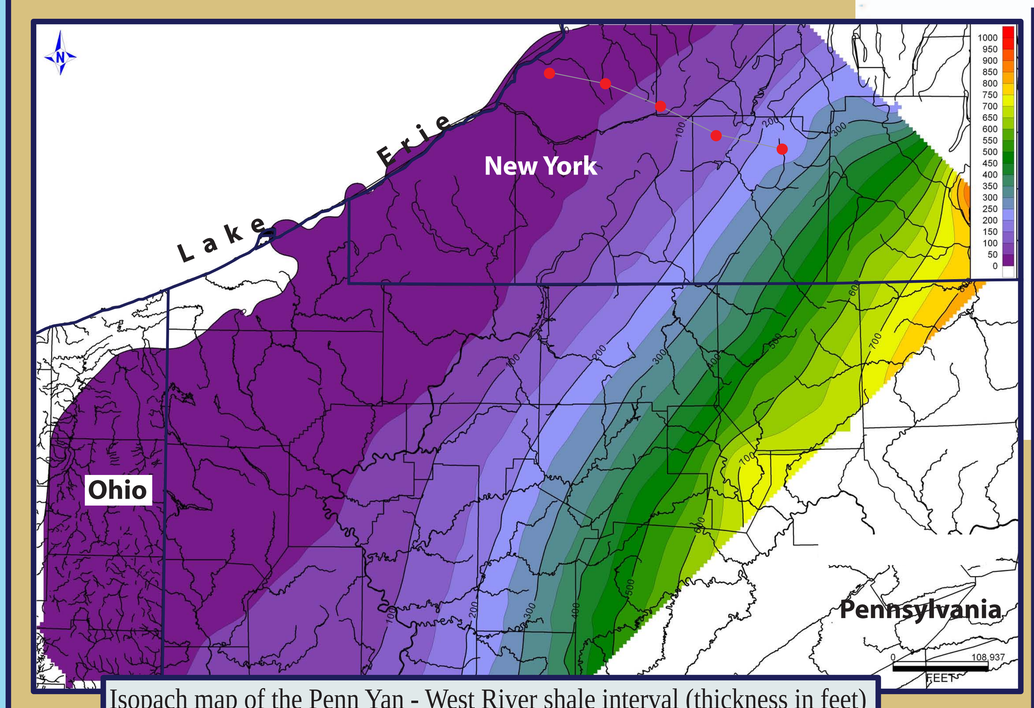


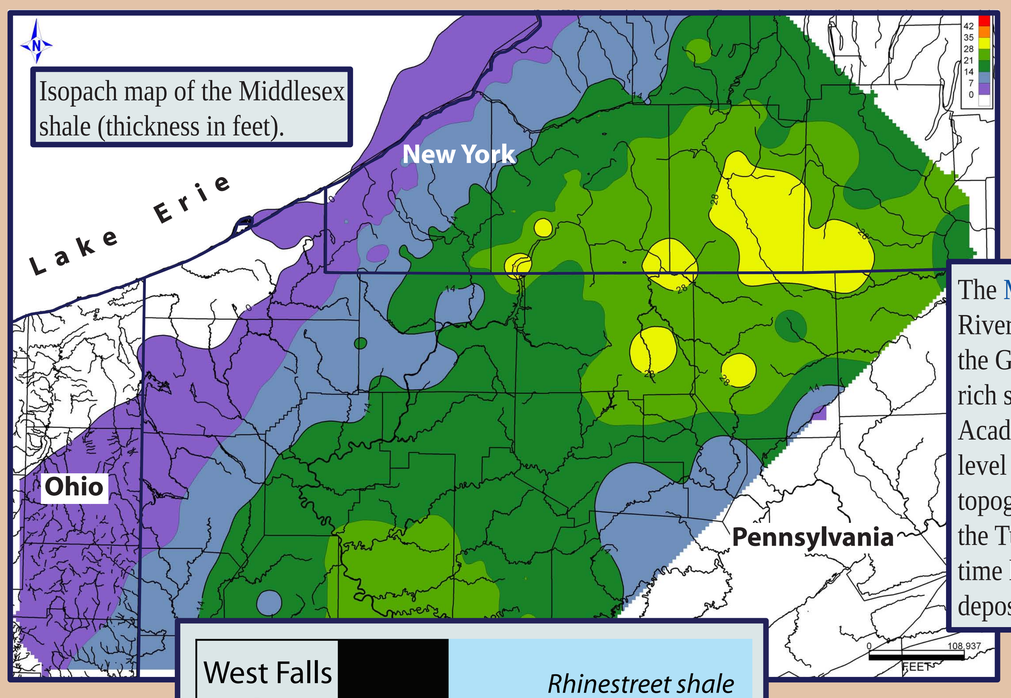


Isopach map of the Geneseo shale (thickness in feet).



Isopach map of the Penn Yan - West River shale interval (thickness in feet) showing the location of the cross-section

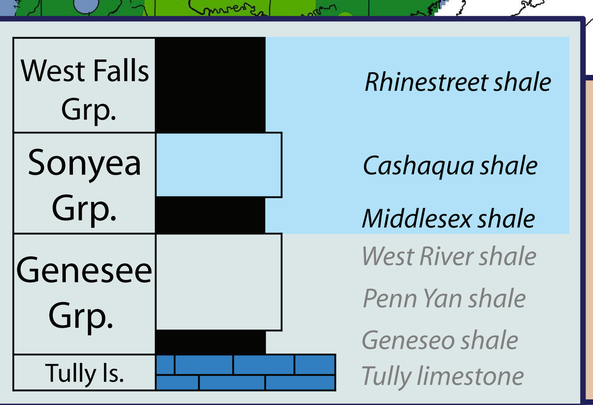
MIDDLESEX SHALE - CASHAQUA SHALE - RHINESTREET SHALE INTERVAL

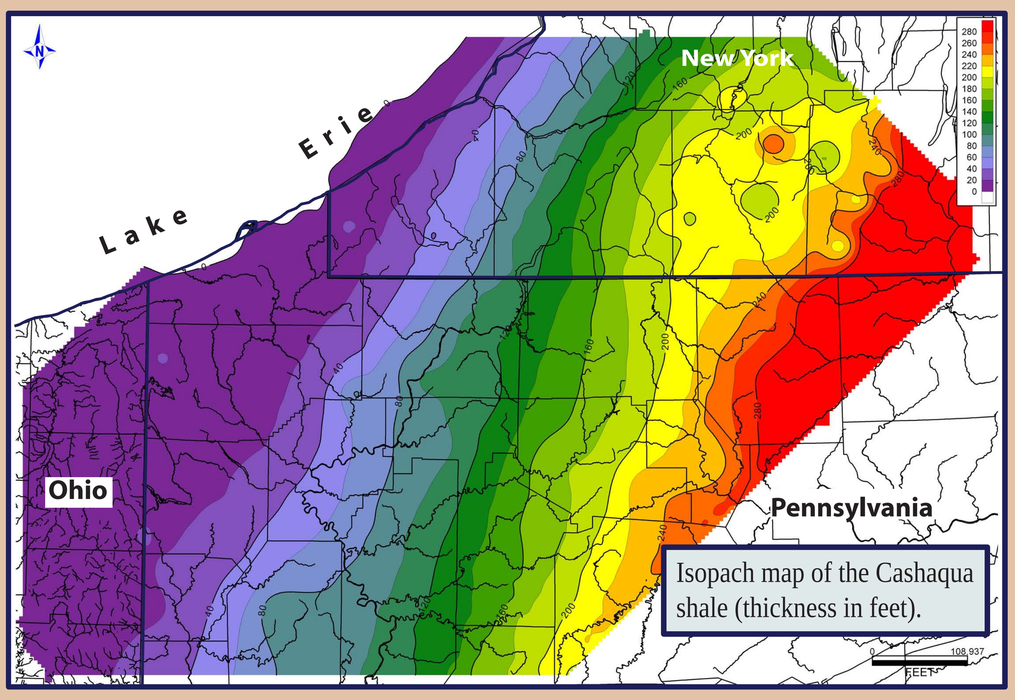


Isopach map of the Middlesex shale (thickness in feet).

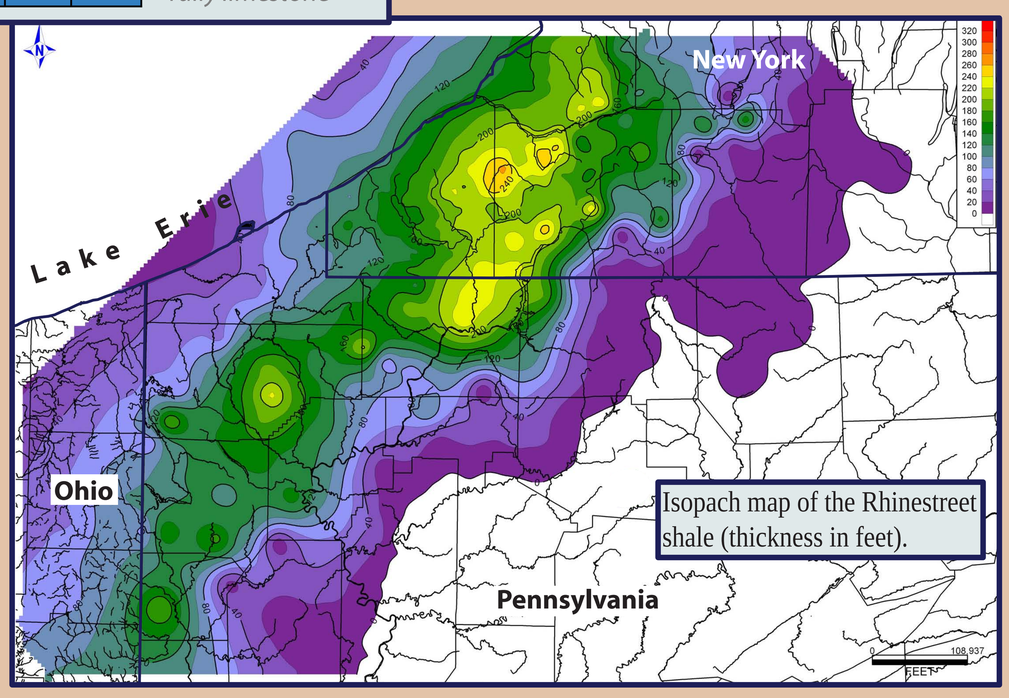
The Middlesex shale accumulated over the West River shale extending farther to the northwest than the Geneseo black shale. TheMiddlesex organic-rich shale reflects renewed tectonic activity in the Acadian thrust belt and/or a eustatic rise in sea level (T-R Cycle IIc; Johnson et al., 1985). The topographic welt that resulted in erosion of the Tully limestone had subsided by Middlesex time leaving no imprint on these and subsequent deposits.

The organic-lean Cashaqua shale tells of a decrease in subsidence rate and/or an increase in the supply of clastic detritus (Ettensohn, 1985). Finally, accumulation of the Rhinestreet shale continued the westward advance of the black shale depocenter. Ettensohn (1985) interpreted this event to be the third of five tectonically induced cycles within the third tectophase, each one initiated by rapid trangression caused by rapid subsidence and deposition of a starved black shale unit. Alternatively, Johnson et al. (1985) relate accumulation of the Rhinstreet shale to a marked eustatic rise in sea level (T-R Cycle IId).





Isopach map of the Cashaqua shale (thickness in feet).



Isopach map of the Rhinestreet shale (thickness in feet).

CONCLUSIONS

The record of Acadian thrust tectonics in the Middle Devonian clastic succession of the Appalachian Basin begins with the Marcellus black shale, specifically the Union Springs and Oatka Creek shales. The former records initial subsidence of the basin following accumulation of the Onondaga limestone during a period of tectonic quiescence at the end of tectophase one (Ettensohn, 1985; Ver Straeten and Brett, 2000). The organic-rich deposits may have onlapped a forebulge generated by the same tectonic activity that had initiated subsidence. Accumulation of the Oatka Creek shale and equivalents from New York well into Ohio and Pennsylvania tells of widespread subsidence during tectophase two. However, deposition of the Oatka Creek shale appears to have been coeval with development of a positive element or welt in western New York that reduced accommodation space thereby favoring only a thin Oatka Creek sequence here. The inferred position of the Oatka Creek topographic high west of the final position of the Onondaga forebulge suggests that the onset of tectophase twowas accompanied by westward migration of the forebulge and basin axis. Accumulation of the balance of the Hamilton Group records further forward migration of the basin axis punctuated by periods of tectonic stability and deposition of carbonate. The basin underwent uplift and erosion at the end of Hamilton time resulting in the removal of ~ 100 feet or more of the Moscow shale, locally cutting into the underlying Tichenor limestone. A lull in tectonic activity and a eustatic rise in sea level is marked by deposition of the Tully limestone over the eroded Moscow shale on what may have been a broad forebulge. This brief interlude of tectonic inactivity was terminated by uplift and erosion of the Tully limestone. The "two-sided" nature of truncation of the Tully in western New York extending into Pennsylvania demonstrates the local nature of maximum Tully erosion (e.g., Brett et al., 1990) placing it a bit to the east of the locus of maximum pre-Tully erosion of the Moscow shale. This may reflect a small amount of retrograde movement of the welt that occurred during the brief period of thrust relaxation recorded by the Tully limestone. Renewed tectonc activity in the Acadian thrust belt (third tectophase) and consequent rapid subsidence of the basin in tandem with a eustatic rise in sea level, resulted in deposition of the Geneseo black shale. The subsequent Middlesex and Rhinestreet black shales reflect further westward migration of the basin axis unaffected by those positive elements that had shaped the stratigraphic architecture of the Middle and Upper Devonian succession of western New York and northwest Pennsylvania.

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