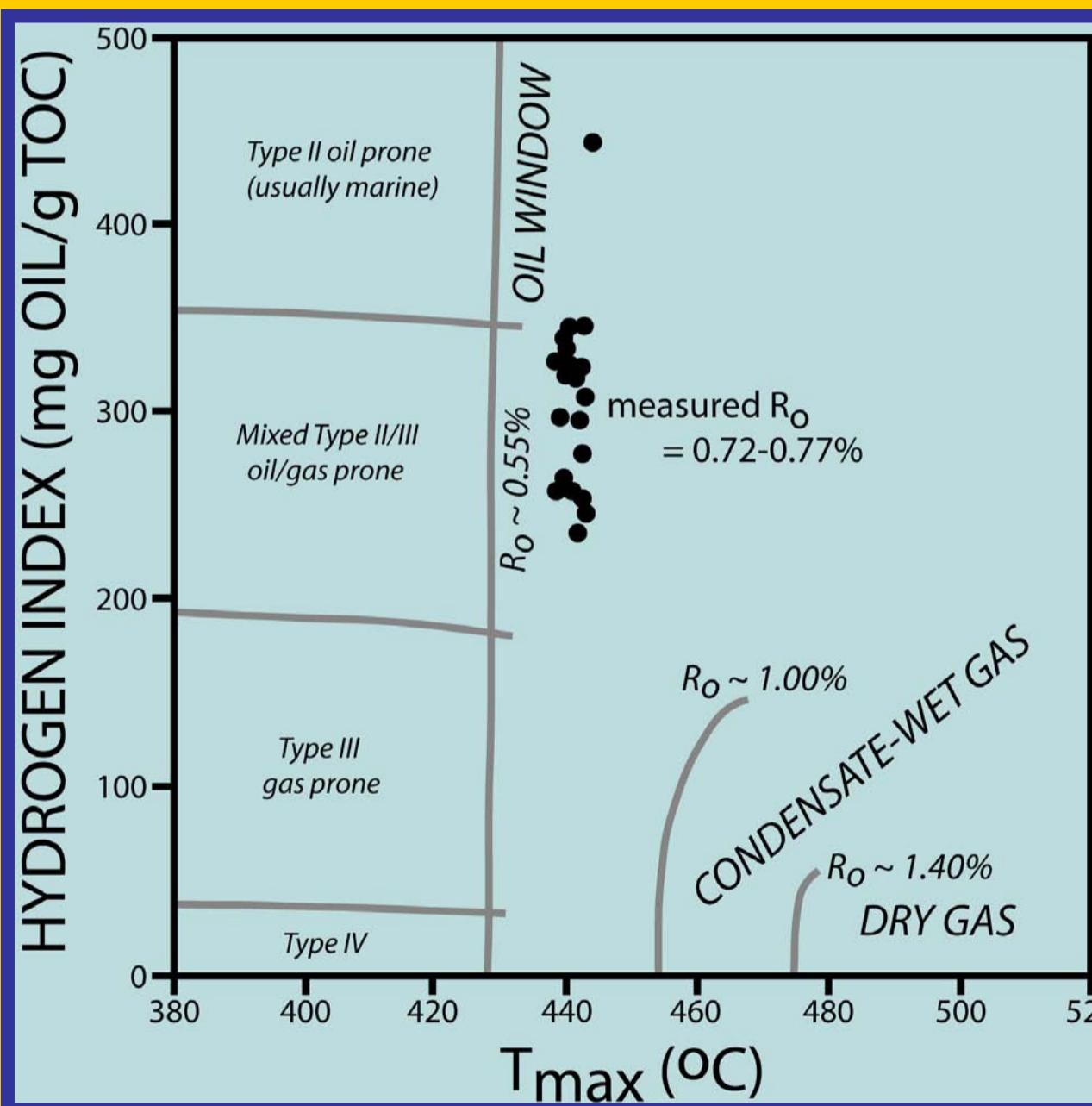


# The Upper Devonian Rhinestreet Shale, Western New York State: from Seal to Fractured Reservoir

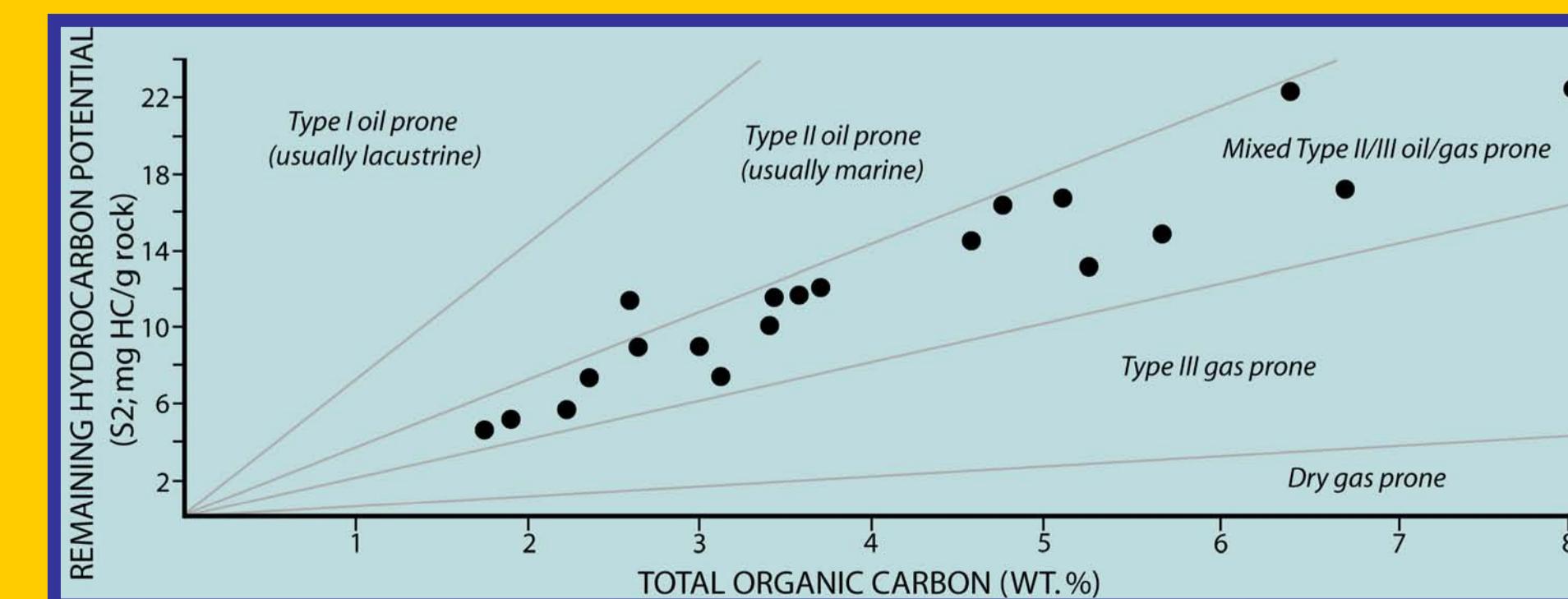
Gary G. Lash, Dept. of Geosciences, SUNY-Fredonia, Fredonia, NY 14063

The Upper Devonian Rhinestreet black shale of the Catskill Delta complex, western New York State, reflects a complex burial and overpressure history that resulted in the generation of multiple sets of vertical joints interpreted to be natural hydraulic fractures (NHF). The EASY% $R_o$  chemical kinetic model was used in this study to model an average vitrinite reflectance value of 0.74% measured on samples collected from along the Lake Erie shoreline. The earliest set of joints, a NS-trending set, is found almost exclusively at the contact of the Rhinestreet shale and underlying Cashaqua gray shale indicating that the former served as a hydraulic top seal at the modeled burial depth of ~2.1 km and prior to the onset of catagenesis (modeled  $R_o$ =0.50%). The pre-catagenic NHFs that propagated from the top of the Cashaqua gray shale into the base of the Rhinestreet shale may have initiated during uplift of the basin caused by the Morrowan docking of the Goochland terrane in the southern Appalachians. A re-newal of subsidence during the Atokan carried the Rhinestreet into the oil window by the Middle Permian (modeled  $R_o$ =0.60%) when bitumen-filled horizontal  $\mu$ m-scale microcracks propagated through these laminated, low-permeability deposits now pressurized by catagenesis. Soon after this, NW-trending vertical NHFs formed within the Rhinestreet, especially its organic-rich basal interval. Thus, those characteristics of the Rhinestreet that enabled it to serve as an efficient top seal favored its hydraulic fracturing during catagenesis. The final phase of NHF generation, an ENE-trending set, probably occurred near the end of the Permian in response to Alleghanian dextral tectonics and at the modeled maximum burial depth of ~3.2 km.



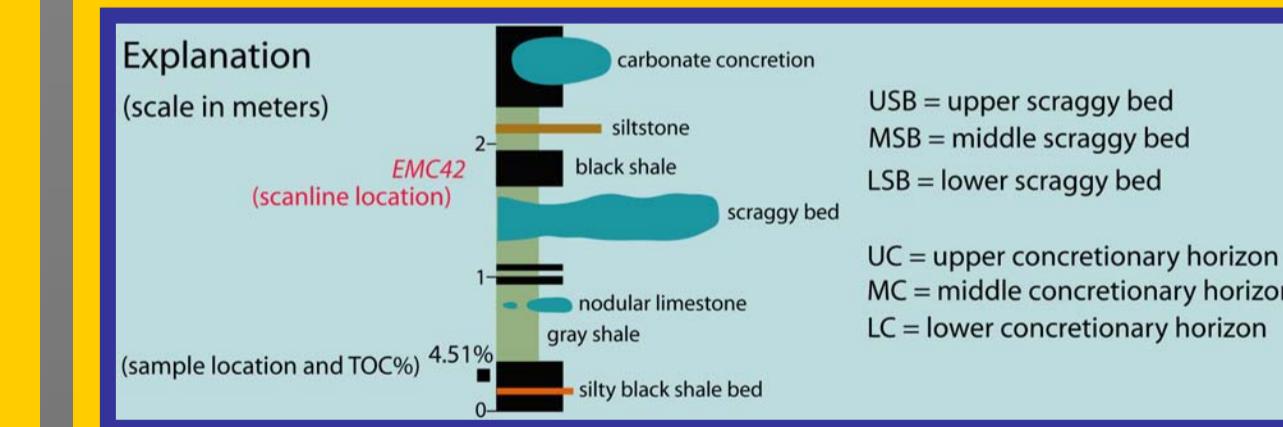
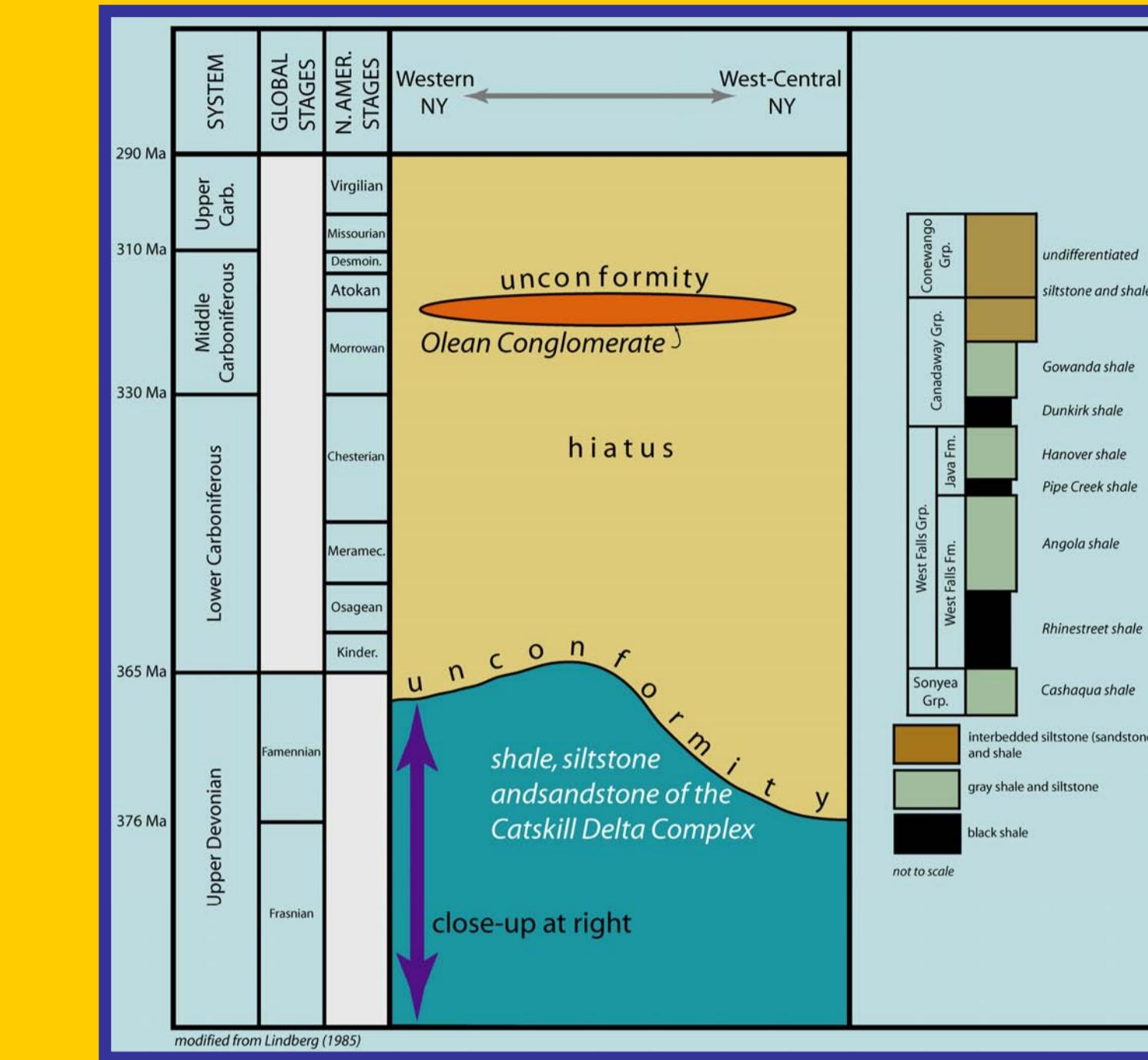
## SOURCE ROCK POTENTIAL

Total organic carbon (TOC) content of the Rhinestreet shale diminishes upstream from a maximum of ~8% in exposures along Eighteenmile Creek. Comparison of (1) the S2 Rock-Eval parameter with TOC and (2) the Rock-Eval hydrogen index (HI; mg hydrocarbons/g TOC) with Rock-Eval  $T_{max}$  suggests that organic matter in the Dunkirk shale is dominantly mixed Type II/III oil/gas-prone kerogen. Measured vitrinite reflectance values of Rhinestreet shale samples range from 0.72% to 0.77% thereby placing this unit within the oil-generating window.

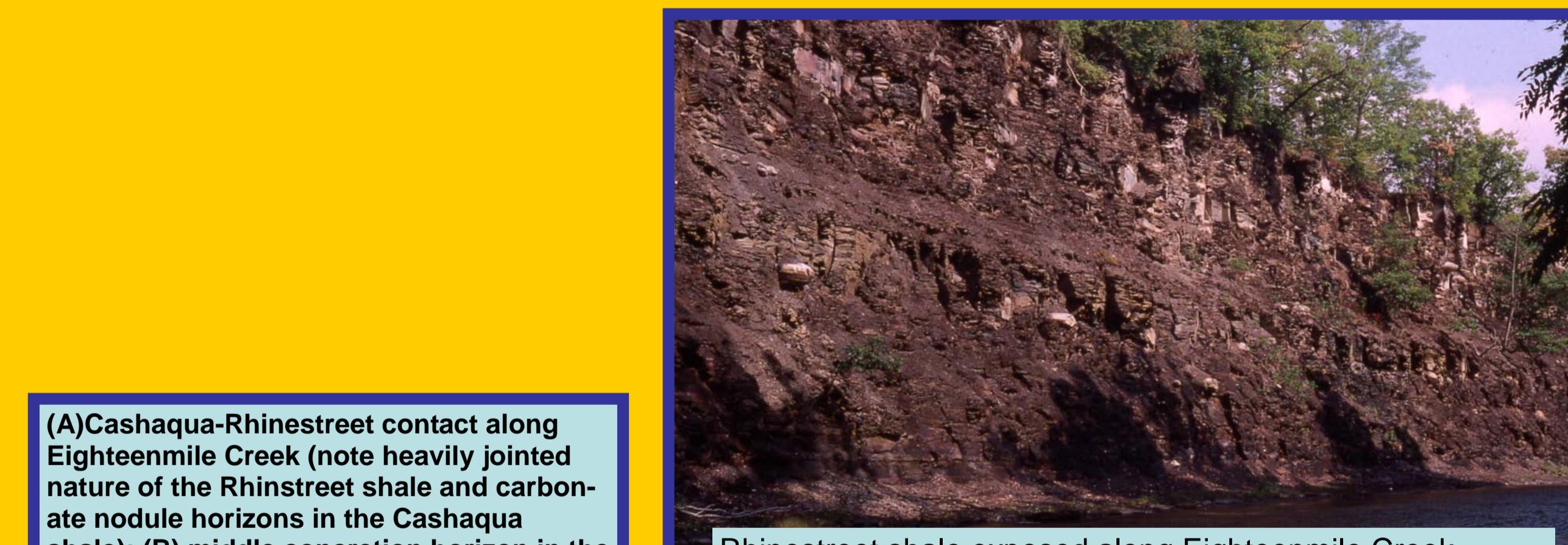
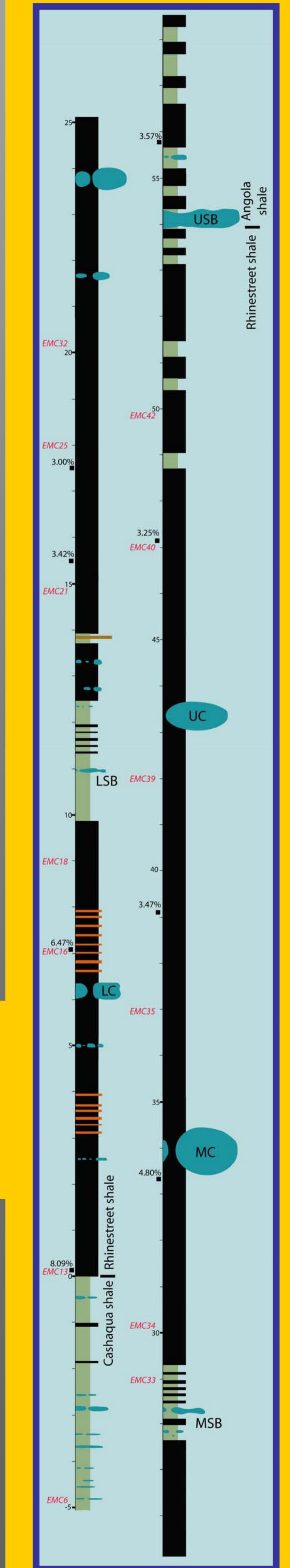


## GENERALIZED STRATIGRAPHY

The Upper Devonian Rhinestreet shale, exposed along the Lake Erie shoreline and vicinity, comprises ~54 m of laminated, heavily jointed organic-rich black shale, infrequent intervals of gray shale, sparse thin siltstone beds, and several carbonate concretion horizons and nodular limestone intervals, the latter termed "scraggy layers" by Luther (1903). The contact of the Rhinestreet and underlying Cashaqua gray shale is abrupt, locally erosional and rather easily recognized in exposure. The upper contact of the Rhinestreet with the overlying Angola gray shale is transitional and marked by an increase in the frequency of gray shale layers. Defining the contact and recognizing it in exposure is difficult at best. Luther (1903) suggested that the contact be placed at an easily recognizable discontinuous nodular limestone bed locally as thick as ~30 cm, what we refer to as the upper scraggy bed, which is accepted here.



## Rhinestreet shale Eighteenmile Creek



(A) Cashaqua-Rhinestreet contact along Eighteenmile Creek (note heavily jointed nature of the Rhinestreet shale and carbonate nodule horizons in the Cashaqua shale); (B) middle concretion horizon in the Rhinestreet shale along Eighteenmile Creek; (C) upper scraggy layer, the arbitrary top of the Rhinestreet shale, on Eighteenmile Creek.

