

Shallow Transgressive Onlap Model for Ordovician and Devonian Organic-Rich Shales, New York State

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Field relations and regional mapping show that organic-rich mudrocks in the Devonian Marcellus to Dunkirk Shales and the Ordovician Utica Shale of New York, which have historically been interpreted to have been deposited in deep anoxic basins greater than 150 meters deep, may in fact have been deposited in relatively shallow water of less than 30 meters (100 feet). These black shales were mainly deposited on the present-day western or cratonward side of the basin, not in the deepest part or at the toe of a prograding clastic wedge as is commonly interpreted. The organic-rich black shales commonly overlie, onlap and pinch out on unconformities, some of which are demonstrably subaerial in origin. Both the Ordovician and Devonian black shales were deposited during periods of high tectonic subsidence driven by thrust-loading to the east. This black shale deposition occurred in the Appalachian Basin while areas to the west were exposed land suggesting relatively low eustatic sea level during deposition. Space was created for the shales more by “basin fall” than eustatic sea level rise and this high differential subsidence may be a key driver in the deposition and preservation of these organic rich sediments.

These observations have led to the development of a new depositional model for black shales in actively subsiding foreland basins. Eustatic sea level is relatively low and there is subaerial exposure on the arches to the west of the basin. Black shale is deposited in relatively shallow water (most likely <30 meters deep) on the western, cratonward flank of the basin. The black shale is most organic rich where it was deposited in the shallowest water far to the west and becomes progressively less organic rich approaching the deepest part of the basin. This is at least in part due to progressively more dilution from clay and silt that are sourced from the highlands to the east but it may be that the longest duration of anoxic conditions occurred in the shallowest water. The deepest part of the basin is the site of turbidite and organic-poor shale deposition, not black shale. Progressively shallower organic-poor marine deposition occurs farther to the east until there is a transition to non-marine siliciclastic fluvial-deltaic deposits. Higher subsidence to the east causes beds, depositional cycles and sequences to thicken eastward and pinch out to the west.