ville clastics, fracture porosity and thick delta front sandstone development combine in the more eastern outcrop belts to increase the potential for a hydrocarbon reservoir in the Clearville siltstone.

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Paleomagnetism of Late Ordovician Neda Iron Ore from Wisconsin and Late Ordovician Queenston Shale from New York

The Neda iron formation is a hematite and goethite-rich oolitic ore which occurs in lens-shaped deposits on top of the Maquoketa Shale at only a few locations in the Wisconsin area. Its origin has been a puzzle for over a hundred years, but there have been suggestions that it is the westernmost extension of the Queenston Shale. Paleomagnetic studies were undertaken to see if paleopole directions from the two formations could aid in determining the origin of the Neda.

Thermal demagnetization of the Neda samples indicates the remanence is carried by hematite. Chemical demagnetization suggests the remanence is produced by the interstitial material rather than the oolites. The paleopole from 25 samples is at S 45.4°, W 48° (α 95 = 16°). This pole position is similar to Late Mississippian to Early Permian of North America rather than Late Ordovician. This suggests that the hematite in the ore was produced from dehydration of goethite during Late Mississippian time.

Queenston Shale samples from western New York were similarly measured. Thermal demagnetization indicates the remanence is carried by hematite and the pole position from 8 samples is at S 45°, W 38° (α 95 = 10°). This pole position is very similar to that of the Neda. This indicates that both formations were presumably subjected to the same post-depositional chemical changes in the late Paleozoic, but it does not conclusively show that the Neda is in fact the western extension of the Queenston. This late Paleozoic pole position has been found in almost all red sediments of Ordovician age in North America, both folded and nonfolded, which suggests that the remanence is not simply due to deformation produced by the Appalachian orogeny.

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A Local Deep Water Basin and Shoreline Model for Middle Devonian Ludlowville Formation of New York

In the Seneca Lake region, both the Ledyard and Wanakah members of the Middle Devonian Ludlowville formation have a black shale facies. This grades westward to a gray shale facies and eastward to a gray shale and siltstone facies. The black shale facies represents an anoxic basin of deeper water than the shallower water gray shale facies to the east and west. The axis of this basin trends northeast-southwest.

The Ludlowville formation from Lake Erie to the Genesee Valley has many thin argillaceous limestone beds, 1 to 4 in. (3 to 10 cm), that are useful for detailed correlation. Because these thin beds can be traced as far as 43 mi (70 km), this part of the outcrop belt probably parallels an ancient east-west shoreline. Between Genesee Valley and Seneca Lake, the inferred shoreline turns to a northeast direction parallel to the axis of the basin, and bedrock exposures display a barren, black shale facies. In these exposures the thin beds disappear. From Seneca Lake to Owasco Lake, the deeper water, black shale facies gives way to shallower water, gray shale facies with thin traceable beds. Because the thin beds disappear in the basin exposures, it becomes difficult to correlate the detailed stratigraphy of the western beds across the basin with the eastern beds. Some correlations have been made using ammonoids. The inferred northeast-trending shoreline may have circumscribed the northern end of this basin, and then turned southward to become part of the southwest-trending shoreline in eastern New York.

This basin first appeared during the deposition of the Early Devonian Helderberg Group and persisted during the deposition of the Middle Devonian Onondaga Limestone and Hamilton Group. Throughout this period, the basin axis shifted from eastern to western New York. This basin has already proven to be of economic importance as a gas producer from the Onondaga reefs that occur on its margin, and may provide other areas of economic importance.

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Brachiopod Community Paleoecology, Paleobiogeography, and Depositional Topography of Devonian Onondaga Limestone in Eastern North America

The lower Middle Devonian Onondaga Limestone was deposited in a northwest-southeast elongated topographic basin and on the surrounding carbonate platform. Two sedimentary cycles are present in the Onondaga. The Edgecliff represents a transgression which spread epeiric seas over much of eastern North America. During the Nedrow-Lucas regression, the interior of the platform became restricted resulting in the deposition of evaporites. The Moorehouse transgression continued through the deposition of the Tioga Bentonite, followed by pre-Speeds-Dundee regression from the craton.

Onondaga brachiopod communities, arranged from nearshore to offshore, include the Atrypid-*Megakozlowskiella*, Atrypid-*Levenea*, Chonetid, *Atlanticocoelia*, Ambocoeliid, and *Truncalosia* communities. The Onondaga-age Eastern Americas Realm is divided into the Appohimchi province in the Appalachian basin and the Michigan basin-Hudson Bay Lowland province in the midwest. The provincial assignment of the James Bay region of Ontario is uncertain; the eastern townships of Quebec are near the boundaries both of the two provinces of the Eastern Americas Realm, and of the Eastern Americas Realm and the Old World Realm.

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Stratigraphic Correlation of Planktonic and Larger Foraminiferal Zones

A very few areas of the sedimentary basins of the world are characterized by marine facies of clastic and non-clastic origin, which are rich in planktonic and larger foraminiferal assemblages. Pakistan is one of the countries where the Tertiary marine deposits (Paleocene to Miocene) are represented by both clastic and non-clastic facies characterized by stratigraphically restricted planktonic and larger foraminiferal species, which provide the basis for the interregional biostratigraphic correlation.

The marine clastic deposits of Paleocene to Miocene age in the Lower Indus and Baluchistan basins of Pakistan are rich in the planktonic assemblages. On the basis of the stratigraphically restricted species, 22 planktonic foraminiferal zones were delineated to mark the stratigraphic boundary of the various European stages (Kureshy, 1977). The non-clastic marine deposits of Paleocene to early Miocene age in the Lower Indus and Upper Indus basins of Pakistan, which are interbedded with clastic deposits, are rich in larger foraminifera. On the basis of the stratigraphically restricted species, ten biostratigraphic zones of the larger foraminifera are designated (Kureshy, 1978).

These assemblages are cosmopolitan in occurrence of identical geological ages. The planktonic foraminiferal zones are more widespread and have close resemblance to the Caribbean region, as compared to larger foraminiferal zones. The larger foraminifera of Pakistan have no resemblance to the Caribbean region; however, they closely resemble Middle East and Indo-Pacific regions. The