UPPER DEVONIAN DELTAIC ENVIRONMENTS

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INTRODUCTION

The Upper Devonian of New York is composed of a lithologically and paleontologically diverse sequence of clastics that have played an historic role in the development of geological thought. Study of these strata resulted in the classical "facies" papers by Chadwick, Caster, Cooper and others in the 1920's and 1930's. In the years since 1940, most work has been concerned with detailed geologic mapping and more precise stratigraphic correlation. These studies have been summarized on the geologic map and Devonian correlation chart of New York State (Broughton and others, 1962; Rickard, 1964).

In New York State, the Upper Devonian marine strata cropout in a generally east-west belt over 200 miles long and extend from Lake Erie on the west to the Catskill Mountains in the east. These strata have been subdivided into seven groups, some of which are marked by thin, persistent black shales that enclose eastward-thickening rock wedges. Within each wedge diverse lithologies and faunas can be recognized and delineated. Moreover, similar lithologic and faunal associations can be recognized in each wedge forming the basis for the facies concept mentioned above. That portion of Rickard's Devonian Correlation Chart (formational and members names omitted) with which this field trip is concerned is shown in figure 1.

In 1965, the writers began an analysis of the Smethport or Chemung facies using both paleontological and sedimentological evidence to reconstruct its paleoenvironments. The initial studies were confined to the Sonyea Group in order to define a set of essentially contemporaneous environments that could be compared with those in modern deltas (Sutton, Bowen, and McAlester, in production). The second or current phase of research has dealt with the post-Sonyea Chemung facies in central and western New York.

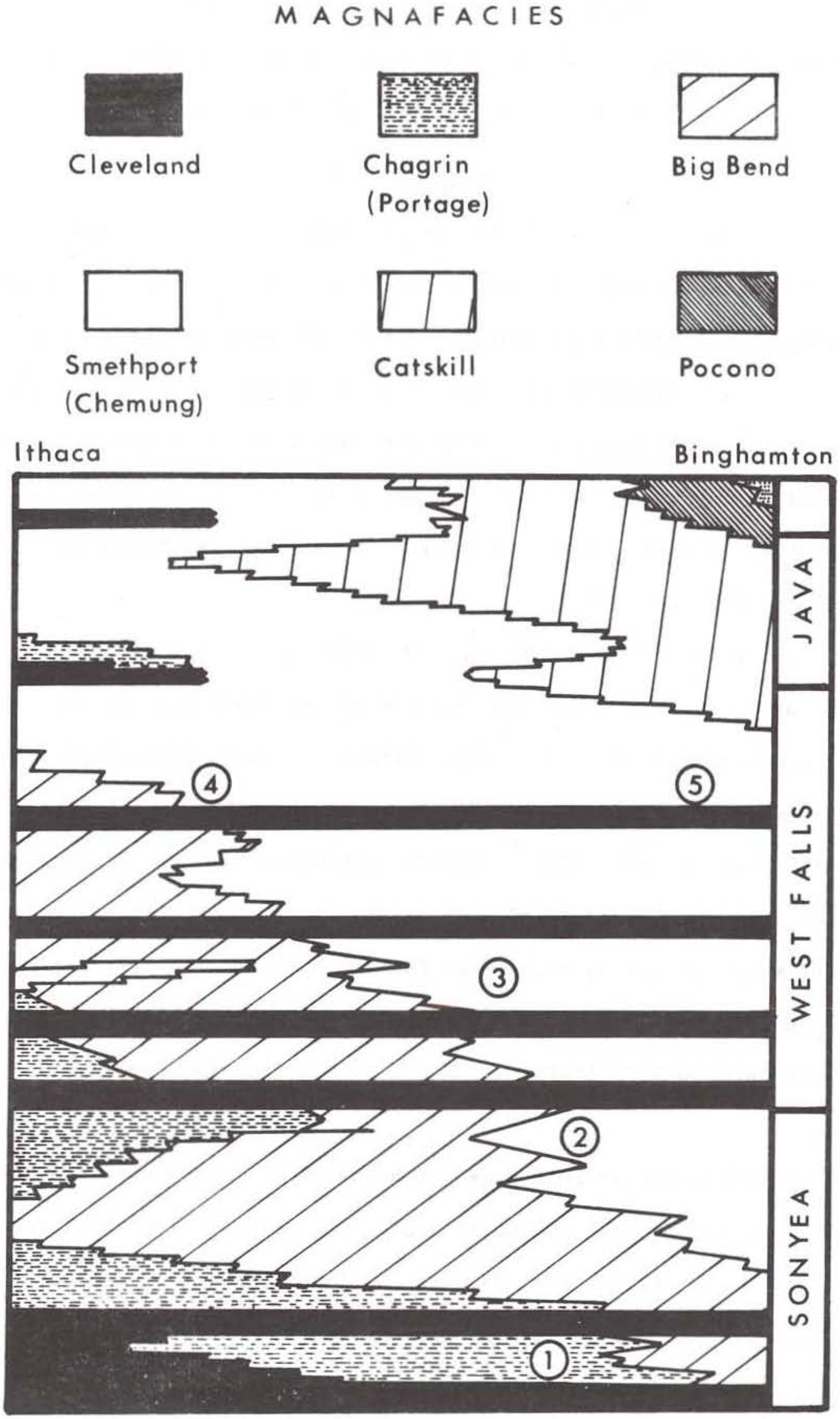

Figure 1. Simplified Correlation Chart of Upper Devonian Showing Major Facies Relationships.

In all, 334 outcrops have been analyzed as to lithology, sedimentary structures and faunal populations. From this analysis the following environments can be recognized: open shelf, prodelta, delta platform, delta front sands, channels, distributary mouth bars, and estuaries. Five outcrops have been chosen for this trip to display some of these environments. The locations of the stops are shown in Fig. 2 and in the diagramatic cross-section of the inferred environments in Fig. 3. A brief description of each environment and its modern analogue is given below. The major features seen at each stop are shown in Table 1.

ENVIRONMENTS

Open Shelf

In modern deltaic settings, the open shelf environment extends from the outer edge of the shelf to the base of the prodelta (Fig. 3). It is a smooth area with a water depth of about 130 feet near the prodelta, sloping gradually to between 240 and 650 feet and 650 feet at the shelf edge. It is slowly supplied with grayish-green silts and clays which are intensely bioturbated and devoid of lamination (Allen, 1964, p. 31).

Upper Devonian rocks interpreted as open shelf deposits consist of interbedded shales and siltstones, the latter marked on their lower surfaces by casts of grooves, tracks, trails and flutes. Internally, the siltstones are cross-laminated, and their tops are marked by current ripples. Shelly benthonic fossils are relatively rare, but burrows, tracks, and trails are abundant. These structures, coupled with the fine grain size of the rocks, suggest slow deposition in relatively deep water. Only clays and silts ordinarily reached this environment where weak currents periodically reworked and sorted the sediments to produce most of the thin beds of silt. More rarely, turbidity currents moving down the prodelta slope deposited coarser-grained silts on the open shelf.

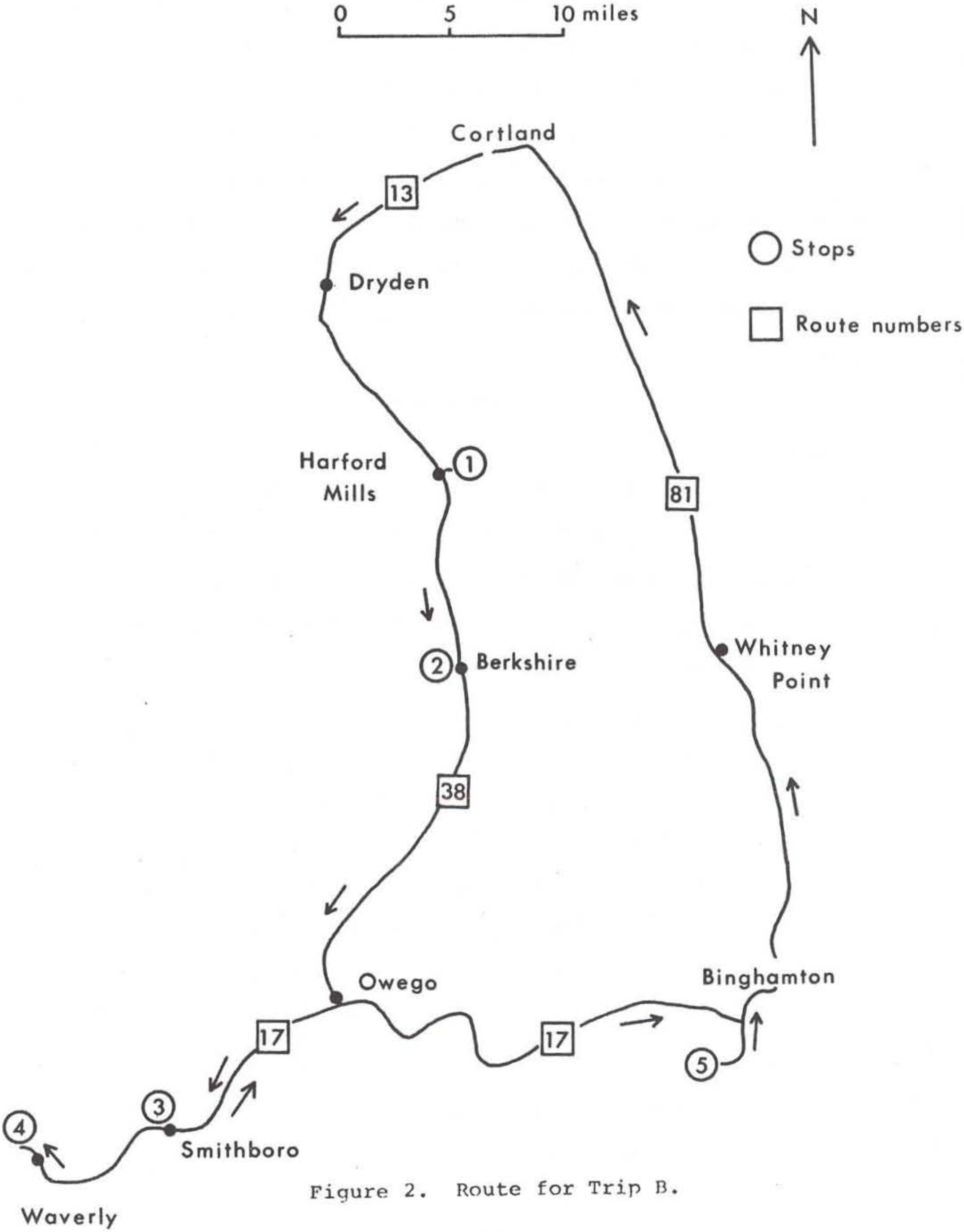

Figure 2. Route for Trip B.

TABLE I MAJOR FEATURES SEEN AT EACH STOP

ENVIRONMENT	LITHOLOGY AND STRUCTURES	PALEONTOLOGY*
1 OPEN SHELF (Harford Mills)	Interbedded gray and dark gray shales, siltstones and mudstones. Small flute casts, groove casts, cross-laminae concretions, tracks and trails	Shelly fossils relatively rare Tracks, trails, burrows (7 taxa found, all rare)
2 PRODELTA (Berkshire)	Mudstone interbedded with siltstone and minor amounts of shale and sandstone. Groove casts, cross-laminations and cuspate ripples	Shelly fossils common Leiorhynchus Chonetes Productella Leptodesma Ambocoelia Tracks, trails and burrows plus 9 other less common taxa
3 PLATFORM (Smithboro)	Mudstone interbedded with sandstone, shale, siltstone, and coquinite. Cross-bedding, laminations, ball and pillow, cuspate ripples, load casts	Shelly fossil abundant Atrypa Cyrtospirifer Productella Crinoids Douvillina Auloporid corals Ambocoelia Cornellites Schuchertella Rugose corals Tylothyris Plant fragments plus 13 other less common taxa
4 DELTA FRONT SANDS (Glory Hill)	Mostly sandstone with small amounts of shale, mudstone, and coquinite. Cross-bedding, cross-laminations, current ripples, parting lineation, mud chips	Large shelly fossils abundant Tracks, trails, and burrows Productella Thiemella Atrypa Nervostrophia(?) Cyrtosperifer Chonetes Tylothyris Crinoids Douvillina Auloporid corals Ambocoelia Plant fragments Rhynchonellids Cornellites plus 8 other less common taxa
5 NEAR SHORE FACIES Channels, Lagoons, and Levees (Ingraham Hill Quarry)	Sandstone and shales with small amounts of shale-pebble conglomerate. Cross-bedding, linguoid ripples, groove casts	Shelly fossils uncommon Plant fragments and tracks, trails, and burrows abundant. plus 18 other less common taxa

*Only most abundant forms listed.

Prodelta

In modern deltas, the prodelta environment extends from the delta front, at the edge of the delta platform, outward to the open shelf, over which the delta progrades (Fig. 3). It is entirely below sea level and is usually covered by 30 to 120 feet of water. Much of the prodelta environment is below the reach of active wave erosion. Sediment supplied to the prodelta comes in plumes of turbid water that spread over the sea above it. The prodelta region typically has a very gentle slope (only 1/4 degree on the Orinoco Delta), a high rate of sediment accumulation, and extensive animal burrowing (Straaten, 1960). In modern Niger Delta the prodelta slopes are covered by thin layers of clayey silt and silty clay with a maximum grain size of very fine sand. The layers are laminated and cross-laminated, with plentiful biogenic sttuctures and shell accumulations (Allen, 1964, p. 31).

Upper Devonian sediments apparently deposited in a prodelta environment are similar to, and intergrade with, those of the open shelf. Like the open shelf sediments, they contain numerous grooves, tracks, trails, cross-laminae, and current ripples. They differ, however, from the open shelf deposits in several respects: the maximum grain size is larger (fine sand instead of silt), many beds are laminated, coquinite shell accumulations are common, and mudstones make up a larger proportion of the lutites. These features indicate the presence of currents sufficiently strong to move fine sand, concentrate shells and form unreworked laminae. Significantly, however, such structures as wave ripples, pillow structures, flute casts, and cross-bedding are extremely rare.

Delta Platform

In modern deltas, the delta platform is a gently inclined, terrace-like structure 5 to 15 miles wide extending from the shore line to the break in slope on the delta front, which normally occurs at water depths between 30 and 60 feet (Fig. 3). It is persistently, but erratically, supplied with suspended silt and clay by flows of turbid water emanating from distributaries. Currents generated by waves and tides are strong enough to move fine sand and coarse silt in the shallower parts of the platform. Near shore, laminated or cross-laminated sands and silts are common. Farther out, the platform may be covered by coarse silt and dark gray clayey silt with finely divided plant debris. Biogenic structures and concentrations of shells are common, particularly on the outer platform. With delta progradation, river sands may build over the platform, where they may ultimately be converted into bars or beaches as a result of wave attack.

Strata deposited on Upper Devonian delta platforms consisted primarily of mudstones and sandstones. Most of the muds, now represented by mudstones, were deposited directly from turbid water and show little or no internal particle orientation. The sands were concentrated through active reworking of the sediments by storm, tidal or wave-produced currents. Cross-bedding, wave and current ripples, groove casts, pillow structures and parallel laminae are common, especially in the coarser sediments. Fossils are abundant and diverse, and coquinite shell accumulations are common, particularly in the outer platform deposits where they occur at the base of reworked sand and silt beds.

Delta Front Sands

Delta front sand deposits in modern deltas are produced by extensive reworking of sediments on the outer parts of the platform by currents and waves. The finer-grained fraction is winnowed out, and the sand accumulates as submerged or partially exposed bars that may be extensive enough to restrict the circulation over the inner platform area behind the bars (Moore, 1966).

Such sand bar deposits are common in the Upper Devonian. They generally show a westward progression up the stratigraphic sequence corresponding to a rapid westward progradation of the Catskill delta. Fossils are abundant and diverse and shell accumulations, now exposed as thin coquinites, lie parallel to the inclined bar surfaces in many of these sands.

Channels

Near-shore channels of modern deltas are filled with coarse detritus interbedded with clay layers. The deposits show several varieties of scour features, trough and planar cross-bedding, load casts, erosional truncation, and clay chip inclusions. Distorted bedding is common due to slumping of the channel walls, or flow in the channel bottom. The sediments are usually poorly sorted, with parallel and cross-laminations undisturbed by organic influences. They may contain remains of marine, brackish and fresh-water faunas (Coleman and others, 1964; Moore, 1966; Straaten, 1960).

Upper Devonian rocks interpreted as channel deposits contain all of the features described above, and are distinguished from the bar sands at the mouths of distributaries by large-scale slump structures, particularly where the channel sands overlie marsh or estuarine deposits. They are coarse-grained poorly sorted and contain mud chips. Shell accumulations are abundant in some of these sands, but the fauna is low in diversity.

Estuaries

Estuaries are partially restricted arms of the sea in which dilution by fresh water lowers the salinity from that of normal sea water. Modern estuarine deposits are commonly dark gray, clayey silts, interbedded with plant debris, clean silts, and thin beds of very fine-to-coarse sands. Thicker sands are restricted to submarine channels. Parallel and cross-laminations, and biogenic structures may be present. Faunal remains include autochthonous brackish-water species, and allochthonous marine species that have been brought in by storms (Allen, 1964; Straaten, 1960).

Upper Devonian estuarine deposits consist of laminated, dark gray, silvery, arenaceous shales interbedded with widely spaced, thin, cross-laminated, and rippled siltstones. Some of the siltstones contain appreciable quantities of poorly preserved fossil debris and current structures showing an easterly current trend, suggesting that the material was swept in from the platform to the west. Thick beds of sandstone with pillow structures and load casts, representing sites of channel development are often associated with the estuarine deposits. Shelly fossils are uncommon but diverse including marine and non-marine forms. Tracks, trails, and burrows are abundant.

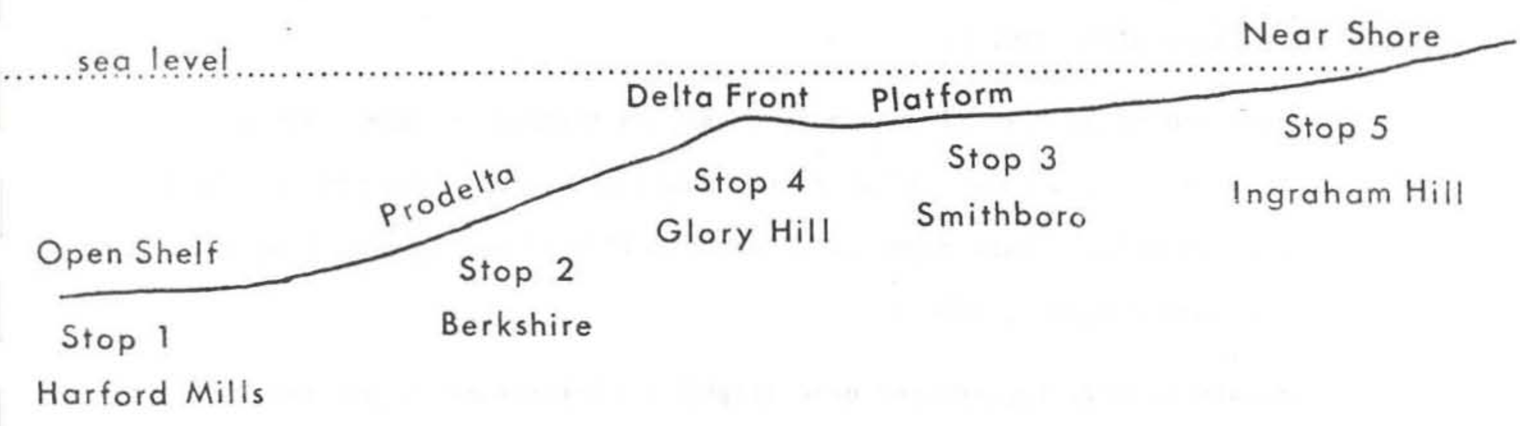

Figure 3. Cross Section of Inferred Sedimentary Environments.

FIELD TRIP ROUTE DESCRIPTION

Start - Holiday Inn, Cortland.

Travel south on New York Route 13 to Dryden (11.8 miles). From Dryden, proceed south on N.Y. 38 to Harford Mills (7.8 miles). Turn left (east) on N.Y. 200 and continue to Griggs Gulf Road (0.6 mile). Turn right. Proceed (0.6 mile) to STOP 1.

Return to N.Y. 38 and continue south to Berkshire (8.4 miles). Turn right (west) on Glen Road and proceed less than 0.5 mile to outcrops of STOP 2.

Return to N.Y. 38 and continue south to Owego (about 16 miles). Follow N.Y. 17 west from Owego to the west side of Smithboro (10.9 miles) for STOP 3.

Continue west on N.Y. 17 past Waverly to O'Brien's Restaurant (11.5 miles) on Glory Hill, STOP 4.

Turn around on N.Y. 17 and proceed east to Binghamton (approximately 41 miles). Leave N.Y. 17 at Pennsylvania Avenue exit and proceed south for 2.5 miles. Turn right on Ingraham Hill Road and proceed 1 mile to Corbisello Quarry, STOP 5.

Return to N.Y. 17, proceed east (right) to Interstate 81 and return to Cortland (approximately 40 miles).

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FIGURE CAPTIONS

Fig. 1 Field trip stops shown on Upper Devonian correlation chart. Chart and magnafacies boundaries modified after Rickard (1964).

Fig. 2 Route map showing stops.

Fig. 3 Cross-section of inferred sedimentary environments.