MIDDLE SILURIAN CLINTON RELATIONSHIPS OF WESTERN NEW YORK AND ONTARIO

William J. Kilgour
Sanborn, N. Y.

The Middle Silurian rocks of Western New York and the Ontario Peninsula are assigned to the Clinton and Lockport Groups and include the Neahga, Reynales, Irondequoit, Rochester, Decew, and Lockport Formations. Only the Lower Clinton Neahga and Reynales Formations and the Upper Clintron Irondequoit Formation will be covered in this discussion. Relationship of the various units is outlined in Fig. 1.

NEAHGA FORMATION

In the area under consideration the Neahga Shale represents the initial deposit of the lower Clinton sea as it re-invaded the area and the eastern strand line transgressed from west to east. The Neahga Shale (Sanford, 1935, p. 170-174) at the type locality in the Niagara Gorge is a soft slightly silty, calcareous gray to green shale 6' thick with the lowest 8" to 12" being harder, more arenaceous and more calcareous than the balance.

The Neahga has not been recognized east of Hickory Corners, N. Y. where it is 4' to 5' thick. To the west it is traced through outcrops at Budd Road, N. Y., Indian Hill, south of Model City, N. Y., and the Niagara Gorge to St. Catharines where it is about 2' thick.

The contact of the Neahga Shale with the underlying Grimsby Sandstone in the area north-west of Lockport, N. Y. is sharp and marked by a thin layer of large rounded pebbles of dark gray, dense dolomite, shale fragments, and an abrupt change in fauna. Where the Neahga is underlain by the Thorold, the contact is easily distinguished although the lower 8"-12" of the Neahga are usually harder and more arenaceous than the balance.

The upper contact is easily drawn whether it is with the overlying Hickory Corners Member or the Merritton Member of the Reynales Formation. Where overlain by the Hickory Corners Member the contact is sharp and abrupt, being marked by a think 3"-6" limestone layer with abundant shale pellets and phosphate nodules in the base of the Hickory Corners. There is no evidence of disconformity where the Neahga is overlain by the Hickory Corners. In the area of Merritton and Thorold, Ontario, however, where the Neahga is overlain by the Merritton Member, large rounded and flattened pebbles of dark gray crystalline limestone have been found in the Neahga Shale which has been reworked in this area. These are considered to have been derived from the Hickory Corners Limestone which is not present here. Thus there is evidence of an hiatus of undetermined magnitude between the Neahga Shale and the Merritton Limestone in the area of Merritton and Thorold, Ontario but to the east there is no such evidence at the contact of the Neahga and Hickory Corners.

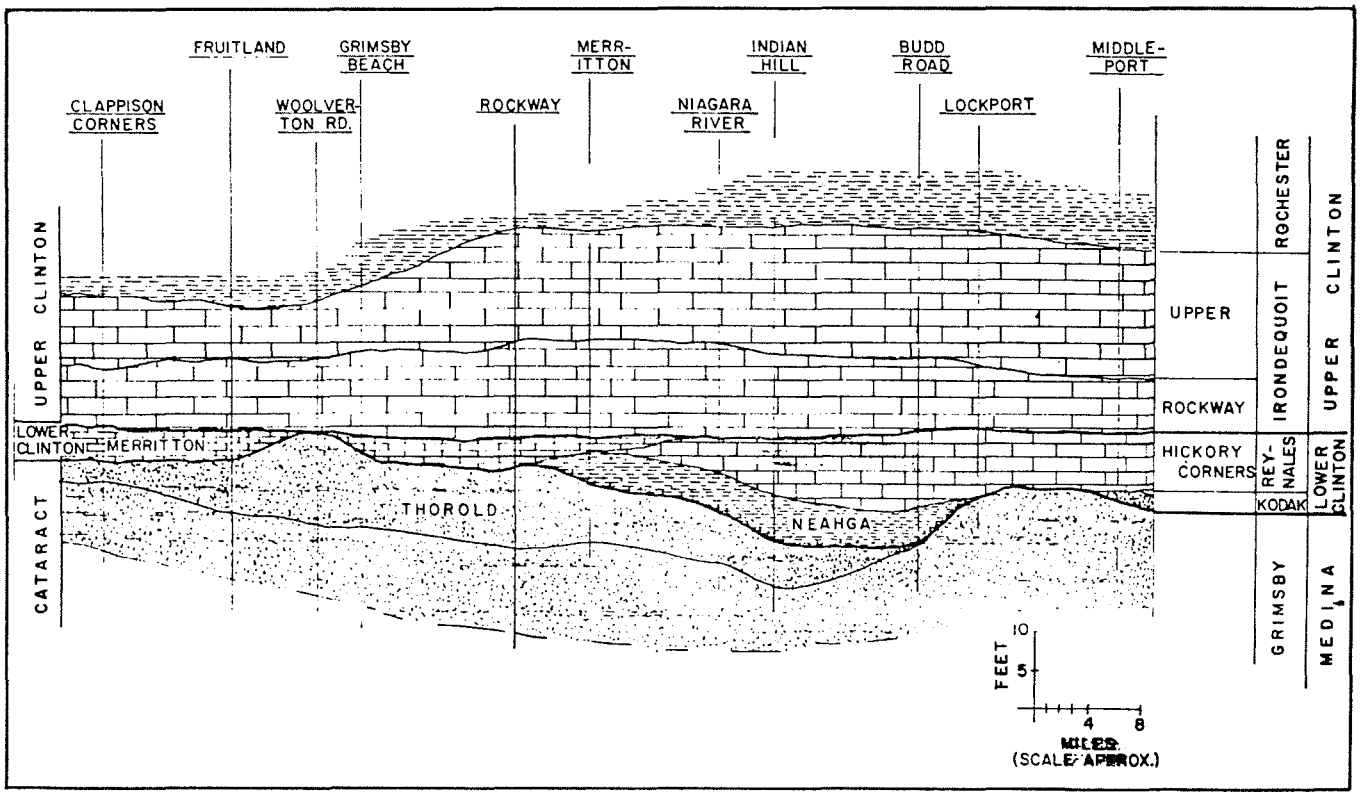

Figure 1. Restored stratigraphic cross-section of Lower Clinton units in western New York and the Niagara Peninsula of Ontario Datum is the Hickory Corners-Rockway contact.

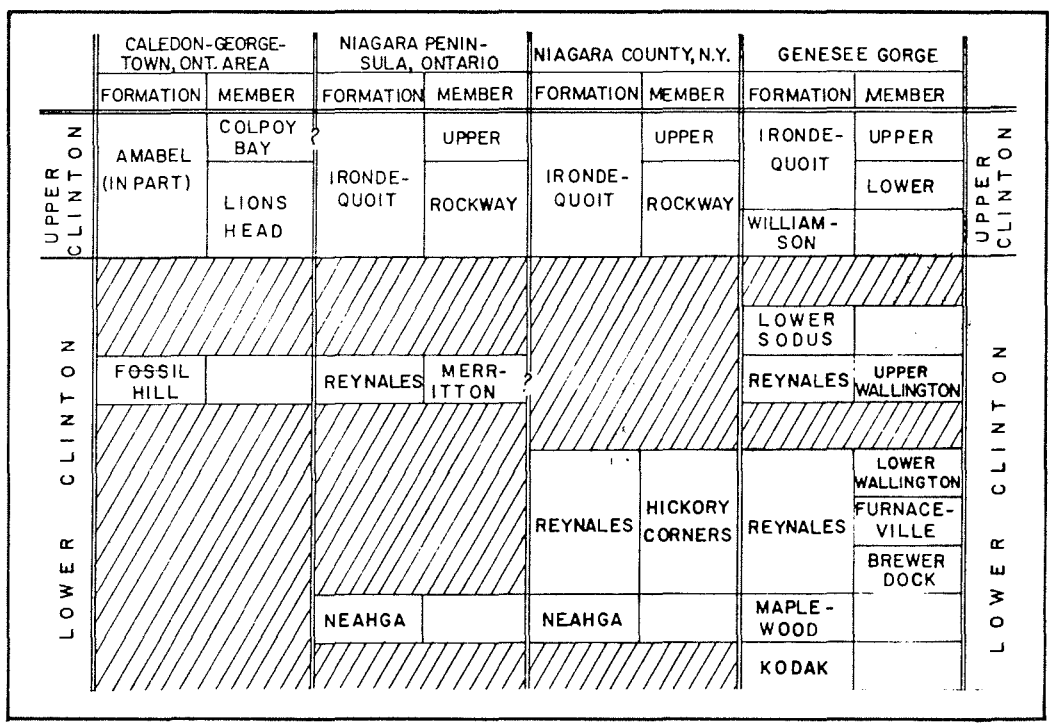

Figure 2. Suggested correlation with other areas.

Fossils are not uncommon in the Neahga but are usually poorly preserved. Fisher (1953) described a unique brown algal microflora and also reported *Hyattidina congesta* in the dolomitic beds at the base of the formation at Hickory Corners, N. Y. This occurence has been confirmed and *Hyattidina congesta* has also been found at this same horizon at Budd Road and Merritton, Ontario. Gillette (1947, p. 21) and Fisher (1953, p. 34) report the ostracode *Zygobolba curta* from this formation. Rare specimens of poorly preserved *Zygobolba sp.* have been found in the Neahga of the Niagara Gorge by the writer.

The absence of the Neahga to the east in the Lockport area is considered due to a local pinching out and non-deposition; to the west of St. Catharines its absence is due to reworking and removal. Deposition of the Neahga Shale was followed by that of the Hickory Corners Limestone with no marked break between the two.

REYNALES FORMATION

The Reynales Limestone was named by Chadwick (1918, p. 344-345). As restricted and re-defined in the area between Medina, New York and Clappison's Corner, Ontario by the writer (1963, p. 1133-1137) it consists of (2) lithologic and faunal units, the Hickory Corners and Merritton Limestone Members.

HICKORY CORNERS LIMESTONE MEMBER

This name was introduced by the writer (1963) and applied to the coarse to medium crystalline, argillaceous, highly siliceous, fossiliferous limestone which occurs at Budd Road 1.4 miles west of Hickory Corners, N. Y. between the Neahga Shale and the Iron dequoit Limestone. It is assigned to the Lower Clinton Group.

The Hickory Corners Member is a thin-bedded, dark-gray, bioclastic, argillaceous limestone with fossils throughout but more abundant and more easily obtained in the shale breaks of the lower more coarsely crystalline portion. A 2-4 inch layer containing phosphate nodules and shale inclusions occurs at the base wherever this horizon is exposed. Chert layers and siliceous streaks are abundant and are a distinctive element throughout the member.

The Hickory Corners has been recognized as far east as the Genesee gorge, but it is felt best to use names already in use in the Genesee area when referring to this part of the Reynales Formation. In this area, the lower part includes a representative of the Furnaceville Iron Ore with the part below the ore named the Brewer Dock Limestone by Sanford (1935). This name should be used only where the Brewer Dock is separated from the overlying limestone by the Furnaceville. The upper limit of the Hickory Corners equivalent in the Rochester area occurs within Fisher's (1960) Wallington and is drawn by the writer at the base of a pronounced conglomerate associated with a "crowded" Pentamerus layer 12-15 feet above the Furnaceville. The Hickory Corners equivalent in the Rochester area thus

consists of the Brewer Dock, the Furnaceville, and the lower part of Fisher's Wallington with the upper contact being marked by the conglomerate in the base of the overlying upper part of the Wallington.

At Middleport, New York, along Johnson Creek the unit is 8 feet thick and highly siliceous and fossiliferous. At Niagara Gorge it is 4.25 feet thick. At Thorold, Ontario, the Hickory Corners Member is absent, but large worn and rounded pebbles of chert and dark dolomitic limestone occur at the base of the Merritton Limestone Member and in the re-worked Neahga Shale. At Rockway, Ontario, 6.5 miles west of Thorold, the Hickory Corners Member and the Neahga Shale are absent owing to erosion prior to deposition of the Merritton Limestone; the Thorold Sandstone is overlain directly by dense, gray Merritton beds, with a few inches of gray to dark, hard shale occurring at the contact.

Chert pebbles occurring at the base of the Merritton Limestone as far west as Grimsby Beach Road are probably derived from the Hickory Corners Limestone which probably once extended at least that far west.

The Hickory Corners Member is underlain by the Neahga Shale except in the Lockport area where both the Neahga Shale and Thorold Sandstone are absent and the Hickory Corners Limestone is in direct contact with the Grimsby Sandstone. The contact between the Hickory Corners Limestone and the Neahga Shale is sharp but conformable and marked by a thin, coarsely crystalline, limestone layer containing black phosphate nodules and green to black shale inclusions. The Hickory Corners Limestone is absent at Thorold, Ontario, but large worn pebbles of dark limestone similar to the Hickory Corners Limestone and associated with phosphate pebbles occur here throughout the reworked basal Neahga Shale remnant. Large rounded and worn pebbles of chert probably derived from the Hickory Corners Member are also found at the base of the Merritton Limestone in this area as well as at several other localities to the west.

The upper contact of the Hickory Corners Limestone Member is easily drawn at all localitites where exposed. Evidence of disconformable relations between this unit and the overlying beds is noted at most localities.

In the Genesee gorge the Hickory Corners equivalent is overlain by a pronounced conglomerate associated with *Pentamerus* 15-18 feet above the Maplewood Shale. The same conglomerate has been observed on Salmon Creek, Town of Ogden, where it also is associated with *Pentamerus*.

At Budd Road the member is separated from the overlying dolomite by a foot of soft, crumbly, brown shale containing a few large, weathered, dark-colored, limestone pebbles, some of which contain pyrite and *Hyattidina* and which resemble the underlying limestone. The change from the dark, crystalline, fossiliferous Hickory Corners Limestone to the soft, brown, unfossiliferous, overlying shale is abrupt. This relationship between the Hickory Corners Limestone and the overlying unit is observed in varying degree at many localitites west of Salmon Creek.

The Hickory Corners Limestone Member is highly fossiliferous at most localities, with bryozoans and brachiopods generally the most common forms found. *Hyattidina congesta* is found at most localities but is uncommon west of Indian Hill (3.5 miles east of Lewiston) in New York. Poorly preserved ostracodes of the genus *Zygobolba* are the only ostracodes found, and these only rarely in this member. Rexroad and Rickard (1965, p. 1217) have reported the presence of typical *celloni* zone conodonts in the Hickory Corners Member.

Although the contact of the Hickory Corners Member and the overlying Merritton Member has not been observed, the Hickory Corners is considered older on the basis of physical evidence. In Western New York, deposition was continuous throughout Neahga and Hickory Corners time. In Ontario, however, it is concluded that the Hickory Corners was deposited but that it and part of the Neahga were removed prior to deposition of the Merritton Member.

The Hickory Corners Limestone Member was deposited over a wide area in the same eastwardly transgressive Lower Clinton sea as the Neahga Shale. As time passed, the sediments which were deposited became less argillaceous, and conditions were more conducive to the development of a marine fauna. The broken and worn nature of the fossils attest to shallow, rough-water conditions. Hickory Corners deposition was closed with continued migration of the eastern strand line to the east and with the western strand line also moving eastward into the area. This resulted in the removal of the Hickory Corners Limestone to the west of the Niagara River and the exposure of the Thorold Sandstone and Neahga Shale prior to deposition of the overlying beds. Thinning and disappearance of the Hickory Corners unit to the west is thus attributed to a relatively greater uplift than to the east. Migration of the strand lines, and the center of deposition, is presently thought due to a change in the relative location and elevation of the Cataract shelf. The Furnaceville Iron Ore was deposited as a stringer within or at the base of the Hickory Corners equivalent in the Genesee area and was closely connected with strand line movements in this area during deposition of the Hickory Corners to the west.

MERRITTON LIMESTONE MEMBER

The Merritton Limestone Member as named and defined by the writer (1963) is a buff to gray limestone at its type locality in the railroad cut west of lock 5 on the Welland Canal near Merritton, Ontario. It is assigned questionably to the Lower Clinton Group.

The Merritton Limestone Member is a medium crystalline, buff weathering, gray to buff argillaceous limestone. It is thin-bedded with thin shale partings being relatively common. Considerable glauconite and pyrite are included in it, although they vary at different localities. The basal 6-inch bed is for the most part very dense and fine-grained and carries black phosphatic sand grains, glauconite, and flat, worn chert pebbles at most localities.

The member is not known east of Thorold, Ontario. It can be traced westward by outcrops from Thorold to Georgetown, Ontario. At Thorold the unit is 2 feet thick. The maximum thickness of 3.5 feet is at Rockway, Ontario, and at Clappison's Corners it is 2 feet thick. It is absent at the Woolverton Road cut west of Grimsby, Ontario, where the road cuts the cuesta and is also absent in the railroad cut at Limehouse, Ontario, northwest of Hamilton, Ontario.

Although the Merritton Member is lithologically distinct, it is very thin. Chert pebbles probably derived from the older Hickory Corners member, are found at the base of the unit at several localities between Thorold and Grimsby Beach Road. This, together with its overlap on the underlying Neahga Shale, Thoroid Sandstone, and Cabot Head Shale, its absence at several localities, and the introduction of a new fauna with no intermingling, indicates a considerable gap in the record.

The disconformity at the top of the Merritton Limestone is not as marked as that at the base. It is marked by large worn pebbles, abrupt change in fauna, and an abrupt change in lithology to a brown shale which grades upward into the brown to buff Rockway Dolomite. The top surface of the Merritton is exposed over a considerable area in the vicinity of Merritton and is very rough, irregular, phosphatic, and lithologically distinct from the overlying unit.

The fauna of the Merritton Member is characterized by an abundance of *Pentameroides* (*Pentamerus*, as identified by previous investigators), and it is primarily on the occurrence of this brachiopod that the Reynales of Ontario has previously been correlated with the Reynales of western New York. At several localitites, particularly at Thorold, corals are also common and form an important part of the fauna.

Schuchert (in Williams, 1919, p. 49) believed that the Clinton form of *Pentamerus* is distinct from the younger "Lockport" occurrences to the north. In this connection, Dr. A. J. Boucot has identified as *Pentameroides* representative specimens of supposed *Pentamerus* collected by the writer from several Ontario localitites (personal communication, 1962). It is likely that past references to the occurence of *Pentamerus* in the Reynales of this area have been in error. In the more northerly areas and along the Bruce Peninsula, all specimens collected to date have been identified as *Pentamerus*, no specimens of *Pentameroides* having been observed although extensive collections have been made. The writer has found no ostracodes in the Merritton Member.

The Merritton Limestone was deposited on the eroded Thorold-Neahga-Hickory Corners surface in a relatively clear and shallow sea covering the entire area. Following its deposition the sea withdrew to the west and a period of reworking and erosion followed so that only a thin Merritton remnant remains today in Ontario as evidence of its former extent. East of Thorold it was removed (if ever deposited).

The Merritton probably represents some part of the Fossil Hill Formation of the more northerly areas. The Merritton Member disappears east of Throld, and its correlation with units in the Genesee area is conjectural on the basis of present knowledge. Lithology and

stratigraphic relationships appear to favor a correlation with the "crowded" *Pentamerus* beds which in the Genesee area form the upper 4-5 feet of the Wallington Formation as defined by Fisher (1960). However, the presence of *Pentameroides* in the Merritton raises the distince possibility that the Merritton is post-Wallington in age since in both the Central States and the Michigan basin *Pentameroides* occurs above *Pentamerus*. Until further evidence bearing on the problem becomes available it is referred questionably to the Lower Clinton.

IRONDEQUOIT LIMESTONE

The upper, more dolomitic, and sparingly fossiliferous part of the Reynales Formation (of previous investigators) is removed and included in the Irondequoit Limestone as a result of the present investigation. Thus, the Upper Clinton Irondequoit is made up of a lower dolomitic limestone, herein named the Rockway Dolomite Member, and an upper limestone member.

ROCKWAY DOLOMITE MEMBER

The name Rockway Dolomite Member of the Irondequoit Limestone (Kilgour, 1963) is applied to the 12 feet of buff to brown and gray dolomite which occurs in Fifteen Mile Creek at Rockway, Ontario, between the Merritton Limestone Member below and the upper part of the Irondequoit Limestone above. It has been considered the upper sparsely fossiliferous, more dolomitic part of the Reynales Formation by previous investigators.

The Rockway Dolomite is a dense to compact, fine-grained, buff to gray dolomite which weathers buff. The unit is for the most part massive with a few gray shale breaks throughout. Three to fifteen inches of blocky brown shale is found at the base of the unit. At most localities a 3-12 inch dolomitic limestone bed occurs at the top of the member overlying a thin, gray to brown shale. The upper contact of this bed with the more coarsely crystalline overlying upper Irondequoit marks the upper limit of the Rockway Member. Close examination is usually required to ascertain this contact, since it frequently occurs in what appears to be a physically unbroken sequence and may thus be quite indistinct. It has in fact been misplaced by Williams (1919) and Bolton (1957).

The Rockway Dolomite Member disconformably overlies the Hickory Corners Limestone, and the Cabot Head Shale.

Evidence that the contact of the Rockway Member with the underlying beds is disconformable is best noted at Budd Road, Niagara Gorge, and Merritton, and has already been discussed in connection with the upper contacts of the Hickory Corners and Merritton Members of the Reynales Formation.

Previous investigators have considered the upper contact of the Rockway Member with the overlying upper part of the Irondequoit Limestone to be disconformable and to represent the entire interval of the

Middle Clinton, although there is no physical evidence of such an important disconformity in the Niagara County and Ontario Peninsula area. In fact, there is stronger physical evidence of a disconformity at the base of the Rockway Dolomite Member, and it is for this reason that it is included in the Irondequoit Limestone as the western equivalent of the sparsely fossiliferous, more dolomitic facies of the lower part of the Irondequoit Limestone as it occurs in the Rochester area.

During Rockway time there was a reduced influence of the Cataract shelf. The Rockway Dolomite was deposited during a time of relatively steady and constant conditions as indicated by its uniformity and continuity over a wide area. It represents a facies of the lower part of the Irondequoit of the Genesee area where an increased amount of shaly interbeds indicates a greater terrestrial influence than to the west where the Rockway was being deposited.

The only fossil usually found in the Rockway Dolomite is the large brachiopod *Constistricklandia canadensis* which has not been noted in association with *Pentameroides*. Bolton (1957, p. 83) has reported *Costistricklandia* from the lower 11 inches of the Irondequoit as he originally recognized it at Decew Falls, Ontario. He has since (personal communication, 1962) removed these beds from his Irondequoit and considers them a part of the Rockway Member as it is defined in this paper.

No ostracodes have been found in the Rockway Member by the writer. Rexroad and Rickard have recently (1965, p. 1219) reported the occurrence of abundant specimens of *Pterospathodus amorphognathoides* Walliser and *Ozarkodina gaertneri* Walliser, the chief guide species for Walliser's *Amorphognathoides* - zone, in the Rockway Member of the Niagara Gorge, as well as numerous other species characteristic of this zone.

CORRELATION

A suggested correlation of the Clinton units between the Genesee and Caledon areas is given (Fig. 2). Since any effort to correlate the Clinton units defined in this paper is complicated by either the lack of a fauna or by the varying distribution of certain faunas, this correlation is based largely on stratigraphic and lithologic criteria with secondary reliance on faunal evidence.

Clinton ostracodes of zonal importance in the area west of the Genesee gorge occur rarely. The only ostracodes reported by others (Gillette, 1947; Fisher, 1953) or found by the writer are poorly preserved specimens of *Zygobolba* which occur only rarely in the Neahga Shale and Hickory Corners Limestone. No ostracodes have been found as yet in the Merritton or Rockway members. Because of this situation it is presently impossible to correlate on the basis of the ostracode zones established by Gillette (1947, p. 22).

SUMMARY

The restored cross section (Fig. 1) summarizes the writer's concept of Lower Clinton relationships in the western New York - Ontario area. The Lower Clinton Group includes the units between the Thorold Sandstone below and Irondequoit Limestone above. The Lower Clinton Reynales Limestone includes two lithologic (and faunal) units--the Hickory Corners and Merritton limestone members. The Rockway Dolomite is included in the Upper Clinton Irondequoit Formation as its lower member. The Hickory Corners, Merritton, and Rockway units are separated by disconformities, the magnitude of which varies from one locality to another. As a result, the distribution of the individual units is discontinuous with one or more of them missing at most localities.

No intermingling of the faunas of the three carbonate units occurs; they are distinctive and easily recognized. The older fauna is restricted to the Neahga Shale and Hickory Corners Limestone and is characterized by abundant specimens of *Hyattidina congesta* in association with other brachiopods including *Eocoelia*. Bryozoa are exceedingly common in the Hickory Corners Member. The second and younger association is characterized by an abundance of the brachiopod reported previously as *Pentamerus* but now identified as *Pentameroides*. With corals, this association is restricted to the Merritton Limestone Member.

The youngest "association" is the occurrence of *Costistricklandia canadensis* in the Rockway Dolomite. This is the only fossil commonly found by the writer and only in the area between Thorold and Mount Albion, Ontario.

With these refinements in the nomenclature and definition of the Reynales Formation, the Lower Clinton Group between Medina, New York, and Clappison's Corners, Ontario, consists of shale and limestone units which are genetically related by deposition during a time of widespread and frequent depositional changes. These changes were caused by strand line fluctuations connected with frequenct shifts in the location and elevation of the Cataract shelf to the north and west. Because of low relief in the general area, relatively minor changes had widespread affect. The change from a relatively thick sequence of sandstone and sandy shale of the Medina to the limestone and shale of the Lower Clinton marked the beginning of the controlling effect of the Cataract shelf in this area. Its effect was apparent earlier and farther south than has been previously postulated.

The striking differences between the Lower Clinton Group of western New York, and the Niagara Peninsula of Ontario are the result of frequent diastrophic changes rather than facies changes. Physical evidence, which when considered collectively offers strong support for this interpretation, includes abrupt vertical and lateral changes in lithology and fauna, absence or overlap of units, and the occurrence of thin conglomerates. The absence of the Thorold Sandstone in the Lockport area and differences in the relationship of the Neahga Shale with the overlying unit depending on whether it is the Hickory Corners or Merritton Limestone are most noticeable.

REFERENCES CITED

Armstrong, H. S., 1953, Geology of part of the Niagara Peninsula of Ontario: Geol. Soc. America, Guidebook Toronto Field Trip, nos. 4-5, 20 p.

Bolton, T. E., 1964, Pre-Guelph, Silurian Formations of the Niagara Peninsula, Ontario: American Association of Petroleum Geologists, Guidebook Geology of Central Ontario.

Bolton, T. E., 1957, Silurian stratigraphy and paleontology of the Niagara escarpment in Ontario: Geol. Survey Canada Mem. 289, 145 p.

Chadwick, G. H., 1918, Stratigraphy of the New York Clinton: Geol. Soc. America Bull., v. 29, p. 327-368.

Fisher, D. W., 1953, Additions to the stratigraphy and paleontology of the Lower Clinton of western New York: Buffalo Soc. Nat. Sci. Bull., v. 21, no. 2, p. 26-38.

_____, 1960, Correlation of the Silurian rocks in New York State: N. Y. State Mus. Sci. Service, N. Y. Geol. Survey, Map and chart ser., no. 1.

Kilgour, 1963, Lower Clinton Relationships, Western New York and Ontario: Geol. Soc. America Bull., v. 74, p. 1127-1142.

Kindle, E. M., and Taylor, F. S., 1913, Description of the Niagara quadrangle: U. S. Geol. Survey, Atlas Niagara Folio 190, 25 p.

Rexroad, C. B. and Rickard, L. V., 1965, Zonal Conodonts from the Silurian strata of the Niagara Gorge: Geol. Soc. America, Bull., v. 39, p. 1217-1220.

Sanford, J. T., 1935, The Clinton in Western New York: Jour. Geology, v. 43, p. 167-183.

Schuchert, C., 1914, Medina and Cataract formations of the Siluric in Ontario and New York: Geol. Soc. America Bull., 25, p. 277-320.

Williams, N. Y., 1919, The Silurian geology and faunas of Ontario Peninsula and Manitoulin and adjacent islands: Geol. Survey Canada Mem. 111, 195 p.