# UPPER SILURIAN CAYUGAN SERIES, NIAGARA FRONTIER, NEW YORK*

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## Introduction

During the Late Silurian, 410 million years ago, that portion of New York State west of the Hudson River and south of Lake Ontario and the Mohawk River was the site of a shallow sea whose connection with the ocean was restricted by reefs and adjacent lands. The presumably arid climate of that time caused rapid evaporation of the restricted sea and the precipitation of dolomite, anhydrite and halite as the salinity of the water was increased. Red and green shales, thin siltstones and occasional black shales were also deposited. These poorly fossiliferous rocks now comprise the Upper Silurian Cayugan Series of New York.

The Cayugan Series of the Niagara Frontier (Niagara, Erie, Orleans and Genesee Counties) contains five formations given in the list below. Thicknesses quoted are those determined for the vicinity of Buffalo. This series overlies the Oak Orchard Member of the Lockport Group ("Middle" Silurian) and is disconformably overlain by the Edgecliff Member of the Onondaga Limestone (Middle Devonian).

Late Silurian, Cayugan Series
- Akron Dolomite, 8 feet
- Bertie Formation, 45 feet
  - Williamsville Member, 7 feet
  - Scajaquada Member, 8 feet
  - Falkirk Member, 30 feet
- Camillus (O-atka) Shale, 100 feet
- Syracuse Formation, 100 feet
- Vernon Shale, 200 feet

} Salina Group, 400 feet

Owing to the unconformable nature of the upper contact, the Edgecliff limestone may rest upon the Akron Dolomite or any of the members of the Bertie Formation at various exposures along the outcrop east of Buffalo.+

Although the Cayugan Series of the Niagara Frontier is 400-700 feet thick, less than 100 feet at the top are exposed in surface outcrops. Consequently, not much is known of the lithology, paleontology, and

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+ The author did not have access to the report by Oliver (this book) hence the omission of the Bois Blanc (editor's note)

stratigraphy of this series in western New York. In an effort to discover some of the more important features of the Cayugan Series in this area, the writer turned to the available subsurface information derived from sample logs and radioactivity logs of wells drilled for natural gas in western New York. This has proved to be a very productive investigation.

The results of this investigation, which has been expanded to include Cayugan rocks throughout New York, northern Pennsylvania, and northeastern Ohio, will be given in another report upon completion of the study. However, it can be stated here that the major results will include: (1) recognition and correlation in the subsurface of Cayugan rock units originally defined on poor and incomplete surface outcrops, (2) an accurate and detailed description of the distribution of evaporites - halite and anhydrite - in these rocks and (3) correlation of the Cayugan rocks of New York with those of Pennsylvania, Ohio and Michigan. At present, it appears that individual salt beds can be recognized and traced in the subsurface and that the Cayugan subdivisions "A" through "H", delineated by Landes (1945), Evans (1950), and Ells (1962) for the Michigan basin and by Ulteig (1964) for northeastern Ohio, can be recognized in New York and Pennsylvania.

## Salina Group

The term Salina (Dana, 1863) has had various applications in the past but in recent years has generally been applied to post-Lockport and pre-Bertie rocks. In New York it contains three formations, Vernon, Syracuse and Camillus, and is approximately 900 feet thick in Onondaga County, the type area. In the Buffalo region it is about 400 feet thick but in southcentral New York the group exceeds 2000 feet in thickness. Studies now in progress indicate that this increase is due almost entirely to the introduction of thick salt beds in the center of the Salina basin.

## Vernon Shale

In its type area, Oneida County, the Vernon Shale (Clarke, 1903) is a massive, poorly stratified brick-red shale with some gray-green shale, shaly dolomite, sandstone and green-black shale ("Pittsford shale"). It is 400 feet thick. Fossils - brachiopods, gastropods, cephalopods, pelecypods, eurypterids, and cyathaspid fishes - occur in a calcareous shale near the middle of the formation. No specific exposure was designated as the type section but in recent years the outcrop along Downing Brook, 1.3 miles south of Sherrill, has been utilized as a standard reference section (Fisher, 1957).

Westward across New York the Vernon thickens to about 600 feet north of Cayuga Lake, then thins to about 200 feet in Erie County. In the vicinity of Buffalo, the Vernon consists of green shale and dolomite with anhydrite. A little red shale and siltstone occur near the top of the formation. No surface exposures of the Vernon are known in the Niagara Frontier. Salt beds occur in the middle of the Vernon in the Genesee River Valley.

Throughout most of the subsurface and presumably along the outcrop belt as well, the Vernon may be subdivided into three parts. Significant facies changes occur. In all three divisions these changes involve the lateral replacement of red shale in the east by mixed red and green shale, then green or gray shale and dolomites, and finally dolomites with anhydrite and halite in the west.

## Syracuse Formation

The Syracuse Formation of Clarke, 1903, has recently been redefined, described and traced along the Silurian outcrop belt by Leutze (1955, 1959). The name originally was proposed for the subsurface salt beds of the Salina Group, but it is now also applied to the associated dolomites, anhydrites and shales. Thus the formation can be recognized along the outcrop belt where the salt beds have been dissolved by ground water.

In Onondaga County, Leutze subdivided the Syracuse into five members, some of which are exposed in the standard reference section, a railroad cut near Manlius Center. These consist of gray shales and gray or brown dolomites with interbedded clay (leached salt beds) and gypsum. The formation is about 160 feet thick. Leutze discovered fossils in several horizons within the formation and assembled a collection of brachiopods, pelecypods, ostracodes, gastropods, cephalopods, and eurypterids. He was able to map the Syracuse Formation and to recognize its subdivisions eastward into southernmost Herkimer County but was unable to carry his detailed work west of Cayuga Lake where the formation is virtually unexposed.

In the vicinity of Buffalo, the Syracuse consists of dolomites and anhydrite but lacks significant beds of salt. It is about 100 feet thick and is not known to be exposed in the Niagara Frontier.

In the subsurface the Syracuse is a readily recognizable portion of the Salina Group but it cannot be subdivided into the five members distinguished by Leutze along the outcrop. The majority of the halite and anhydrite beds of the subsurface Salina Group occur in the Syracuse Formation. Thicknesses in excess of 1000 feet are attained in the center of the Salina basin.

## Camillus Shale

The upper portion of the Salina Group in Onondaga County and eastward consists of a chunky green shale, unfossiliferous, with some red beds in southernmost Herkimer County. Leutze (1959) restricted the application of the name Camillus (Clarke, 1903) to this portion of the Salina. It is about 200 feet thick in the type area, somewhat thinner both east and west of there.

In the Niagara Frontier the Camillus is 80-100 feet thick and includes the O-atka beds of Chadwick (1917), formerly assigned to the overlying Bertie Formation. The Predominate lithology is a green shale, but dolomite, anhydrite and siltstone, also occur. Eurypterids have been reported from a dolomite bed near the top of the formation in

Chadwick's O-atka beds. This uppermost portion of the Camillus is exposed at Akron Falls, Indian Falls, Morganville and Oatka Falls. Another exposure of the Camillus is a small section along Murder Creek north of Akron.

At several localities along the Silurian outcrop belt there are underground mines for gypsum formed by conversion of the subsurface anhydrite of the Salina Group to gypsum through hydration by ground water. The National Gypsum Company has a mine at Clarence Center, the Bestwall Gypsum Company at Akron and the United State Gypsum Company at Oakfield. The stratigraphic position of the gypsum beds mined by these companies has, in the past, been assigned to the Camillus. They are located about 200 feet below the base of the Onondaga Limestone. In nearby gas wells, the Camillus is anhydritic but significant beds of anhydrite occur only in the Syracuse Formation, 150 to 200 feet below the Onondaga. Further study is needed but it appears that the gypsum mines may be in the Syracuse rather than the Camillus. The thickness of the Camillus in the subsurface appears to be quite uniform but the formation has several facies. Dolomite and anhydrite comprise significant portions of the Camillus in the center of the Salina basin; red shales become predominate in the east.

## Bertie Formation

The type section of the Bertie Formation (Chapman, 1864) is located in Bertie township, Welland County, Ontario. In an abstract Chadwick (1917) subdivided the Bertie of western New York into four members, in descending order: Buffalo cement bed, Scajaquada shale and dolomite, Falkirk dolomite and O-atka shale (here included in the underlying Camillus). Chadwick later (see Clarke, 1918, p. 42) renamed the upper member Williamsville as the term Buffalo was preoccupied. The Bertie of western New York is everywhere underlain by the Camillus Shale and overlain, where complete sections are found, by the Akron Dolomite. Owing to the relief of a pre-Onondaga unconformity, however, exposures are found where the Onondaga Limestone directly overlies the Williamsville Member of the Bertie or some lower member. Chadwick was first to point this out.

The thickness of the Bertie Formation in western New York is uncertain because few exposures continue downward into the underlying Camillus Shale. It is believed to be about 50 feet thick where all members are present. Its thickness will, of course, vary from place to place depending upon the amount removed by erosion prior to deposition of the Onondaga Limestone. The contact of the Bertie with the overlying Akron Dolomite is gradational. Its contact with the underlying Camillus is much less clearly understood because of the lack of good exposures. Some authors (Grabau, 1901, p. 115) and Alling (1928, pp. 27-28) have suggested that this contact possibly is disconformable.

The Falkirk Member of the Bertie is composed of massive beds of dark gray dolomite, weathering yellowish brown, which are characterized by coarse conchoidal fracturing, a small marine fauna and a basal eurypterid horizon. Owing to its greater resistance the Falkirk

commonly produces a waterfall where exposed in streambeds. Its thickness varies from 18 to 25 feet. The overlying Scajaquada Member consists of dark shales or blocky waterlimes, less resistant than the Williamsville above or the Falkirk below, and presumably contains more argillaceous material than those two members. It varies from 3 to 10 feet in thickness and, in southern Ontario, eurypterids occur near its base ("Bridgeburg horizon").

The Williamsville Dolomite, because it formerly was mined for natural cement in the vicinity of Buffalo, is perhaps the best known member of the Bertie. It consists of laminated, fine-grained dolomite, up to 5 or 8 feet thick, which weathers light gray. Its pronounced conchoidal fracture, among other criteria, serves to distinguish it from the overlying Akron Dolomite which has an irregular fracture. According to Monahan (1931, p. 379) most of the fossils, especially the eurypterids, of the Bertie Formation cited by Ruedemann (1925) and others have been obtained from the Williamsville Member.

The Bertie Formation is noted for its abundance of well-preserved eurypterids, most of which apparently were obtained from the upper or Williamsville Member. In addition to these, bryozoans, brachiopods, gastropods, cephalopods, ostracodes, and graptolites also have been found.

Exposures of the Bertie Formation and the overlying Akron Dolomite are fairly common in the Niagara Frontier region. Outcrops in Buffalo are located near the Main Street entrance to Forest Lawn Cemetery, in the storm sewer on East Amherst (old Bennett quarry), and in a New York Central Railroad cut between Kensington and Morris Avenues. East of the city important localities are in Ellicott Creek at Williamsville, in the Louisville Cement quarry near Clarence, at the falls in Akron Falls Park, at Indian Falls, at Morganville and along Route 19 and in Oatka Creek at North LeRoy.

## Akron Dolomite

The highest rock unit of the Silurian in the Niagara Frontier is the Akron Dolomite (Lane and others, 1908). The type section is an outcrop in Murder Creek, at Akron, New York, where the formation is about 8 feet thick. Other exposures are cited in the discussion of the Bertie (except Indian Falls, Morganville and North LeRoy).

The Akron consists of gray to buff, mottled and banded dolomite, fine-grained and often pitted by the solution of fossil corals. The lower contact with the Bertie is gradational and difficult to identify. The upper contact with the Onondaga Limestone is a conspicuous disconformity broadly undulating, with occasional channels or "dikes" of sandstone or arenaceous limestone extending down into the underlying Akron (or Bertie where the Akron is absent). Although not an abundantly fossiliferous rock, the Akron is the most fossiliferous portion of the entire Cayugan Series in western New York. Its fauna includes corals, brachiopods, gastropods, cephalopods, and ostracodes. Eurypterids and graptolites also have been reported but are relatively rare.

The Akron Dolomite of western New York appears to be a continuation of the Cobleskill Limestone of Eastern New York. Doubts regarding the tracing and correlation of these units, particularly the Akron, across Ontario, Monroe and Genesee Counties persist despite the efforts of several stratigraphers (Schuchert, 1903; Hartnagel, 1903; Alling, 1928; Hoffman, 1949; Rickard, 1953; Leutze, 1959). In the subsurface it frequently is not possible to separate the Akron-Cobleskill from the underlying Bertie in sample logs because the lighologic differences are slight. However, where the Cobleskill is a fossiliferous limestone, the separation is more easily made. Radioactivity logs provide an additional means of differentiating these formations in some parts of the subsurface.

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