THE SALINA GROUP

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Introduction

It is a strange paradox that the Salina Group, which was of such importance in the history and early industrial development of central New York, remains one of the least understood of the Paleozoic groups in the region. After brilliant pioneering work by Vanuxem, study of Salina stratigraphy and paleontology languished for almost a century. James Hall's interest in fossils led him to direct his own efforts, and the State Survey which he so long dominated, towards better collecting grounds. The late Prof. H. L. Alling of Rochester published an excellent study of the salt deposits (1928), and contributed important petrographic information. D. H. Newland wrote several papers dealing with the Salina Group, but these center on economic geology. Short papers by Ruedemann, Sarle, Chadwick and several others discuss various aspects of Salina stratigraphy and paleontology. These publications, chiefly short notes, are widely scattered in the geologic literature. Only in the last decade has systematic study of the Salina Group been undertaken. Alling and Briggs (1961) described the regional relationships of the Syracuse and adjacent formations. Their study will be a basic reference for years to come, but they have left much to be done by future workers. The unsolved problems of the Salina Group provide a challenging field for students of stratigraphy and paleontology alike.

Geologic Setting

The Salina Group was deposited during a single great cycle of sedimentation. Above is the marine Cobleskill and below is the marine Guelph-Lockport. Between them, the Salina Group is characterized by red beds, evaporites, and a sparse fauna containing many strange forms: eurypterids, phyllocarids, scorpions, and New York's oldest known fishes. The cycle records a time of restriction of the Silurian seaways and their subsequent reopening. A marine withdrawal began earlier to the north and east, but its influence on sedimentation in central New York became notable by the time the Guelph Dolomite was being deposited farther west. Thus the Guelph is unknown east of Rochester, and its stratigraphic position in the Syracuse area is occupied by predominantly red clastics of the Vernon Shale, oldest formation of the Salina Group (Fig. 1). The writer attributes this relationship to facies change, and believes that the lower part of the Vernon is at least as old as the Guelph. An alternate interpretation may be that the Guelph is missing due to a disconformity between the Salina and the older formations. Just south of Herkimer, the Lockport is absent, and the Vernon shale overlies the Herkimer Sandstone Member of the Clinton Group (Rochester Shale equivalent). A few miles farther east, at the village of Deck, the Vernon is absent and the Syracuse Formation lies on the eroded, irregular surface of the Herkimer. The presence of at least one unconformity is certain, but its age is open to question.

According to some writers the Salina sediments record a time of marine withdrawal, but it is more accurate to say that they indicate hydrographic restriction of a particular basin. Michigan, West Virginia, New York, and the states between shared a common depositional basin during late Silurian time. For convenience, this has been called the Salina Basin (Leutze, 1960, fig. 1. Alling and Briggs,

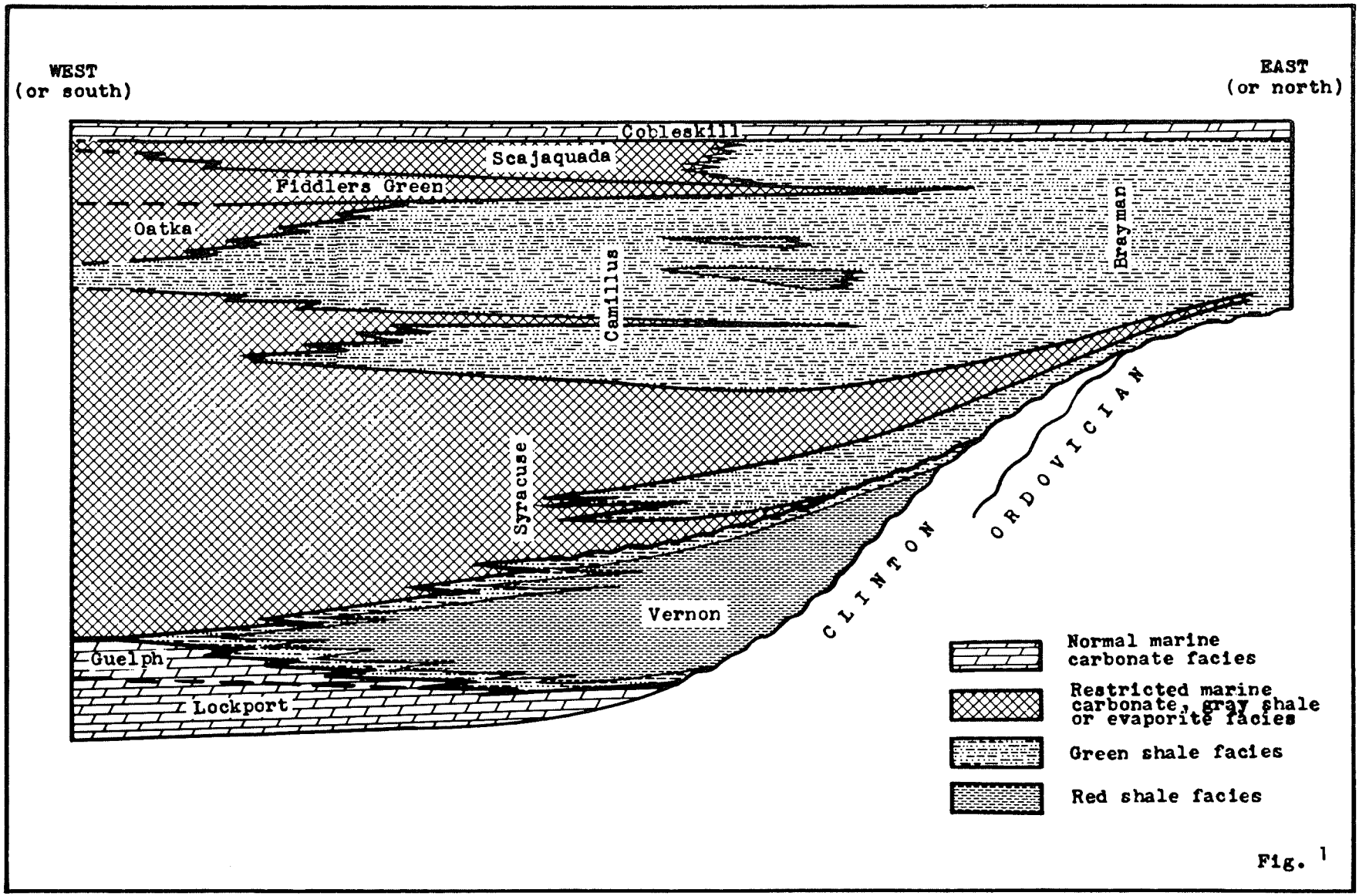

Fig. 1. Diagrammatic cross section of the New York Salina Group. Not drawn to scale.

1961, fig. 12, subdivided this basin into three intimately connected basins). Throughout this area, the lithologies and faunas peculiar to a restricted basin are developed. Several brief episodes of marine invasion and retreat are recognizable in the stratigraphic sequence. In New York, the Salina marine tongues override all older Silurian deposits (Fig. 1), and this fact makes it incorrect to say that this was a time of marine withdrawal.

During the existence of the Salina Basin the Adirondack region, Appalachia, and all adjacent lands had been worn low by long erosion. They supplied only fine clastics to the great, shallow depression. The basin had intermittent (or greatly restricted) connections, via the Hudson Bay lowlands, with an Arctic seaway. Salina Basin faunas are consequently more closely related to those of Gotland and Central Europe than to British Silurian assemblages. Probably other channels connected the Salina Basin from time to time with open seas to the south and west.

When marine connections were cut off, the waters stagnated. Depending on tide, weather, and tectonic conditions, vast mudflats were either shallowly submerged or temporarily exposed. Mud-cracked layers alternate with beds containing marine faunas throughout the Salina Basin. Only hardy euryhaline organisms could survive in this environment for long. Times of evaporation which brought about the deposition of salt and gypsum were followed by influxes of less saline water. In New York State, two lentils containing marine faunas directly overlie two evaporite horizons, suggesting that marine transgressions terminated evaporite deposition.

The Type Salina Section in Central New York

The oldest Salina unit is the Vernon Shale. Although the Pittsford Shale was originally designated as the lowest member of the Salina Group, later workers generally agree that it is best to consider it as a part of the Vernon distinguished chiefly by the eurypterid fauna found in a few lentils at Pittsford. The Vernon remains one of the least understood formations in the State. It is a great wedge of bright red shale, with local lentils of green shale, dolomite, sandstone, or gypsum. that reaches its maximum thickness of 500 to 600 feet in the vicinity of Syracuse.

The highest beds of the Vernon Shale are typically green, locally interbedded with a few thin shaly dolomites. Detailed measurement of the upper part of the Vernon indicates that progressing westward, the highest red beds are found successively lower in the section. Thus it appears that the red bed facies wedges out in a westerly direction due to replacement of red shales by green at both top and bottom. There is a corresponding increase in number and thickness of dolomitic beds and green shales throughout the formation. At Illion Gorge, not less than 95 percent of the formation is red shale. In Onondaga County, the writer estimates that red beds make up about 70 percent of the formation. West of the Genesee River, less than half of the formation retains its red color.

Because it weathers rapidly, exposures of the Vernon Shale are temporary. Erosion has developed miniature badlands on some steep slopes (Fig. 2). A field study of the Vernon might reveal continuous recognizable beds or zones within the formation. Thus far, there has been little attempt to relate one exposure to another.

The fauna of the Vernon is evidently restricted to a few very thin lentils and is known only from isolated localities. The section described by Wayland-

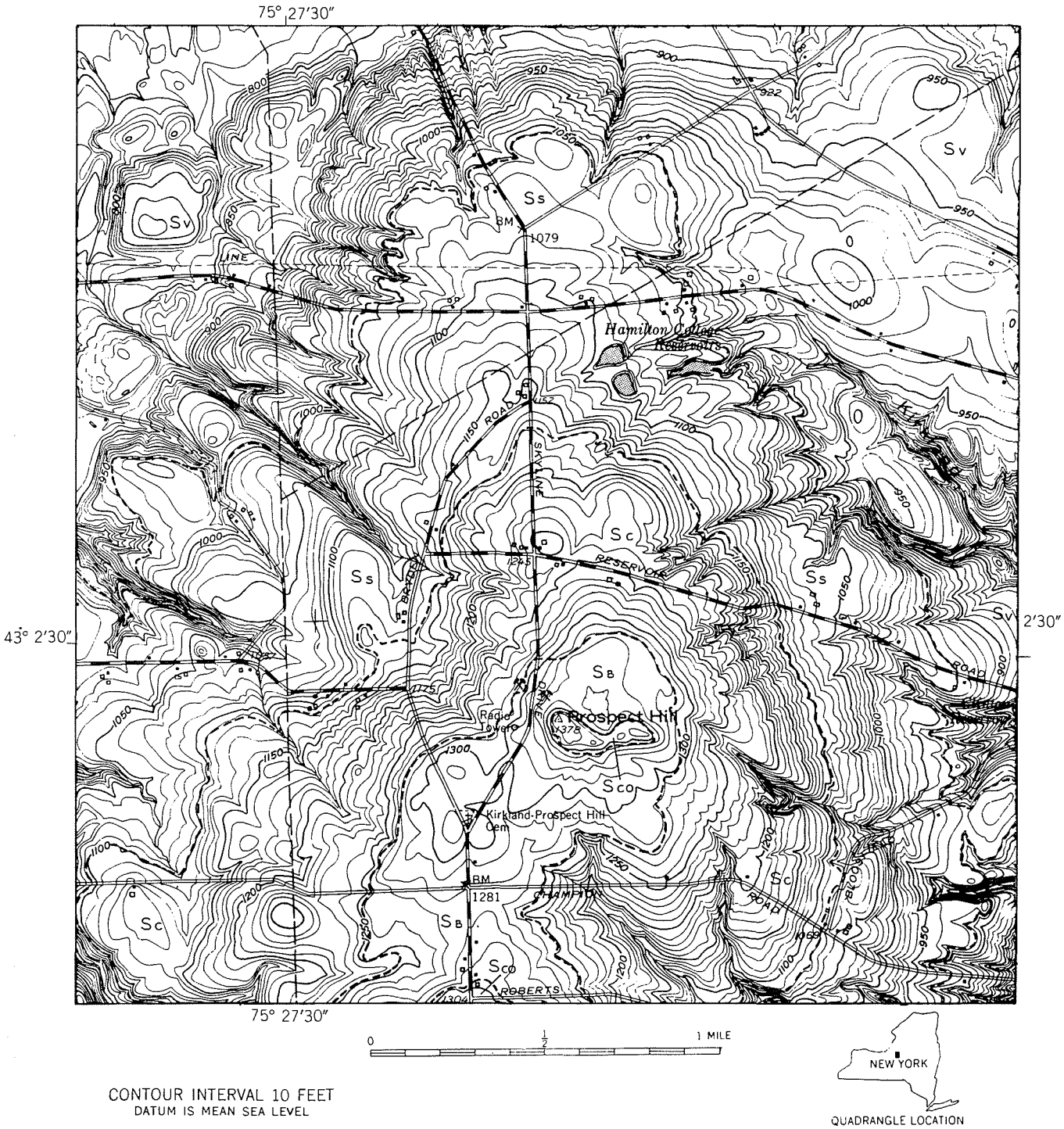

Fig. 2. Part of Clinton quadrangle showing influence of Salina Group on topography. Intricately eroded Vernon shale (Sv) underlies low ground. Typical Vernon topography in north and northwest part of map. Dolomite beds of Syracuse formation (Ss) cap Vernon to form terraces. Steeper slopes eroded on Camillus shale (Sc), as on northeast slope of Prospect Hill. Bertie formation (Sb) with resistant Fiddlers Green member at base supports plateau atop hill. Small outlier of Cobleskill dolomite (Sco) forms the pinnacle.

Smith (in Kjellesvig-Waering and Caster, 1955, p. 1042) near the town of Vernon contains the most diversified fauna: pelecypods, a gastropod, cephalopods, and two genera of brachiopods; a single siphonophore, remains of armored fishes, eurypterid fragments, and ostracodes.

The Syracuse Formation rests disconformably on the Vernon Shale at Syracuse and exposures to the east. To the west, a conformable relationship is inferred. The abrupt change in lithology from soft shale to resistant dolomite is marked by a corresponding change in topography. The lowest dolomites of the Syracuse Formation create a flat terrace which contrasts strongly with the eroded shale slopes below (Fig. 2). The Vernon Shale is almost impermeable, so that ground water flows out in springs and seeps at the formational contact.

The Syracuse Salt was originally defined as the salt and associated sediments known only in the subsurface. At the outcrop, only the overlying Camillus Shale was recognized. In 1956, the writer redefined the Camillus Shale and first published the term "Syracuse Formation" (Fig. 3) as applied to a separate mappable unit. The Syracuse Formation at Syracuse was divided by the writer into five lithologic members. The Transition Member is composed of thin gray dolomite beds which alternate with dull green shales. A pebbly, sandy bed of dolomite marks the contact with the Vernon Shale. The eurypterid genus Waeringopterus is found in the lowest part of the formation and is prolific at one horizon. This member is not fully exposed anywhere in Onondaga County, but its thickness is estimated from composite sections to be between 70 and 80 feet.

Overlying the Transition Member is a bed of structureless gray clay averaging 12 feet in thickness. Locally, blocks of bedded gypsum encased within this Lower Clay Member suggest that it is the residue of a soluble evaporite bed. Salt well logs support such an interpretation, as this stratigraphic position corresponds to a major salt bed in the subsurface just south of Syracuse.

The Middle Dolomite Member (37 to 44 feet thick at Syracuse) is composed of well-bedded gray to brown shales and dolomites. All of the dolomite beds are very impure. The gray shales at the bottom of this unit contain an abundant marine fauna composed chiefly of mollusks and brachiopods, but with Medusaegraptus (graptolite? sea weed?), ostracodes, and rare eurypterid fragments. This is the Camarotoechia zone, named for the commonest brachiopod.

A second bed of clay, the Upper Clay Member, overlies the Middle Dolomite. It resembles the Lower Clay Member in every respect save stratigraphic position.

The Upper Dolomite Member (approximately 15 feet thick) is the highest division of the Syracuse Formation. The lowest beds of the member are shaly and contain a marine fauna similar to that of the Camarotoechia zone, but with fewer brachiopods and a large, pectinoid pelecypod. The reticulate ornamentation and shape of this clam suggests that it belongs to the genus Actinopteria, and the faunal zone is known as the Actinopteria zone. This zone is only a few inches thick, but contains many fossils. The assemblage is dominated by pelecypods, gastropods, and cephalopods. Eurypterids, ostracodes, conularids, brachiopods and phyllocarids have also been found in the zone. Above the Actinopteria zone are beds of shaly dolomite and a bed of pitted dolomite known as "vermicular rock". The pits are evidently due to the leaching of some soluble mineral which leaves the remaining dolomite looking somewhat like vesicular lava. The highest part of the member is composed of thinly laminated argillaceous dolomite. Since the next higher formation (Camillus) is a shale, the contrast in lithologies is locally marked by

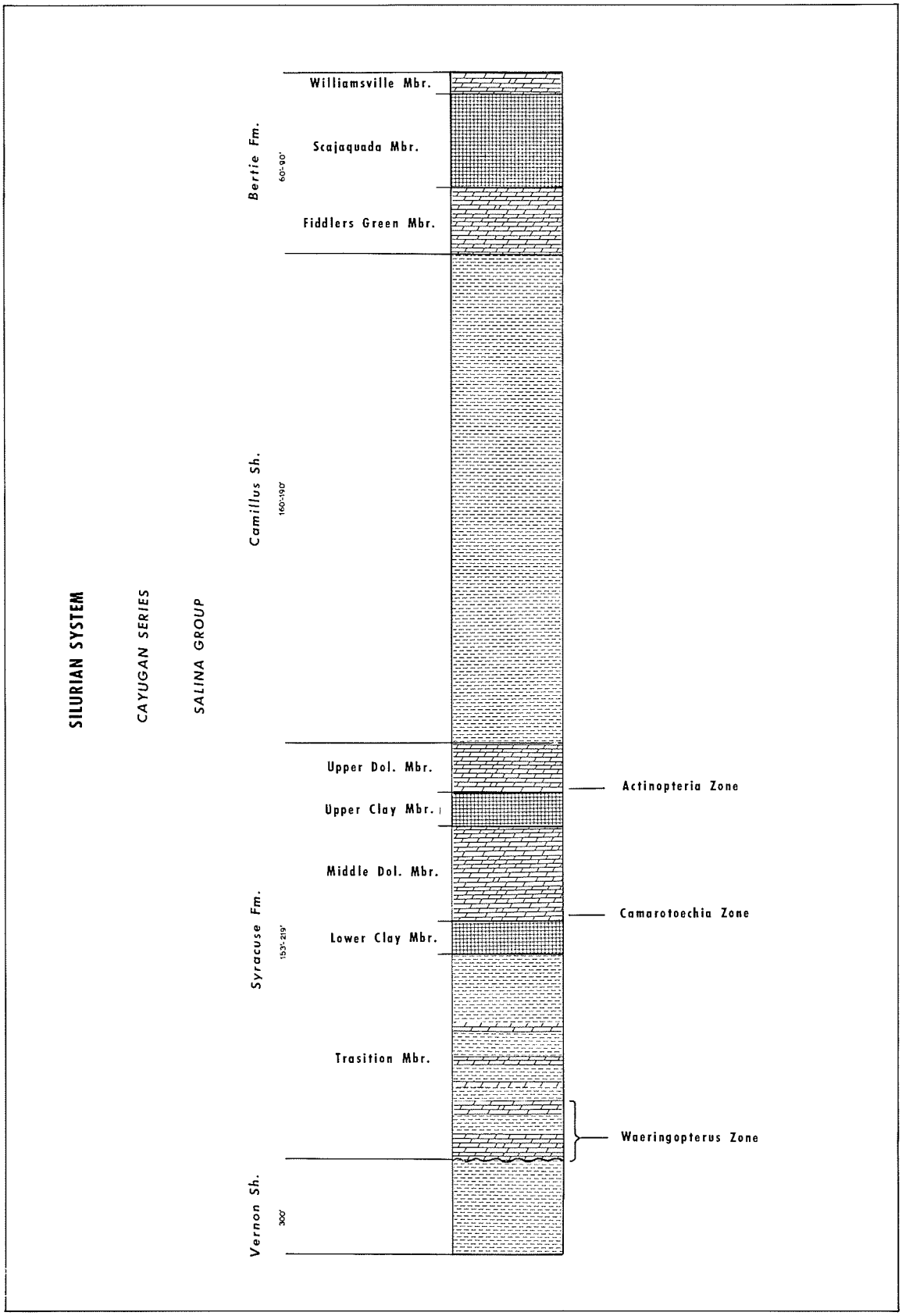

Fig. 3. Stratigraphy of the Salina Group.

a topographic bench (Fig. 2) and by waterfalls on some streams.

In the vicinity of Syracuse, the aggregate thickness of the Syracuse Formation is about 150 feet. Although there are exceptional beds, the formation can be distinguished from adjacent stratigraphic units by: 1. The abundance of dolomite and evaporites; 2. gray, tan, or brown colors; 3. the distinctly bedded character of the rocks. Both the Vernon and Camillus have a massive, earthy appearance.

The Camillus Shale is conformable with the Syracuse Formation and the two lithologies intertongue down-dip and to the west (Fig. 1). The Camillus is a homogeneous olive green shale with a maximum thickness of about 200 feet. It weathers rapidly to irregular chips which soon bury the exposure unless removed by erosion. East of Syracuse, two zones of dull red shale seem to hold fixed stratigraphic positions within the formation. A thin dolomite near the bottom thickens to the west, where it is underlain by a bed of gypsum. Gypsiferous and sandy zones are present at some outcrops of the Camillus Shale, but their continuity is unknown. No significant fossils have been reported from this formation.

The Bertie Formation is composed of three members. The Oatka Shale, considered by Chadwick to constitute a fourth member, is simply a dolomitic portion of the upper Camillus Shale. The lowest, and topographically most significant member of the Bertie, is the Fiddlers Green. It is a tough gray dolomite that is 27 feet thick at the type locality in Fiddlers Green Gorge at Jamesville and averages about 25 feet thick across most of the State. Its outcrop belt is marked by a terrace (Fig. 2) and many waterfalls. Ostracodes are prolific in this unit, and the highest beds contain the famous Herkimer County eurypterid fauna (zone of Eurypterus remipes remipes).

The Fiddlers Green is overlain by the Scajaquada Member. Its lithology is not constant along the strike, but from Syracuse to Cayuga Lake, it is an impure gypsum which was formerly quarried. At exposures where the gypsum has been leached out, the Scajaquada resembles the clay beds of the Syracuse Formation.

The highest member of the Bertie is the Williamsville, an argillaceous dolomite ("waterlime") which grades into the overlying Cobleskill Dolomite. It attains thickness of around 7 feet in western New York, where it has been extensively quarried for natural cement manufacture. This member is the main eurypterid horizon of the Buffalo area. In the vicinity of Syracuse it is similar in thickness and lithology but contains very few fossils.

Summary of Salina Paleontology

The Upper Silurian poses especially difficult paleontological problems throughout the northeastern states, where the Cayugan rocks were deposited in a restricted marine basin. The faunas in this arm of the sea were composed chiefly of hardy forms able to survive in an environment characterized by highly variable salinity, and drifting organisms. Within the confines of the Salina Basin, the following generalizations apply to typical faunas: 1. Fossils are sparse; 2. Small number of species but local abundance of individuals; 3. Corals, crinoids, and trilobites are very rare; 4. Ostracodes, eurypterids, and the rarer arthropods are relatively abundant; 5. Brachiopod and molluscan assemblages are similar in various parts of the basin and at several horizons. The entire fauna has a strong provincial aspect, with few forms which are significant for inter-regional correlation. Paleontological correlation is further complicated by the poor preservation of most calcareous organic remains in the Cayugan rocks of the regions. This

condition is largely attributable to the dominance of evaporites, dolomite and red shale. Calcareous skeletons are rarely preserved in any of these lithologies, though chitinous material is frequently found in a remarkable state of preservation. Alling and Briggs (1961, p. 529 and 539, table III) have aptly summarized the difficulties of attempting to use Salina faunas in stratigraphic correlation. Eighty-two percent of the names which appear on their check list of Cayugan fossils are listed for only one formation or area, and an additional 10.7 percent are listed only twice. Consequently, any given assemblage appears to have very few species in common with penecontemporaneous assemblages in other parts of the Salina Basin, or even with the faunas reported from adjacent formations in the same area. Not only does this situation appear highly unnatural, but it also presents the non-paleontologist with an erroneous impression as to the diversity of Cayugan faunas.

Actually, Cayugan faunas are remarkably similar in all parts of the basin. Among the brachiopods, both articulates and inarticulates are represented. Lingula, a genus noted for its tolerance to variable salinity, and Orbiculoidea are both found in the argillaceous facies. It is somewhat surprising to note that they are much less common than articulates at most exposures. Camarotoechia is widespread, as are two other types: a small, smooth, rostrate form with the general appearance of Hindella or Whitfieldella, and a small dorsoventrally flattened brachiopod. The latter is represented by Schuchertella or Stropheodonta at some horizons and by Chonetes at others. It has generally been assumed that articulate brachiopods require a normal marine environment, but the persistence of the above forms throughout the Salina Group suggests that they adapted to precarious living conditions and variable salinities. Since the times when the basin was sufficiently freshened to allow the existence of normal marine faunas must have been relatively brief, judging from the thinness of the fossiliferous zones, these brachiopods were capable of rapid dispersal. Were it not for the articulate brachiopods, it would be easier to argue that the entire Salina fauna represents a brackish or fresh-water assemblage to which drifting and swimming forms were added.

Gastropods, pelecypods, and cephalopods are the common representatives of the phylum Mollusca. Most of the gastropods fall into one of two generalized types, either a high spired form resembling Hormotoma or Loxonema, or a smaller, low spired, rapidly expanding conch like Holopea. The majority of the cephalopods are either brevicones with visored apertures (Pristeroceras, Phragmoceras, Hexameroceras, Tetrameroceras, etc.), or straight orthocones. Among the pelecypods, two shapes can be expected: a Pterinea-Actinopteria type of pectinoid, and a Modiolopsis-like shell of small to moderate size.

Arthropods are abundantly represented by species of Leperditia, and less commonly by other ostracode genera. Eurypterids are abundant locally, but only in thin zones. At other horizons they are rare.

Cyathaspid fish fragments are present, particularly associated with the red bed facies. Bryozoa, conularids, scyphozoa, graptolites, and many other groups have been reported from Salina rocks, but none of these are sufficiently common or widespread to merit discussion in this synopsis.

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*Dr. Leutze's M.S. thesis and Ph.D. dissertation are important sources of unpublished information on the stratigraphy and paleontology of the Salina Group in New York State and have been added to the list of references. - Editor.