SURFICIAL GEOLOGY OF THE SYRACUSE FIELD AREA

by Ernest H. Muller

Introduction

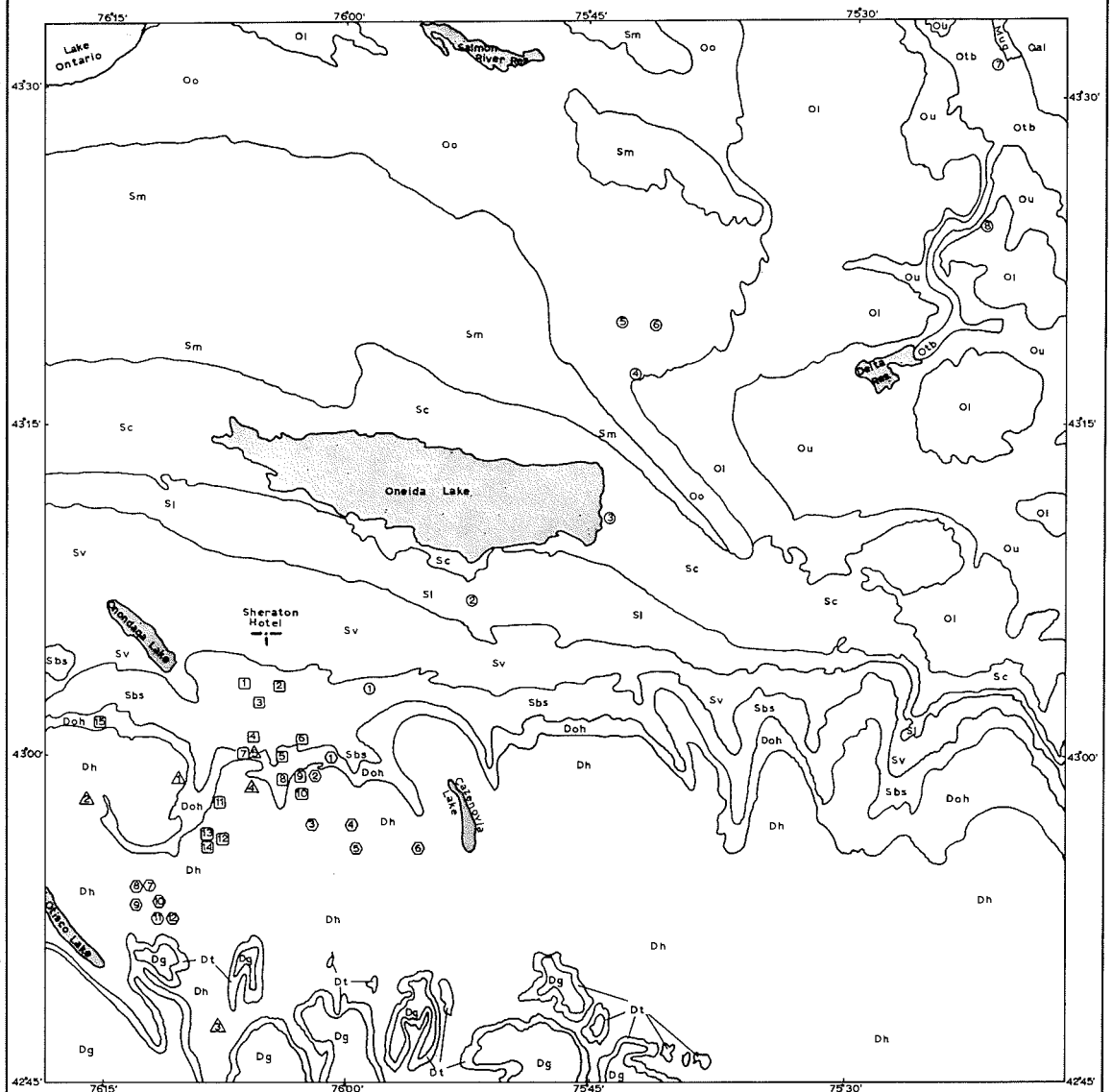
The following notes provide a frame of reference for field trips in the Syracuse area, planned for the 36th Annual Meeting of the New York State Geological Association, May 8-10, 1964. These trips range from Rome in the east to Marcellus in the west and from Boonville in the north to Tully in the south. No effort is made to provide uniform treatment throughout the area of concern; rather, relationships at certain stops are developed in detail, whereas others are treated only in general terms.

Regional relationships

Syracuse is located in the border zone between two major physiographic provinces. North of the city, undulating plains of the Ontario Lowland stretch away to Lake Ontario. Streamlined ridges of glacial till give much of the lake plain its distinctive topographic texture. South of Syracuse, the land rises more than a thousand feet within a few miles, forming the north-facing margin of the Appalachian Uplands. Northeast of Syracuse the Oneida basin, an eastward extension of the Ontario Lowland, isolates the Tug Hill Plateau from the Appalachian Uplands to which it is physiographically related.

In unglaciated parts of Pennsylvania and lightly glaciated parts of southern New York, physiographic history is recorded in accordance of summits. Following late Paleozoic regional uplift, the Syracuse area presumably experienced similarly long erosion that beveled the southward dipping strata. Because intensity of glacial scour increased northward across New York, summits south of Syracuse are rounded and reduced in elevation, retaining only approximate summit accordance. Suggestive similarity of summit elevation in the Tug Hill Plateau and the upland south across Oneida trough led Newell (1940) to hypothesize correlation of the erosion surfaces. Such physiographic correlation is presently viewed with reservation because of strong evidence of intense glacial scour and marked structural control.

Paleozoic strata are exposed in generally east-west trending zones, with almost imperceptible regional dip southward beneath progressively younger beds (fig. 1). Differing resistance of these layers has resulted in a broadly cuesta-form or terraced (Schichtstufenlandschaft of Hanefeld, 1960) character which may be as much a result of glacial scour as of normal erosional processes. Terrace and summit levels are characterized by generally north-facing scarps and more gentle southward dip slopes. Thus, the broad, east-west trending basin between the Tug Hill Plateau and the Appalachian Uplands is controlled largely by the trend of Silurian sediments. Within this lowland belt, the Lockport Dolomite forms a broad buried ridge that separates the Oneida and Cicero-Canastota depressions which are developed respectively on the Rochester and Vernon Shales. Massive carbonate strata in the Upper Silurian and Lower Devonian section support sloping bench remnants in the border scarp of the Appalachian Upland.



LEGEND

Devonian	Dg	Genesee Gp.
	Dt	Tully Ls.
	Dh	Hamilton Gp.
	Doh	Onondaga Ls, Oriskany Ss, Helderburg Gp.
Silurian	Sbs	Cobleskill Ls, Bertie Gp, Camillus Sh, Syracuse Fm.
	Sv	Vernon Sh.
	Sl	Lockport Gp.
	Sc	Clinton Gp.
Ordovician	Sm	Medina Gp, Queenston Fm.
	Oo	Oswego Ss.
	Ol	Lorraine Gp.
	Ou	Trenton Gp.-black shales
	Otb	Trenton Gp.-limestones, Black River Gp.
Pre-Ꞓ	Mug	Granitic, Charnockitic, Metasedimentary

Formation Boundary

① Trip B
[1] Trip C
△ Trip D
① Trip E

GEOLOGIC MAP
SHOWING
FIELD TRIP STOPS

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Map taken from the Geologic Map of New York; New York State Geological Survey Map and Chart Series No. 5, 1962

Drawn by W.F Chester, 3/64

Pre-glacial drainage of the plateau

Principal elements of the weakly cuestaform topography are assumed to be pre-glacial, the product of long drainage evolution and erosion throughout the Cenozoic Era. In the lowlands north of Syracuse, thick drift cover and intensive glacial scour obscure the preglacial drainage pattern, permitting inference only as to major drainage lines (see "Bedrock Topography in the Oneida Lake Area, New York). Differential scour was concentrated primarily along strike of non-resistant beds and through existing lowlands, particularly as they lay parallel to directions of prevailing ice-flow.

In the upland south of Syracuse the pattern of glacially-deepened through valleys gives evidence of controls inherited from the deeply-incised, mature pre-glacial drainage system. Short, steep obsequent streams drained the north margin of the plateau toward inferred ancestral drainage lines in the lowland. Longer, south-flowing streams followed resequent courses, ultimately crossing the transverse folds of the Ridge and Valley Province, or doubling back northward where captured by developing master obsequent streams. Representative of the latter is the Tully-Cortland valley system which apparently had its pre-glacial outlet southwest into the Cayuga trough and thence northward.

Between Stops 2 and 3, Trip D crosses the inferred divide between obsequent and resequent pre-glacial valleys. Drilling and seismic data show a pronounced rise of about 650 feet within the 3 miles from the Solvay Process brine field south across the Tully (Valley Heads) moraine to Tully Lake (Faltyn, 1957; Durham, 1958) in the Tully-Onondaga trough. This coincidence of association of the Tully moraine and the inferred bedrock divide led Durham to hypothesize similar control of Valley Heads moraine loops in other seismically uninvestigated through valleys.

Left-bank tributaries of Onondaga Creek, such as the one at Vesper on Trip D, enter Onondaga Creek from the northwest with barbed and hanging junctures. This relationship suggests progressive capture of headward tributaries of the south-flowing stream by an aggressive obsequent ancestral Onondaga Creek. Rampant piracy so close to the border scarp argues against great antiquity of the scarp in its present position prior to glaciation. The fact that the left-bank headwater tributaries in question occupy furrows parallel to glacier flow and shaped primarily by glacial scour suggests the possibility that their orientation may be a product of glacial control, rather than a reflection of pre-glacial drainage pattern.

Streamline glacial topography

Superposed on the broadly cuestaform character of the upland, and all but obscuring this gross relationship is the pronounced molding of most ridges and summits into elongate, parallel, elliptical hills. A few miles south of the border scarp, streamline hills such as Irish Hill (Trip D, Mile 49) are drumlinoids, composed of bedrock almost without till veneer. Farther north, most streamline hills are drumlins, composed entirely of lodgment till. A few, like Mt. Olympus on the Syracuse University campus, are demonstrably rock-cored.

Streamline topographic features in the Syracuse area indicate a field of glacial flow without major discontinuity such as might suggest a significant change in flow direction during waning of the ice sheet. Where the drumlin field is particularly prominent in the southeastern outskirts of Syracuse, the prevailing

orientation of long axes is N28W. Southward it curves gradually to nearly due south. Maximum deviation from areal flow direction results from deflection of flow along the scarp or into an oblique through valley.

As products of glacial molding, streamline topographic features predate stagnant and marginal ice features that may occur among them. Thus at Mile 56.7, Trip D, a drumlin just east of Barker Hill Rd. is truncated by Smoky Hollow meltwater channel.

Moraines

Topographic features of the Tully glacial series have been described by von Engeln (1921). Features of the Tully moraine are observed near Stop 3 on Trip D. This massive, valley-stopping moraine is a part of the Valley Heads moraine system which in many central New York through valleys comprises the divide between St. Lawrence and Susquehanna watersheds. As in other through valleys, the Valley Heads moraine loop at Tully is notably steep and abrupt on its proximal (northerly) margin. It is much less impressive as approached from the south, because thick outwash deposits comprise a ramp leading south from the distal edge of the moraine.

Stratified drift comprises most of the exposed area of the Tully loop moraine. Kame and kettle topography of the moraine proper pass southward into pitted outwash; kame terrace of the valley wall passes similarly into outwash plain. The Tully Lakes, occupying several of the larger kettles, resulted from burial of isolated masses of stagnant ice by outwash carried from the active ice margin. It may be inferred that during deposition of the Valley Heads moraine, the ice margin for a time stood at an "advanced Valley Heads position" south of Song Lake. Subsequently, the "massive Valley Heads" moraine was formed as the loop north of the Tully Lakes, while outwash spread southward over and around the stagnant and melting ice of the more advanced position. Similar relationships are found in Valley Heads moraine loops in other through valleys, suggesting similarity in oscillation of the ice margin, and perhaps partly explaining the massive character of this moraine.

Although the Valley Heads moraine is prominent in its looping trend across valley divides, it is not everywhere easy to trace over adjacent uplands. The Tully moraine, north of Tully (Mile 43.9, Trip D) is a conspicuous exception, with prominent constructional topography for more than 2 miles where it is crossed obliquely by the field trip route.

No radiocarbon data are yet available in the Syracuse area. Correlation of the Tully moraine depends on more or less continuous tracing southwestward to Wyoming County where Valley Heads outwash is established as having been deposited more than 12,020 years ago, and to the Colgan mastodon site in Cayuga County near King Ferry which was unvovered by receding ice more than 11,040 years ago (Merritt and Muller, 1959, p. 477).

Recessional moraines are discontinuous and patchy north of the Valley Heads moraine. This is probably a function both of recessional history and because marginal deposition took place into proglacial lakes and onto scarp slope positions vulnerable to removal by marginal meltwater streams. Stratified drift and marginal meltwater channels seen on both Trips B and D help to fill in missing history of the receding ice edge.

The one significant recessional moraine in the Syracuse area north of the Valley Heads moraine is crossed twice on Trip B. Stagnation features east of Camden, including Stops 4, 5 and 6 are part of this broad belt. Delta Reservoir occupies a reach of the ancestral Mohawk-Oneida Valley imponded initially by this moraine, and The Palisade (Trip B, Mile 112.7) is a post-glacial, bedrock gorge resulting from displacement of Mohawk River from its ancestral valley by this same imponding. This moraine is traceable from the vicinity of Camden through Eddy Hill, Stanwix and Verona. Although the relationship of this moraine to the moraine sequence in western New York is not established, Taylor's (1924) correlation of it with the Albion moraine is not supported.

Meltwater channels

Recession of the ice sheet northward from the divide-producing Valley Heads moraine resulted in imponding of pro-glacial meltwaters in many troughs at the north margin of the plateau. Initially many of these primitive trough lakes drained south across the moraine divide, but in time they developed integrated drainage westward until the ice sheet began to thin against the plateau margin in the Syracuse area. Thereafter, meltwater streams draining eastward parallel to the border scarp notched gorges from one trough to the next at the north margin of the plateau from Syracuse to Oneida. The plexus of channels near Syracuse controlled the levels of short-lived pro-glacial lakes between Lake Warren and Lake Iroquois (Fairchild, 1909; 1932a).

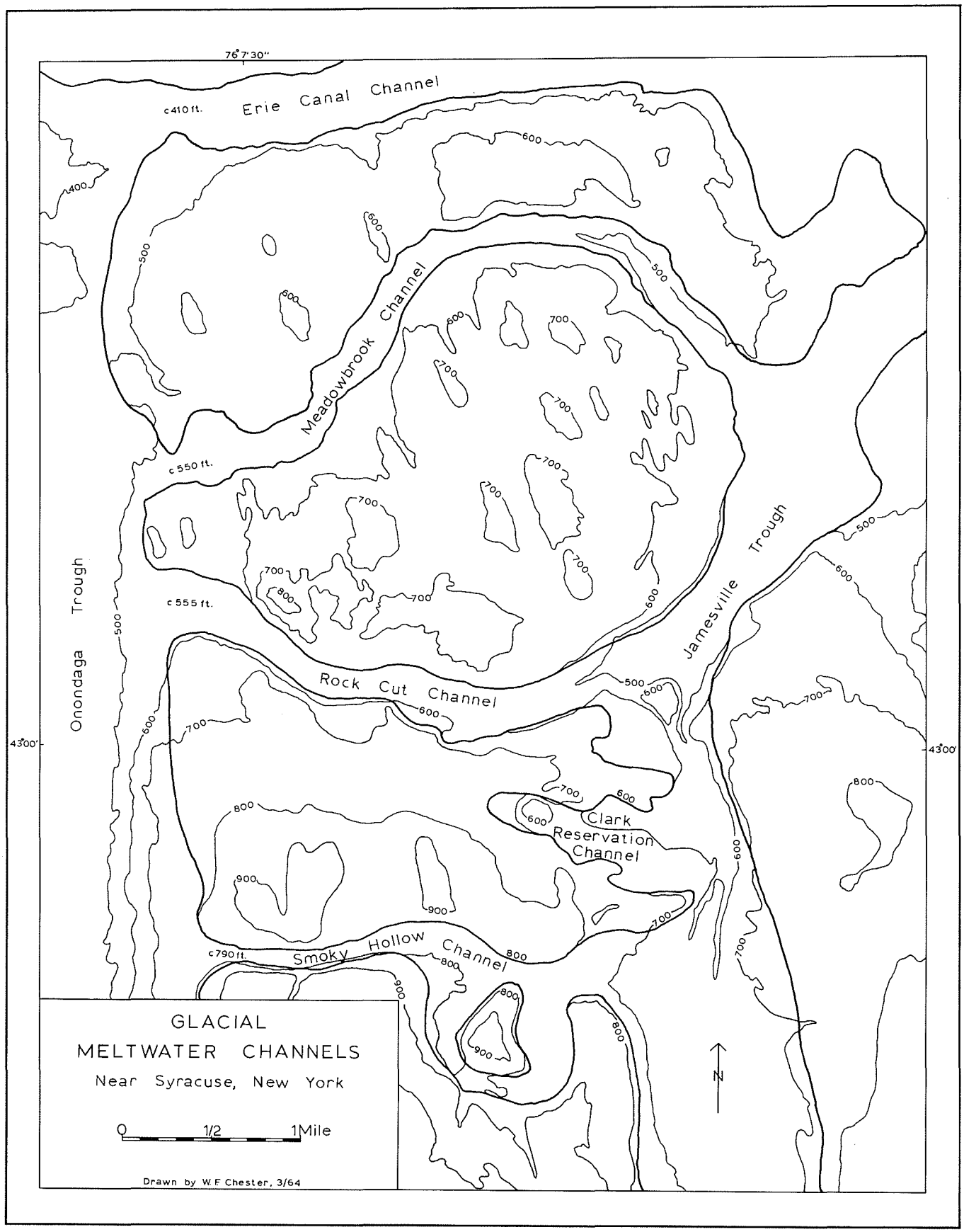
Sissons (1960) points out that glacial meltwaters flow frequently beneath, through and over the ice itself and argues that many channels in the Syracuse-Oneida area are of subglacial origin. Accumulating evidence indicates that several of the channels were occupied more than once, suggesting a complex recessional history.

Several meltwater channels visited by Trips B and D are described briefly below. These include the Syracuse channels, the Green Lake channel and Boonville Gorge.

Syracuse channels

A group of channels that traverse the ridge between Onondaga and Jamesville troughs are of dimensions that suggest they were cut by meltwater discharge from extensive imponding to the west. These channels in sequence from highest and oldest in the south to youngest and lowest in the north are Smoky Hollow, Clark Reservation, Rock Cut, Meadowbrook, and Erie Canal channels.

Smoky Hollow is a 2.25 mile long gorge, incised more than 100 ft. through the Hamilton Group to a threshold near 790 ft. msl. hanging 350 feet above the floor of Onondaga trough. Eastward the channel descends with average gradient of 50 ft/mile, cutting through the Onondaga Formation. The feature that distinguishes Smoky Hollow from other cross channels is the horseshoe-shaped meander loop (Hopkins, 1914) and umlaufberg produced by neck cutoff east of Barker Hill Road (Stop 4, Trip D). Recent unpublished studies by Sarah Street and Lawrence Cerrillo support Sissons suggestion that this and others of the Syracuse channels record a complex history of multiple episodes of glacier fluctuation. The Loop is partly filled with as much as 96 feet of stratified drift that is overlain at the west end by rhythmically-bedded lake sediments. Lodgment till overlying ablation drift is exposed in the ditch where Barker Hill Rd. rises north of Smoky Hollow. Although The Loop was not occupied by major meltwater stream after final


76°7'30"
c 410 ft.
Erie Canal Channel
Meadowbrook Channel
c 550 ft.
c 555 ft.
Onondaga Trough
Jamesville Trough
Rock Cut Channel
Clark Reservation Channel
c 790 ft.
Smoky Hollow Channel
43°00'
GLACIAL
MELTWATER CHANNELS
Near Syracuse, New York
0 1/2 1 Mile
Drawn by W.F. Chester, 3/64
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deglaciation, the cutoff truncates a drumlin east of Barker Hill Rd. indicating that final meltwater action followed final molding of streamline ridges.

Clark Reservation State Park (Stop 5, Trip D) contains particularly striking evidence of meltwater scour and plunge-pool drilling. Directly northeast of the parking lot is the steep-walled basin of Green Lake (Jamesville Lake of Quereau, (1898)). At the west end, twin channels lead to a threshold about 175 feet above the lake. By analogy, the bedrock bottom of the plunge pool may well be at comparable depth below the level of the lake and cut into the Camillus Shale, but detritus and marl partly fill this basin. East of Green Lake a broad, deep channel leads to Jamesville trough. Standing at the brink of the basin one can imagine the roar of a waterfall comparable in some respects to Niagara, plunging into the amphitheater below.

About 100 yards west of Green Lake in Clark Reservation is the basin of Dry Lake. Although considerably smaller and shallower than the basin of Green Lake, this too has characteristics of a plunge pool occupied for a short interval and cut perhaps by a stream with smaller discharge. The rock threshold at 720 feet, between the two basins, rules out any suggestion of uninterrupted progressive headward migration of the falls. Rather, it raises a question as to the initial declivity responsible for originating the upper plunge-pool. North and northeast of the Dry Basin - Green Lake line are a number of other basins and a long, narrow ravine cut deeply into the Onondaga bench and underlying carbonate rocks. Several are closed basins but none are as deep as the basin of Green Lake, and none contain ponds or lakes. All have eastward-opening channels leading to Butternut trough, yet all are presently controlled by subterranean outflow. Although the origin of the features of Clark Reservation will continue to intrigue geologists, most details are presently understood in terms of subglacial and glaciomarginal drainage possibly controlled in part by previously developed and subsequently modified solution features.

Third of the Syracuse channels and the best developed is Rock Cut channel, utilized at present by Rock Cut Road, Delaware, Lackawanna and Western Railroad, and an unsightly association of junk yards. This steep-walled, flat-bottomed channel is floored by the Fiddlers Green Dolomite, with threshold at 550 feet at the west end and average eastward gradient of less than 10 ft. per mile. It is difficult to conceive of the cutting of a canyon of these dimensions during the brief time involved in northward recession of the ice margin to uncover the next lower marginal channel. Plunge-pool cutting of the magnitude that produced Green Lake basin is considered improbable in view of the higher bedrock floor of this channel. This leads to the hypothesis that cutting of the Rock Cut channel took place during several recessional episodes, an hypothesis strengthened by evidence in configuration of the south wall in the Syracuse Caves area. This location at the edge of Clark Reservation may be visited on foot (Stop 5, Trip D) if time permits. Amphitheater-like cusps cut into the south wall strongly suggest cutting by water plunging into the channel from the south where no present stream exists. Like the basins in Clark Reservation this may be a plunge-pool drilled by a subglacial or glaciomarginal stream. In either case it testifies to glacial advance south beyond Rock Cut Channel after the channel had attained essentially its present dimensions.

The fourth of the Syracuse channels, the Meadowbrook channel is narrower and less sharply incised than the Loop and Rock Cut channels. With threshold level essentially the same as that of the Rock Cut channel and with orientation toward rather than away from the ice sheet, this channel could not have carried

major discharge very long. Drumlin truncation behind Manley Field House is such as to confirm that glaciomarginal drainage took place after the final episode of drumlin-molding.

The Erie Canal channel (Mile 1.6, Trip D) is utilized by Erie Boulevard and formerly by the mainline of the New York Central Railroad and the Erie Canal. Lying largely at about 410 feet, the floor of this channel is depositional rather than erosional. The succession of peat, marl over fine sand and clay underlain by coarse alluvium suggests that rising waters of Lake Iroquois inundated this channel, though it may well have been used by meltwaters during the latest glacial recession. Deep fill beneath the channel of Ley Creek suggests that it follows the course of yet another drainage line at elevation too low to have carried post-glacial meltwaters.

Green Lakes State Park

Stop 1, Trip B, visits an area of plunge-pool development in Green Lakes State Park which is almost as striking as that of Green Lake in Clark Reservation State Park. The lakes in the latter park occupy two plunge pools in a meltwater channel cut into the Syracuse Formation between Limestone Creek and the Iroquois lake plain. The western threshold at about 535 feet msl. is incised into glacial drift which in turn is so distributed into the head of the channel as to indicate that meltwater shaped the Green Lakes channel before as well as after the latest glacial episode.

Green Lake is in the shape of a ping-pong paddle with warped handle towards the north. At its deepest Green Lake is 180 feet deep, with its rock floor at less than 240 feet above sea level. Up-valley, 750 feet to the west, Round Lake is comparable in depth and dimensions. With a drop of only about 100 feet from lip to lake level, the pool has maximum depth of 171 feet (Miner, 1933). Both the variableness of depth and gorge width attest to interrupted or "leap-frogging" headward plunge-pool migration in this channel. North of the north end of Green Lake test drilling penetrated 138 feet through marl, peat, silt and clay without apparently entering either till or shale bedrock.

Boonville Gorge

One of the most striking meltwater channels in central New York is the Boonville Gorge, cut by the overflow of proglacially imponded waters from the Black River to the Mohawk Valley. Followed today by N.Y. Rte. 46, Lansing Kill and the abandoned Black River Canal it extends about 12 miles from Boonville to Hillside and the ancestral Mohawk Valley. Incised deeply into the Utica and Trenton Formations the gorge includes three somewhat diverse sections. From its northern threshold at 1130 feet, south to the point where Lansing Kill enters the gorge as a small left-bank tributary, the canyon is steep-walled but open and flat-floored on bedding surfaces of massive limestone. Southward convergence of valley walls shows this northernmost reach of Boonville Gorge to be a converted former tributary to Black River. Although modified evidence of this former valley are observable on the western wall of the valley for another mile or so, sharp incision of Lansing Kill rapidly changes the aspect of the gorge bottom. Across the former drainage divide, the canyon is deep and narrow with gradually steepening gradient. Near Pixley Falls (Stop 8, Trip B) the gorge is about 500 feet deep with shoulder-width of 2000 feet and width-depth ratio of 4:1. Less than a mile southwest of Boonville Gorge State Park is the famous "five combines", a flight of 5 locks by which the Black River Canal mounted its steepest ascent. From this

point south to the hamlet of Hilltop the gorge is incised into the bottom of a gradually broadening south-flowing tributary of the ancestral Mohawk River, which it joins at Hilltop.

Lake Iroquois and its successors in the Oneida Basin

Waning of the ice sheet from the plateau border in the area between Syracuse and Oneida permitted free drainage eastward across the saddle near Rome, thus imponding proglacial Lake Iroquois. In the Syracuse area Coon (1960) distinguished 3 stages or levels of Lake Iroquois. The highest or main stage is represented by strand features at 435-440 feet msl, and is approximately marked by the course of the abandoned Erie Canal in many places east of Syracuse. Spits and barrier bars north of Syracuse are developed at 415 to 425 feet indicating a weakly developed shoreline which in many places closely parallels the main strand. Presumably the modest lowering from the main to the second or Pine Plains strand resulted from reduction of the divide at Rome.

As a result of lowering to the 395 to 400 foot level Lake Iroquois became divided into several basins. The Lockport Dolomite is assumed to underlie the east-west rise that parallels the south shore of Oneida Lake. South of this rise, on the dip slope of the inferred Lockport cuesta and the overlying non-resistant Vernon shale the subsequent basin contained a shallowing remnant of Lake Iroquois during this, the Cicero stage. Marked dune development on the floor of the Pine Plains lake stage is related to the Cicero strand and in places the shore scarp is quite distinct, though low and inconspicuous elsewhere. The Cicero and Canastota mucklands are the last remnants of this filled basin, occupying structural position similar to that of glacial Lake Tonawanda in western New York.

North of Chittenango, the Canastota swamp, comprising part of this Cicero stage basin, has been drained and developed for muckland farming. Post-Iroquois sedimentation is largely clastic in the south and east, but the peat and marl section thickens markedly northward toward the center of the basin. In the vicinity of the Sky-High Farms (Stop 2, Trip B), auger sampling yields a post-Iroquois profile that includes 1 to 3 feet of peat over as much as 16 feet of marl (Hasser, 1954). The invertebrate fauna in the marl section, as recently studied by Julia Veinus suggests possible minor oscillation in depth of the embayment during progressive filling, but it does not otherwise yield direct evidence of climatic change. In the Cicero swamp, a part of the Cicero stage basin several miles west of Sky-High Farms, a 16-ft. peat profile shows pollen zonation beginning with the early pine period (A-1) of Deevey, and ranging through progressive maxima of spruce, of pine and fir, then of hardwood species with a double peak of hemlock frequency. This succession affords a basis for correlation and interpretation of postglacial climatic change suggesting early minor temperature oscillation, with a xerothermic interval reflected by the hemlock minimum between two crests (Cox, 1959).

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