Guidebook

for the

~~26th~~ 23rd ANNUAL FIELD MEETING

OF THE

NEW YORK STATE GEOLOGICAL ASSOCIATION

meeting at

PLATTSBURG, N. Y.

MAY 18 - 19, 1951

Itinerary and Guidebook prepared

by the staff of the

New York State Science Service,

assisted by Philip Oxley, Hamilton College

Albany, N. Y.

1951

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THE ITINERARY

Friday afternoon - May 18 - Western Loop	Time	Mileage
Leave Champlain College gate, proceed north on U. S. 9	1:00 P.M.	0.0
Turn left - Cornelia Street (Routes 3 and 365)		1.3
Plattsburg State Teachers College on left		2.0
Intersection Routes 365 and 22B (stay on Route 365)		5.1
Base of Saranac River delta deposited in Fort Ann stage of glacial Lake Vermont		8.0
Summit level of Fort Ann stage delta - 630 feet		8.8
Right on Route 374 - crossing edge of Saranac River delta deposited in Coveville stage of glacial Lake Vermont - El. 729 feet		10.4
Passing 103 year old Clinton State Prison-Dannemora, N. Y. named after a community in Sweden having similar iron ore deposits		15.8
Stop 1 - Leave buses and walk up hill	1:45 P.M.	16.7

The first part of the highway cut is through an alaskitic phase of the Lyon Mountain granite. The foliation is horizontal to sub-horizontal. Occasional pre-Cambrian diabase dikes cut the granite as do stringers of pegmatite, aplite and "silexite." After a covered interval, outcrops of migmatite may be seen further up hill. The rock is probably a granitized amphibolite. Small overthrust faults cut the rock. Lineation is horizontal. Near the end of the walk, several trachyte dikes may be observed.

Board buses again	2:30 P.M.	17.6
Ellenburg Mountain ahead to the northeast - El. 2654 feet		19.0
Potsdam sandstone float in field on left		20.4
Chazy Lake on left - Lyon Mountain in background El. 3810 feet		22.0
Chateaugay mine ahead		27.7
Bear right at road fork		28.9
Turn sharp left at service station		29.1
Bear right - Chateaugay mine on left		29.2

See description of this mine in section on Economic Geology. Recent production at this mine has exceeded $3,000,000 in value annually.

Bear left at Railroad crossing		29.5
Waste rock from iron mining on left		29.6

This feldspar-rich gangue is being used by The Construction Sales Corporation of Albany for "Go-Sticks" a patented product to prevent car wheels from spinning on ice. Other uses involving such frictional properties are contemplated.

Stop 2 - Entrance to 81 mine-open pit	3:00 P.M.	32.8

The group will be guided at this stop by mine personnel. This old mine was reopened as an open pit early in 1948.

Board buses to continue trip	3:45 P.M.	
Turn left in Standish		33.5
Crossing kame-terrace formed against ice block in Saranac River valley. Road cuts down through kame-terrace. Whiteface Mountain may be seen ahead.		39.1

	Time	Mileage
Foot of ice-contact slope which trends approximately east-west		40.3
Intersection with Routes 3 and 365. Turn right		44.1
Lyon Mountain granite in roadcut		44.5
Stop 3 - Roadside cut of granitized amphibolite cut by basic dikes	4:15 P.M.	45.0
Buses turn around and proceed east on Routes 3 and 365	4:35 P.M.	45.2
Village of Clayburg - Saranac River on right		46.4
High level local glacial lake delta (El. 1000 feet) across valley		51.3
Surge tower on power tunnel across Saranac River. A 12 x 12 foot rock tunnel extends for 3/4 mile from surge tower southwest to dam at falls on Saranac River. Penstock connects tunnel with hydroplant of Eastern New York Power Corporation on the river.		52.0
Bear right on Routes 3 and 365		54.1
Right at fork in Cadyville, off Routes 3 and 365		60.2
Cross delta of Coveville stage-Lake Vermont		60.9
Right		60.95
Left		61.0
Potsdam sandstone cliffs across river in gorge		61.2
Stop 4 - Kent Falls	5:05 P.M.	61.7

Collect Potsdam at this stop for this must not be done at Ausable Chasm.

The section of Potsdam exposed in the Saranac River was estimated by Van Inen at 1170 feet. It consists mainly of barren sedimentary quartzites and coarse sandstones, with cross bedding, sometimes with an amplitude of 3', occasional layers of conglomerate containing flat greenish clay shale pebbles, and some layers showing extensive "fucoidal markings," indicating reworking by worms. The greater thickness here belongs to the Lower Dresbach (Mt. Simon equivalent). Shortly downstream from the falls has been found traces of the Crepicephalus fauna of the middle Dresbach. The Lower Franconia is missing, so that the middle Dresbach is succeeded by the Ptychaspis zone of the Upper Franconia, which represents the top of the Potsdam outcrop in this section. Farther northwest the Prosaukia zone has been found above it, bringing the top of the Potsdam nearly up to the top of the Franconia.

Trilobite layers are unfortunately not accessible enough to be shown to the group.

	Time	Mileage
Leave Kent Falls	5:35 P.M.	
Passing Marine sand deposits		63.8
Intersection with Route 22B - bear left		64.2
Morrisonville		64.5

In 1898 a well was drilled in search of oil near Morrisonville. Drilling continued for about two years. At the end of that time, 1345' had been penetrated of which the bottom 775 feet was Potsdam sandstone. No indication was apparent that the bottom of this formation had been reached. A little oil was found in one of the strata of the Potsdam and one horizon was water-bearing. The log follows:

	Time	Mileage
Glacial drift 0-20 feet		
Beekmantown (dolomitic ls.) 20-520 feet		
"Transitional beds" (dolomite and ss.) 520-570 feet		
Potsdam sandstone 570- 1345 feet		
Delta of Saranac River deposited in marine waters on left (El. 425 feet)		64.9
Intersection with routes 3 and 365 - bear right		66.4
Champlain College - Plattsburg	6:00 P.M.	71.5
Saturday morning - May 19 - Southern loop		
Leave Champlain College gate	8:30 A.M.	0.0
Sharp left at traffic light on Route 22		0.2
Sand pits in marine deposits on right		1.6
Bridge across Salmon River - Upper Canadian, Providence Island dolomite outcrops up and downstream		4.3
Right on county road		7.6
<u>Stop 1</u> - Marine sands and gravels with fossil shells	8:45 A.M.	8.1
Buses turn around		
In the sand pits on the west side of the road, large numbers of the small white <u>Macoma groenlandica</u> may be found. The fragile blue <u>Mytilusedulis</u> is more characteristic of the gravelly layers. <u>Saxicava rugosa</u> is much less common.		
Leave Stop 1	9:10 A.M.	
Return to main road - turn right on Route 22		8.6
Left in village of Peru		9.9
Right on Route 22B in village of Peru		10.2
Straight ahead off 22B		10.7
Right turn		11.3
Left turn		12.5
Along Peru glacial beachers - Fort Ann stage		13.7
These beaches, poorly seen from the road, constitute one of the best series in the Champlain Valley. These have been carefully surveyed and it was found that they slope southward at 5.6 feet per mile. The rounded beach cobbles may be seen strewn in the fields and piled in stone fences. Well-developed hooks on the southern ends indicate the northerly component of the wind during the warning stages of the ice sheet.		
Straight at crossroads		14.8
Left at intersection		16.3
Right turn in village of Harkness		16.6
Granitic gneiss in roadside exposure		19.2
Road leading to Arnold Hill mine (see description in section on Economic Geology)		19.4
Continue on road to Clintonville		
View of Whiteface Mountain on right		20.3
Left on Route 9N at Clintonville-Ausable River on right - Lake Vermont lakesands in valley		21.4
<u>Stop 2</u> - Quarry in anorthosite	9:45 A.M.	26.2
Various types of anorthosite can be seen in this quarry. Some of the phases closely approximate the "Marcy" type - other, crushed zones, more closely		

	Time	Mileage
resemble the "Whiteface" type. The whole mass has been faulted and later minerals have formed along the shear zones.		
Leave Stop 2	10:15 A.M.	
Fort Ann stage beach across Ausable River-outskirts of Keeseville		27.5
Pokamoonshine Mt. (exfoliated granite dome) in distance on right		27.7
Potsdam sandstone outcrops in river		27.8
Intersection Routes 9 and 9N in Keeseville - continue north on Route 9		28.3
Stop 3 - Entrance Ausable Chasm	10:25 A.M.	30.1

The group will go as far as possible in the post glacial gorge of the Ausable River as time allows.

AUSABLE CHASM

The Potsdam sandstone here consists of three gently tilted fault blocks, of which the middle is downdropped between the other two. The fault separating the middle from the upper (upstream) block is seen just at the turn of the gorge downstream of and in sight from the bridge by which the main road crosses the chasm. The lower beds, exposed in the end blocks, represent the lower barren part of the Potsdam. At the upper end of the gorge ripple marks can be seen. These beds have also yielded the trail Protichnites, which can be seen on exhibition at the lodge, also the large Climactichnites. A thin horizon in the middle block has yielded a sparse fauna, unfortunately not accessible at present, indicating the presence of the Crepicephalus zone, middle Eau Claire time. PLEASE DO NOT HAMMER THE ROCKS OR ATTEMPT TO COLLECT. YOU WON'T GET ANYTHING, ANYWAY.

	Time	Mileage
Lv. Ausable Chasm	11:25 A.M.	
Road cut through delta of Little Ausable River deposited in Plattsburg stage of marine waters.		34.3
View across Lake Champlain - Mt. Mansfield, highest in Vermont (El. 4364') in background		34.7
Stop 4 - Cedar Edge Cabins - Fort Cassin (Upper Canadian) limestones in Champlain shoreline	11:35 A.M.	36.0

This section, measured by Ruedemann (1906, P. 397) was for many years the only known fossiliferous exposure of the Fort Cassin beds aside from the type section at Ft. Cassin, Vt. The beds are dolomites with some beds of pure and very hard limestones. These limestones masses are replete with fossils, unfortunately very difficult to extract. Here can be seen a siphuncle of the large piloceroid, Cassinoceras explanator and abundant isolated siphuncles of Proterocameroceras brainerdi. Other cephalopods include the coiled Tarphyceras seelyi and Eurystomites kellogi, known only from this horizon, the straight annulated Protocycloceras lamarcki, fragments of the trilobite Isoteloides whitfieldi, gastropods, and occasional brachiopods. The lower beds of this section contain abundant Murchisonia obelisca and Calaurops lituitiformis. Regretably, collecting is difficult and is good only under propitious conditions of weathering.

	Time	Mileage
Leave Stop 4	12:00 Noon	
Stop 5 - Day Point	12:05 P.M.	36.7

Here, along the Champlain shore, is exposed a section of Chazyan rocks forming a low anticline, and separated from the Fort Cassin on the south by a fault, located at the buildings on the large estate which can be seen from Day Point. The section is described in detail by Ruedemann (1906).

The Chazy is here remarkably fossiliferous, the lower beds of massive limestone with some reefy structures, contain abundant fragments of algae, bryozoa, trilobites, brachiopods and gastropods, and also several species of large endoceroids. These beds were, for many years, the only known occurrence of Plectoceras jason, the large coiled cephalopod, which was first described from the Mingan Islands, as well as Deltoceras vaningeni. The higher beds, best seen at the north end of the section, are calcarenites notable for an abundance of trilobites in great variety, including "Eoharpes" antiquus, Lonchodomas halli, Pliomerops canadense, Illaenus erastusi, Illaenus globosus, Thaleops ovata, Isotelus obtusus, the brachiopods Camerella varians, C. longitostris, Hebertella vulgaris, and have yielded cystids, Malocystites and Paleocystites.

This fauna is unique in the Chazyan in several respects, and the exact position of these beds is uncertain, Ruedemann (1906) regarded them as Lower Chazyan, which influenced Cushing to name the Lower Chazyan Day Point limestone which, however, is defined not in terms of this section, but as A of Brainerd and Seely from the type section at Chazy. Raymond (1906) and later Ruedemann (1912) considered these beds to belong to the Middle Chazyan Crown Point limestone. Cover obscures relationship and faunal similarities are closest to division B2 of the Chazy section.

In this exposure is a camptonite dike, 72" wide striking N 71 W. It yields no fossils.

Battle of Valcour Island

From the stop at Day Point, we can look across the short stretch of water to Valcour Island. This narrow strait was the scene of a naval battle between an inferior, poorly equipped, and insufficiently manned American force, and a superior fleet of British warships, invading from Canada.

After the disastrous American invasion of Canada in the early part of 1776, Benedict Arnold withdrew his battered army to Ticonderoga, where he set about building a naval force to repel the invasion he knew would be forthcoming. He was able to assemble a fleet of 15 vessels, mostly small boats, with a total of 88 guns. His most formidable vessel was a 12-gun schooner, the Royal Savage. This inadequate force was manned by land soldiers, drawn mostly from the garrison at Ticonderoga, and to add to the confusion, the armament was a collection of all sizes and shapes. The difficulty of maintaining effective firepower must have been great indeed when each vessel's gun-crews were working with guns of various calibers!

On the morning of 11 October 1776, word was received that the British fleet had been discovered passing Cumberland Head. Captain Pringle, the English commander, had 25 warships, including the INFLEXIBLE, 300 tons and carrying 18 guns, which by itself was capable of destroying the American fleet, and a number of smaller armed boats, with a total of 89 guns. This fleet was manned by trained British seamen.

Arnold brought his small force into Valcour strait and moored his vessels in a small bay on the island as near together as possible. The British, sailing down the east coast of the island did not discover the Americans until they had passed the southern tip, and, since there was a strong wind blowing from the north, the larger ships could not beat back within range. The smaller gunboats closed in and by 11 o'clock they began firing. The CARLETON, a 12-gun schooner, and some smaller vessels, supported the gunboats. By some mistake, Arnold's heaviest ship, the ROYAL SAVAGE, drifted beyond the American line, southward toward the enemy, and took the fire of the gunboats alone. Badly shot up, she was run aground on Valcour Island and burned during the night by the British.

At 12:30 the engagement became general and raged until dark. During this fighting the Americans were harassed from the shores of the mainland and Valcour Island, by Indian allies of the English under Major Carleton. Captain Pringle recalled his fleet around 5 o'clock after trying vainly to bring up his heavier ships. He anchored out of range of the American guns and waited to renew the attack the next day. The American fleet had been severely cut up and one ship had been sunk, and their losses in men were "about sixty." The British had lost 3 gunboats, and their casualties amounted to about 40 men.

Arnold had used up about 3/4 of his ammunition, and "being sensible to the inferiority of his force," decided to sneak past the English fleet in the darkness and make his escape to Crown Point. Slipping quietly in single file, past the line of enemy ships the Americans reached Schuyler Island the next morning. Due to excess damage, two more of the American vessels had to be sunk. The British awoke to find their prey gone and joined hotly in pursuit. They caught up to the fleeing American just after they passed Split Rock and a running battle ensued, during which the American fleet was scattered and destroyed. For the two day's battle, the American losses, in men, amounted to "eighty odd," while the English losses were "about forty." This English victory was not followed up, and shortly afterward they returned to Canada.

Although this battle resulted in a decided victory for the British, it helped to prevent the invasion in force. The American rebels proved that they were prepared to fight for their ideals, and what is just as significant, that they were able to fight, in spite of inferior equipment and lack of training.

Lv. Stop 5	12:40 P.M.	
Day Point quarry on left - formerly quarried Chazyan limestones		38.5
<u>Lunch Stop</u> (#6) - Cumberland Bay State Park	1:00 P.M.	46.3

Battle of Plattsburg

The battle of Plattsburg was fought on land, but the victory was determined by the naval battle that raged in Cumberland Bay while the land armies were fighting.

The year was 1814, and the time just after Napoleon had been defeated in Europe. A good many of Wellington's seasoned veterans had been arriving in Canada and by the end of August the British had 15,000 men at Montreal, ready for the invasion of the United States. Sir George Prevost, Governor of Canada, and General-in-Chief of the armed forces there, commanded the invasion by land, while the British fleet, under Commodore Downie, proceeded up Lake Champlain.

General Alexander Macomb, in command at Plattsburg, had only 3500 men, but General Benjamin Mooers, commanding the militia, had been very energetically gathering his forces and had succeeded in assembling about 5000 men.

Prevost announced his intention to seize and hold northern New York as far down as Ticonderoga, and called upon the inhabitants to renounce their allegiance and support him. By September 5, he was within 8 miles of Plattsburg, but Macomb had been busy the while erecting block houses and redoubts in preparation for the attack. The next day Prevost advanced in two columns, the right one crossing over to the Beekmantown road. To oppose the advancing right column of the enemy, Macomb sent Major John Wool with 280 regulars to support the militia who were already in that vicinity. The British advance guard was encountered at Beekmantown and as soon as the engagement was begun the militia broke and ran. The regulars, however, stood firm and resisted valiantly, although pushed back steadily toward Plattsburg. The British forced the Americans back over the Saranac River, but when they tried to cross, were repulsed. Prevost then spent the interval from the 7th to the 11th of September in bringing up batteries and supply trains and constructing works that would command those of the Americans.

In the meantime, the British naval forces, under Commodore Downie, were approaching Cumberland Head. Downie had one brig, two sloops-of-war and twelve gun-boats; plus his flagship, the CONFIANCE, 38 guns. The American Commander, Captain Thomas MacDonough, lay in Cumberland Bay with his fleet consisting of: flagships SARATOGA, 26 guns; one brig; two schooners; and ten gunboats.

On the morning of September 11th, the British flotilla rounded Cumberland Head at the same time that the land forces were moving to a renewed attack. The en-suing naval engagement lasted for two hours and twenty minutes and resulted in victory for the Americans, altough both fleets had been severely damaged. Downie was killed, and was buried at Plattsburg. The Americans lost 110 men, and the British lost over 200 men.

On land, the British had been attempting to cross the Saranac River at two places but were being vigorously repulsed by the Americans entrenched on the south side. The news of the great naval victory heartened the defenders and alarmed the British, who started to withdraw immediately. The fighting ceased at twilight on the 11th, and the English retreated to Canada.

Captain MacDonough received great honors and rewards for his crucial victory, including a grant of 2000 acres of land from the State of New York and 200 acres on Cumberland Head, overlooking the scene of his triumph, bought by the State of Vermont and presented to him. The MacDonough Memorial Monument can be seen in downtown Plattsburg.

Saturday afternoon, May 19 - Northern loop	Time	Mileage
Leave Cumberland Bay State Park and proceed west	2:00 P.M.	
Intersection Route 9		47.1
Trenton outcrop in road cut (Dolgeville facies)		47.9
Trenton outcrop in road cut (Dolgeville facies)		48.4
Cumberland Head shale in road cut		49.0
Trenton limestone in road cut		50.1
Upper Trenton limestone in road cut		50.6
Crossing Ingraham esker - note gravel pit in the crest		52.4
The Ingraham esker runs about 7 miles in a northerly direction from this point and will be crossed twice more on this trip.		
Village of Ingraham - cross esker again		53.5
Outcrop of Day Point limestone		55.8
Day Point (lower Chazyan) limestone in field on right Filled with pink cystid stems		56.3
Turn right on Sheldon Lane - Chazy Lime and Stone Co. quarry on left - quarrying Crown Point limestone		57.5
<u>Stop 7</u> - Little Monty Bay locality	2:20 P.M.	57.9

This locality has suffered nomenclatorial vicissitudes. Little Monty Bay now appears on the topographic maps as Trombley Bay, and the road has recently sprouted the name of Sheldon Lane. It is, nevertheless, the locality which has been long known as Little Monty Bay (Ruedemann 1906).

The section on the north side of the road shows the lateral rapid alternation between calcarenites and the fine grained dove grey calcilutites which contain the famous association of trilobites, cephalopods and gastropods, the <u>Glaphurus pustulatus</u> fauna of Raymond. Here trilobites, cephalopods and gastropods appear almost to the exclusion of all other types, and supply an association unique in the Chazyan. Lower beds, currently attributed to the Crown Point limestone, show similar reef structures, but lack the Glaphurus fauna.

On the south side of the road, the party will walk to the south, descending through the Crown Point limestone, to see cross bedded calcarenites attributed to the Day Point limestone.

	Time	Mileage
Leave Stop 7	3:05 P.M.	
Turn left at lake shore		58.9
Cross Little Chazy River		62.3
Turn right - intersection with Route 9		65.7
Cross Big Chazy River		65.8
Roadside outcrop -		66.4

On left is Day Point limestone in place, coarse calcarenite. On the right is a glacially transported boulder of the Lacolle conglomerate, of Trenton age, typically developed in Quebec.

Stop 8 - Coopersville quarry (Bechard farm) -	3:25 P.M.	67.4

Buses turn around

These quarries, now abandoned, are cut into typical reef structures in the Chazyan. Much of the material is a blue coarse grained limestone full of crinoid and cystid fragments; there occur large reef masses made up of calcareous algae (Strephochetus and Stromatocerium, the coral Lamottia, and calcareous sponges (Eospongia, Hudsonospongia). The calcarenites also contain Maclurites magnus. Here also are fine grained lime muds with the characteristic Glaphurus pustulatus fauna. This exposure illustrates, far more clearly than the last, the relation of the reef and interreef beds, and the perplexities of differentiation of the Middle and Upper Chazyan where reef facies are involved.

Leave Stop 8 - Proceed westerly on Route 9	3:55 P.M.	67.4
Turn left at intersection with Route 9B. Potsdam sandstone		70.8
Potsdam sandstone in Railroad underpass cut		73.3
Right on Route 348 in Village of Chazy		74.0
Quarry in limestones of Black River age		74.6

Stop 9 - Type section of the Chazyan	4:10 P.M.	75.1

The type section of the Chazyan consists of gently dipping strata exposed for an interval of about two miles along the Chazy-West Chazy road. Time permits only the examination of the upper part of the section.

At the base are seen heavy bedded limestones, the surfaces covered with Maclurites magnus. These beds are the source of the rare Gonioceras chaziense and Ruedemannoceras boyci as well as Spyroceras clintoni. Other fossils are not obvious, but the bed has yielded brachiopods and trilobites, also Bellerophon and Raphistoma. Above are less massive shaly weathering limestones, rather poorly exposed, and then a thin layer of yellowish weathering dolomite which was taken as the base of Brainerd and Seely's division C. Above 11' of relatively barren limestone, the upper part of wich is the "Birdseye limestone" of Emmons, is a layer containing small nodules of the alga Strephochetus ocellatus, most colonies of which are found growing on small shells, most commonly Murchisonia. This bed is the source of the rare Orthoceras modestum and Ecdyceras sinuiferum, the first of the ascoceroid cephalopods. Above a poorly exposed interval are the limestones of the upper part of the Valcour limestone in which the fauna is dominated by the brachiopod Rostricellula plana.

Leave Stop 9	5:00 P.M.	

	Time	Mileage
Crossing Tracey Brook fault (covered by swamp)		75.9
Cross Ingraham esker		76.9
Right on Route 348		79.8
Left on Route 22 in village of West Chazy		80.5
Middle Canadian (Beekmantown) limestone in field on left. Potsdam sandstone boulders are patches of bars and ridges of waterworn drift discharged by torrential glacial waters into glacial Lake Vermont. 4 miles to the northwest is a great bare area of Potsdam sandstone known as the Altona Flat Rocks which was the source of this material. The ice edge spillway is spectacularly developed in the Flat Rock area.		82.3
Middle Canadian (Beekmantown) limestone at County Home		86.4
Beekmantown limestone in field on right		87.4
Chazy limestone in field on right-probably Crown Point		87.9
Chazy limestone		88.2
Old quarry in Chazy limestone on left		88.8
Plattsburg Rock Products Co. quarry on right (Chazy ls.)		88.9
Left		89.5
Right		89.55
Left on Cornelia St.		90.2
Right on Route 9		90.9
Left on Route 9 (Discharge at hotels if desired)		91.0
Right on Route 9		91.2
Champlain College - end of trip	5:45 P.M.	92.1

Pre-Cambrian

The Clinton County pre-Cambrian rocks lie in the foothills section of the northeastern Adirondacks. The geology of this area is fairly characteristic of the eastern Adirondack region, although the topography is not quite so rugged.

The pre-Cambrian section is composed of a wide variety of rock types listed below in the order of the relative ages, i.e., youngest to oldest:

Diabase and rhyolite dikes
Gabbro-diorite dikes
Syenite-granite series
Anorthosite
Gabbro and amphibolite
Grenville series

On top of the pre-Cambrian section, scattered Pleistocene sediments are preserved in highly variable thicknesses.

Grenville. Although the ancient Grenville sediments probably once covered the entire area, only scant remnants are preserved, and the identity of all but some quartzites and certain gneisses and schists have been obliterated by the abundant igneous intrusions represented in the area. The small amount of Grenville preserved is all intimately penetrated by the intrusives so that the term "mixed rock" is properly applied to such occurrences.

Gabbro and Amphibolite. Most of the gabbro and amphibolite masses lie within the Lyon Mountain granite. All of the gabbro is somewhat metamorphosed,but in some cases the original igneous textures are largely preserved. Much of the amphibolite is properly considered to be a metamorphic facies of the gabbro (hence, a metagabbro), and in a few places the transition from gabbro with igneous textures to good amphibolite can be observed in the field. It should be kept in mind, however, that some of the amphibolites not directly associated with gabbro may well have been derived by metamorphism of Grenville sediments.

Anorthosite. The anorthosite is rather meager in amount in the area now under consideration, but it is part of a much more extensive mass that forms the greater part of the central massif of the Adirondacks. Two distinct facies are recognized, the "Marcy type" and the "Whiteface type". The latter is most common in this area, and typically is a light greenish-gray rock essentially composed of 70-90 percent calcic plagioclase and 10-30 percent mafic minerals. The "Marcy type" is characteristically dark blue, coarse-grained, and composed of 90 percent or more calcic plagioclase, with less than 10 percent mafics. Representative "Whiteface type" anorthosite will be seen in an old quarry near Ausable Forks.

Syenite-Granite Series. Compared with the rest of the Adirondacks, syenitic phases are scantily represented and where present appear to be transition phases of the larger granite masses.

Of the granites, the Lyon Mountain granite is the most extensive in the area. Characteristically it is a pink, medium- to fine-grained, alaskitic microcline granite moderately foliated and abundantly shot through with pegmatite, aplite, and silexite dikes. It contains abundant sheets and lenses of amphibolites and dark gneisses locally. Such "mixed rock" zones probably represent incorporated and partially-assimilated screens of old Grenville sediments into which the granite was intruded. All of the magnetite deposits of the area are associated with the Lyon Mountain granite.

The related Hawkeye granite is typically a coarse-grained microperthite-microcline granite of low mafic content and porphyritic textures locally. Most of the rock is moderately gneissoid, although local areas may be practically devoid of foliation or, on the other hand, almost schistose. In contrast to the Lyon Mountain granite the Hawkeye seldom forms "mixed rock" associations with older metamorphics. It is possible that the Lyon Mountain and Hawkeye granites represent separate facies derived from the same parent magma.

Dike Rocks. The relative ages of the diabase and rhyolite dikes which occur in the area are not clearly shown, but it seems probable that they are of the same age essentially. The gabbro-diorite dikes, on the other hand, are believed to be definitely older than the diabase and rhyolite. None of the above dike rocks are of important areal extent.

PALEOZOIC HISTORY

Cambrian System

Potsdam sandstone - The Potsdam sandstone rests on an uneven pre-Cambrian surface through the length of the Champlain valley, extending west to the Thousand Island region across its north flank. To the south, in the Mohawk Valley, the formation becomes more calcareous, grading into the "Theresa" of Saratoga, and eventually the lower Little Falls of the Mohawk valley.

The Potsdam consists of 300 to nearly 1500 feet of sandstone, sedimentary quartzite, with occasional beds of conglomerate, characteristically with flat green clay pebbles, occasional calcareous sandstones and thin beds of pure dolomite. Cross bedding is a common feature, sometimes to the amplitude of three feet. Surfaces commonly are ripple marked; also common are "fucoidal markings" where the sediments have been reworked by worms. Common in all beds are large rounded and frosted sand grains. Occasionally the base is strongly arkosic.

Marine faunas are confined to relatively thin layers, either of thin-bedded sandstone with some lime cement, or to the conglomerate layers. Restudy of these has shown that the Potsdam can be correlated with the Upper Cambrian of Minnesota and Wisconsin.

In the northern end of the Champlain valley the basal 1000 feet are barren except for occasional trails, *Protichnites* and *Climactichnites*, the former an arthropod trail, the latter of uncertain origin, probably a gastropod. These beds, together with the included trails, are also characteristic of the Mt. Simon sandstone, basal Dresbach, of Minnesota. They are completely absent in the southern end of the Champlain valley.

Above these sandstones occur calcareous sandstones with a fauna of the *Crepicephalus* zone of the Eau Claire formation, containing *Lonchocephalus minutus*, *Komaspidella seelyi*, *Hyolithes*, and *Lingulepis*. This horizon has been found from Fort Ann northward to Kent Falls. The underlying *Cedaria* fauna and the overlying *Aphelaspis* fauna are unknown in New York.

The Ironton horizon (lower Franconia), characterized by *Camaraspis*, *Elvinia* and *Berkeia*, is present in the "Theresa" at Saratoga, which becomes sandy to the east, so that the same horizon occurs in the middle of the Potsdam at Fort Ann and Whitehall. It is succeeded by the *Conaspis* fauna, of middle Franconia age. No higher faunas have been found in the south end of the Champlain valley.

The next trilobite zone, of *Ptychaspis*, occurs only in the north, where it lies closer to the *Crepicephalus* zone than does the *Elvinia* zone of the south; plainly the lower and middle Franconia is absent or represented at the most by a few feet of barren sandstone. At Kent Falls, the Ptychaspis zone lies at the top of the exposed section. At Chateaugay it is succeeded by the Prosaukia zone, bringing the top of the Potsdam to a position high in the Franconia stage. The Trempeleau, highest Upper Cambrian, is missing in the northern Champlain valley. It is represented only in the south by the Hoyt formation of Saratoga, and its equivalents which disappear shortly north of Ticonderoga.

"Theresa" - The "Theresa" formation is properly a facies of the Potsdam, as recognized in the Mohawk and Champlain valleys. There has been no uniformity in usage as to the lithological division between these formations, and present work shows that the contact between the "Theresa" and Potsdam, between beds dominantly of sandstone and those dominantly dolomitic but with appreciable beds of sandstone similar to those of the Potsdam occurs at different horizons in different places. At Saratoga the Theresa begins at or below the base of the Ironton; at Fort Ann its base occurs above the middle of the Franconia. It has not been studied in the northern Champlain valley, but indications are that the higher Franconia beds are here dominantly sandy, of Potsdam rather than Theresa lithology.

Hoyt - The Hoyt limestone represents deposition of late Trempeleau age at Saratoga, consisting of oolitic limestones and dolomites characterized by three bands of Cryptozoon, and an associated trilobite fauna with Plethopeltis, Saratogia, Prosaukia, Keithiella, Plethometopus, the gastropods Matthevia and Pelagiella, and the brachipod Lingulepis. The beds are present at Fort Ann and Whitehall, where there is rapid faciological change between limestone and dolomite. The thinning edge of the formation is seen at Ticonderoga. No beds of Hoyt age are present at Shoreham, Vt., and deposits of late Trempeleau age are unknown farther north in the Champlain valley.

Little Falls - Cushing and Ruedemann (1914) regarded the section at Saratoga as comprising the Potsdam, Theresa, Hoyt and Little Falls. The Little Falls is a dolomite, free from sand, with occasional bands of Cryptozoon in the Mohawk valley, and supposedly barren otherwise. It has long been known mainly as the source of quartz crystals, the "Little Falls diamonds." The upper beds in the type area, which will ultimately be separated, yielded some gastropods of Gasconade aspect, and are more properly grouped with the Lower Canadian Tribes Hill formation. The underlying part is a facies of the Potsdam-Theresa sequence of the Saratoga region, lower and middle Upper Cambrian in age.

The so-called Little Falls at Saratoga is not true Little Falls, and recent finds confirm its Lower Canadian age, indicating that it is the equivalent of the Tribes Hill formation, and of the Lower Canadian of the southern Champlain valley. The Little Falls, like the Theresa and Potsdam are, as formerly employed, lithological units of various ages in different places. At Fort Ann, "Little Falls diamonds" and the typical lithology can be found in the lower part of the Hoyt (Whitehall formation) interval, and again in an overlying and as yet unnamed interval (Baldwin Corners group; Flower, ms.).

Canadian System

The "Calciferous sandrock" of the old reports originally embraced the "Theresa" facies as well as the overlying dolomites. Brainerd and Seely (1890) presented a measured section at East Shoreham, Vt., dividing the "Calciferous" into lettered units A through E, not because they couldn't remember what came after E, but because they ran out of rock. Whitfield described a fauna from Fort Cassin, Vermont, of Ordovician aspect; later these beds were to be known as the Fort Cassin formation. Cleland described quite a different fauna in the Mohawk valley, later named the Tribes Hill formation. This fauna, much older, was the source of much confusion in relation to the Ozarkian-Canadian controversy; Ulrich contended that it was lowest Canadian, younger than the highest Ozarkian. More recent work, largely unpublished, has shown that the Upper Ozarkian (Gasconade) and lower Canadian (Tribes Hill) are actually facies faunas of the same age. Dolomites beneath the Tribes Hill, which yielded occasional Cryptozoon and Lingulepis, were regarded as Upper Cambrian, present in the Mohawk valley and disappearing somewhere in the southern Champlain valley.

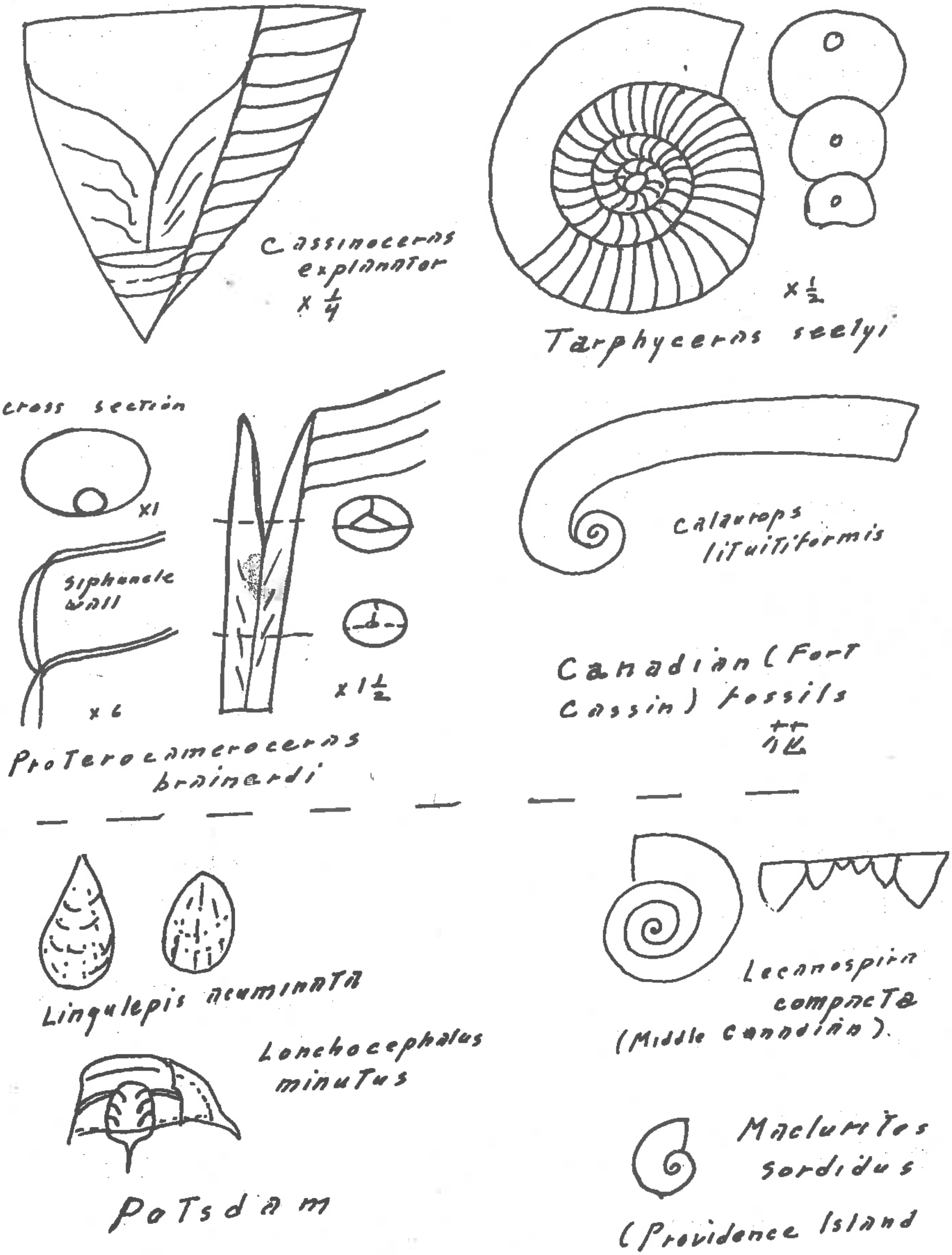

Cassinoceras explanator x 1/4
Tarphyceras seelyi
x 1/2
cross section
x1
siphuncle wall
x 6
x 1 1/2
Proterocameroceras brainerdi
Calaurops lituitiformis
Canadian (Fort Cassin) fossils
Lingulepis acuminata
Lonchocephalus minutus
Potsdam
Lecanospira compacta (Middle Canadian).
Maclurites sordidus
(Providence Island

Plate I

Attempts made to subdivide the Canadian over an extensive area led to widely differing conclusions, largely because all attempts began with the "classic" divisions of Brainerd and Seely. Their division A. was dolomite; B was limestone, C was dolomite, D was limestone and E was dolomite. This is not, after all, very profound.

Stripped of the complexity of new and some unpublished names, Canadian deposition in the Champlain Valley is as follows:

Lower Canadian time is marked by a widespread invasion of the sea depositing some sandstone, dolomites and limestones with complex facies relationships, marked in particular by rapid lateral changes from dolomite to limestone. The fauna in these beds indicates conclusively Lower Canadian age (Gasconade) characterized by cephalopods of the family Ellesmeroceratidae, the gastropod Helicotoma uniangulata, the trilobite Paraplethopeltus sp. The top of the Lower Canadian is everywhere marked by an erosion surface, with solution cavities in the limestones filled with a sedimentary breccia. Lower Canadian beds are unknown in the northern Champlain valley on the New York side. They comprise the interval in Vermont of the upper part of division A of Brainerd and Seely, and the entire division B. Lower A is of late Franconia age; the entire Trempeleau, highest Cambrian, being absent from Shoreham northward.

Middle Canadian time is marked by a second widespread marine invasion depositing coarse dolomites, many quite sandy in the northern Champlain valley, and beds of relatively pure limestone in the south. The fauna is characterized by primitive endoceroids (Cyptendoceras and Clitendoceras), Bassleroceras, the gastropods Lecanospira compacta and Leseurilla sp., and the trilobite Bathyurus conicus (Billings). This fauna is found in the Spellman and Kirby ledges at Beekmantown, New York, and indeed, it is only this interval which has been found in place of Beekmantown. It is the Beauharnois formation of southern Quebec, and the Rockdale limestone of the southern Hudson valley. It comprises the divisions C and lower D of the section of Brainerd and Seely at Shoreham, Vermont, the Cutting formation and lower Bascome of Cady (1945).

Upper Canadian time is separated from the Middle by a widespread break in deposition represented in the Missouri section by several hundred feet including the Jefferson City, Cotter and Powell formations. This interval, the lower part of the Upper Canadian, is represented in New York only by deposits of late Jefferson City time in the Ogdensburg region, at Middle Falls, N. Y., in the thrust block called the Bald Mt. limestone; and it has recently been discovered by Mr. Donald Fisher in the eastern Mohawk valley.

The Fort Cassin beds, originally embracing upper D of Brainerd and Seely and all of division E, represent a sequence of (1) prominent silty sandstones, (2) alternating limestones and silicious dolomites, (3) massive dolomites with a few beds of pure limestone and (4) thin bedded limestones and dolomites grading upward into massive reefy beds of limestone alternating with dolomite. As these are traced upward the limestones disappear, giving place to the dolomites of division E. These beds have been separated as the Providence Island formation (Ulrich 1938) and mapped by Cady as the Bridport formation.

The Fort Cassin beds contain a large and beautifully preserved fauna, but one extremely difficult to extract because of the hardness of the limestones. Formerly, only two good localities for these beds were known, the type section at Fort Cassin, Vermont, and the section measured by Ruedemann (1906) along the shore of Lake Champlain south from the town of Valcour. These beds present a nearly complete section of the upper part of the Fort Cassin including the richly fossiliferous beds. The fauna is dominated by three types of cephalopods, which are characteristic of the Upper Canadian all over the world: the large piloceroids (Cassinoceras explanator), the coiled cephalopods of the Tarphyceratida (Tarphyceras seelyi, Eurystomites kellogi) and primitive endoceroids (Proterocameroceras brainerdi). Protocycloceras lamarcki is also common here. The commonest trilobite is the large asapeid, Isoteloides whitfieldi. Common gastropods are Calaurops lituitiformis, Plethospira cassina and Murchisonia obelisca, Ecculiomphalus volutatus and Maclurites (?) acuminatus and Syntrophia lateralis. Brachiopods are scarce, Polytoechia apicalis the commonest.

The Fort Cassin beds as restricted have a thickness of about 250 feet. The Providence Island formation (= Bridport of Cady), 470 feet thick at Shoreham, Vt., is not sharply set off from the underlying Fort Cassin, but has been distinguished as a mapable unit owing to its thickness and lithological difference. The dolomites are largely barren, but contain at the top a few beds of limestone. The only common fossil is the small gastropod "Maclurites" sordidus (Hall), originally described from Glens Falls, New York.

LOWER ORDOVICIAN

CHAZYAN

The Chazy limestone as a unit is one of the most prolific formations in the New York section. It marks the appearance, in great abundance and variety, of genera, families and sometimes higher groups which are to persist throughout the remainder of the Orodovician; it marks the appearance in the column of abundant members of two phyla, the echinodermata and the Bryozoa; the first appearance of the pelecypods, practically unknown in the Canadian. The gastropods, which have been less closely studied, show less marked changes, but in the cephalopods its base marks the disappearance of old and the appearance of new groups which are, for the most part, orders rather than families.

It marks a change in quite a different way - paleogeographic. Where the Canadian limestones were fairly uniform throughout North America, in the Chazyan, for the first time, the column begins to be composed of a series of definite facies faunas, which modify the range of species and genera locally and complicate the problem of widespread geographic correlation.

The Chazyan is a time of restricted seas; the Chazyan sea itself never penetrated to the south end of the Champlain valley. We find its marine equivalents with strikingly similar faunas only in a few places, the Mingan Islands, Newfoundland, and to a lesser degree, Oklahoma and Nevada. Beds now regarded as Chazyan in age in other regions of North America have rather different faunas, and plainly the effects are in part the result of paleogeographic conditions, but also in part ecological.

The Chazyan of the Champlain valley consists of about 700 feet of sediment, mainly of limestones. The type section, southwest of Chazy village, was measured by Brainerd and Seely (1888), and divided into three major units which, as in the Canadian, they indicated by letters. Cushing (1905) proposed geographic names for these divisions, the Day Point, Crown Point and Valcour formations. In view of the lack of apparent evidence that the Chazyan was laid down in three cycles of deposition, it is perhaps wishful thinking to attempt to map the formation in terms of these three units, particularly since rapid facies changes complicate correlation, reef structures produce anomalies in thickness, and may even present apparent violations of the supposedly immutable law of superposition. The matter presents particularly vexing problems in the Champlain valley where there is not only much cover, but the ever present possibility that such cover may conceal a normal fault bringing into juxtaposition beds of different ages. Lateral tracing becomes unfortunately inferential, and faunal studies have as yet shown enough anomalies in the more controversial sections that the possibility is ever present that a correct evaluation has not been made between facies faunas of different ages, and geographic variations in the faunas of beds of the same age.

Chazyan Fossils

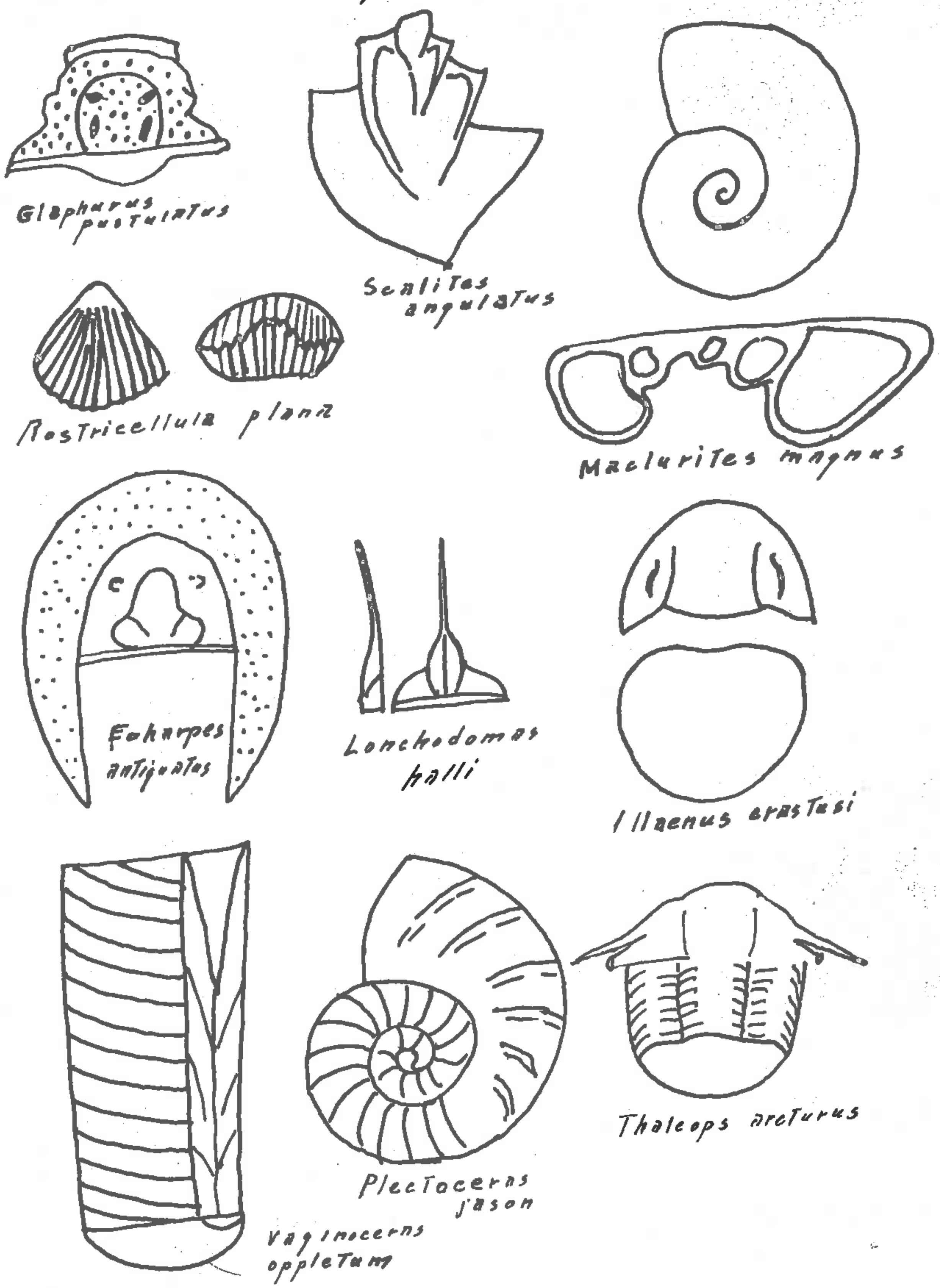


Plate II

The type section of the Chazyan shows the following succession: The Lower Chazyan (Day Point) is made up mainly of coarse calcarenites; in some beds all fossil remains are reduced to unidentifiable fragments of sand size; other beds yield abundant fossils, mainly brachiopods, trilobites and bryozoa. Here are the beds with Hebertella exfoliata, and Hebertella vulgaris; near the top of the section in a single thin bed occurs the striking gastropod Scalites angulatus. Among the upper beds are some composed almost completely of cystid fragments; cystids are absent in the lower hundred feet. It is the cystid fragments which, upon weathering, give to many of the limestones of the Chazyan a characteristic pinkish hue.

The Middle beds (Crown Point) of the Chazyan section are mainly massive, lime muds rather than lime sands; some layers show abundant calcareous algae, mainly. Stromatocerium and Strephochetus, which in other regions are the essential constituents of reefs in the Chazyan; other beds show surfaces covered with the large Maclurites magnus, perhaps the most characteristic single Chazyan fossil.

These beds are separated by a few feet of barren buff weathering dolomite from those considered Upper Chazyan, with a layer of "bird's eye limestone," succeeded by beds with abundant small nodules of Strephochetus ocellatus, which has mainly grown on small fossils, generally gastropods. Above this are calcarentites dominated by the brachiopod Rostricellula plana in great abundance.

Nowhere in the type section is there anything closely similar to the beds exposed on Day Point, or to the reef beds which were seen at Little Monty Bay or at Coopersville. Such reef beds, consisting of massive lime muds replete sometimes with calcareous algae and sponges, or pure fine lime muds with a typical cephalopod facies, show abrupt alternation with the even bedded calcarenites of the typical section. The following types of associations can be recognized:

1. Lingula brainerdi fauna - sand and siltstones with Lingula brainerdi and very little else. Found at most places at the base of the Chazyan, but apparently a facies fauna which is found at the base of the transgressive Middle Chazyan, where the Lower Chazy is absent.

2. Typical lower Chazy calcarenites, with a fauna of trilobites and brachiopods, and later cystids; it attains its fullest expression in the higher beds of this section, where the characteristic but rare Scalates angulatus appears.

3. The Plectoceras jason assemblage - seen on Day Point, with abundant brachiopods, bryozoans, and a large association of trilobites characterized by Eoharpes and Lonchodomas. Usually found in rather muddy massive limestones with frequent reef structures modifying the otherwise even bedding.

4. The Maclurites magnus association - Maclurites with Gonioceras, Spyroceras, and algal beds containing a greater admixture of small gastropods and brachiopods.

5. The Glaphurus pustulatus fauna - Confined to fine grained pure lime muds, with abundant trilobites, Glaphurus, large illaenids, and Isotelus common, and abundant gastropods. Regarded by Raymond as a reef facies present in the lower Valcour limestone. Contains locally an extremely prolific cephalopod fauna.

6. Reef beds, dominated by algal structures, with trilobites and brachiopods, but without the characteristic Glaphurus, and without the cephalopod assemblage. Regarded as very possibly reef beds, often associated with and underlying the above, of Middle Chazy age, though considered as Valcour by Raymond.

7. The fauna dominated by Rostricellula plana, calcarenites, often weathering to relatively thin layers, completely dominated by this brachiopod in great abundance.

MIDDLE ORDOVICIAN

MOHAWKIAN

Time does not permit examination of the Middle Ordovician beds on this trip. The completion of the Column is briefly as follows:

"BLACK RIVER BEDS" The Black River, of various of the older reports of the northern Champlain valley, consists of the northward extension of the Amsterdam limestone overlaid by the dense black massive limestone, the "Isle La Motte Marble," which is hard, relatively barren, yielding large Maclurites logani, (readily confused with M. magnus of the Chazyan,) and an undescribed Actinoceras. Kay (1937) places both formations in the lower Trenton.

GLENS FALLS LIMESTONE - This is the "Trenton limestone" of the older reports in the Champlain valley, thinner bedded black limestones with shaly partings. Kay (1937) has recognized two divisions, the Larrabee limestone of Hull age and the Shoreham limestone of lower Sherman Fall age. Typical thin bedded Trenton limestone with abundant Cryptolithus tesselatus.

CUMBERLAND HEAD FORMATION - Interbedded limestones and black shale in the northern Champlain valley, containing abundant barren lime muds of essentially the "Dolgeville facies" southwest of the Adirondacks. Cryptolithus and graptolites are reported.

STONY POINT FORMATION - This consists of black shales of Utica aspect about 600 feet thick, and indeed is the "Utica" of old reports in the Champlain valley. Contains Triarthrus and graptolites indicating late Canajoharie age.

Paleozoic Igneous Activity

The Paleozoic rocks of the lower Champlain valley are cut by a profusion of dikes of considerable variation in composition. These dikes are quite distinct in age from the widespread diabase and still older trachyte dikes of the pre-Cambrian. These earlier dikes have in no place been found to cut the Potsdam or later rocks, whereas the later systems cut Potsdam, Beekmantown, Chazyan and Trenton rocks.

On the basis of cross-cutting relationships, the oldest Paleozoic dikes are monchiquites, which are particularly characteristic of the Champlain shore from Cumberland Head south to Essex and Split Rock Point. These were succeeded by trachyte dikes (bostonite) in a smaller, overlapping area from Ligonier Point south to Split Rock Point. Both of these dike invasions have been tentatively dated as contemporaneous with the Taconic Disturbance.

Still later are camptonite dikes, such as the one seen on Day Point. The area in which these are found is almost coterminous with the monchiquite, but the age relation is uncertain. It is believed, however, that the camptonite is somewhat younger.

The pre-Cambrian dikes (diabase and trachyte) average between four and five feet in width. The Paleozoic dikes, however, are seldom wider than three feet. Close observation will show border chilling and evidence of repeated widening and injection in the same dike.

Structural Geology

The tectonic history of the region about Plattsburg is still somewhat fragmentary for glacial deposits in the valley lowlands have masked the greater part of the rock floor and structural interpretations are based on only too few outcrops.

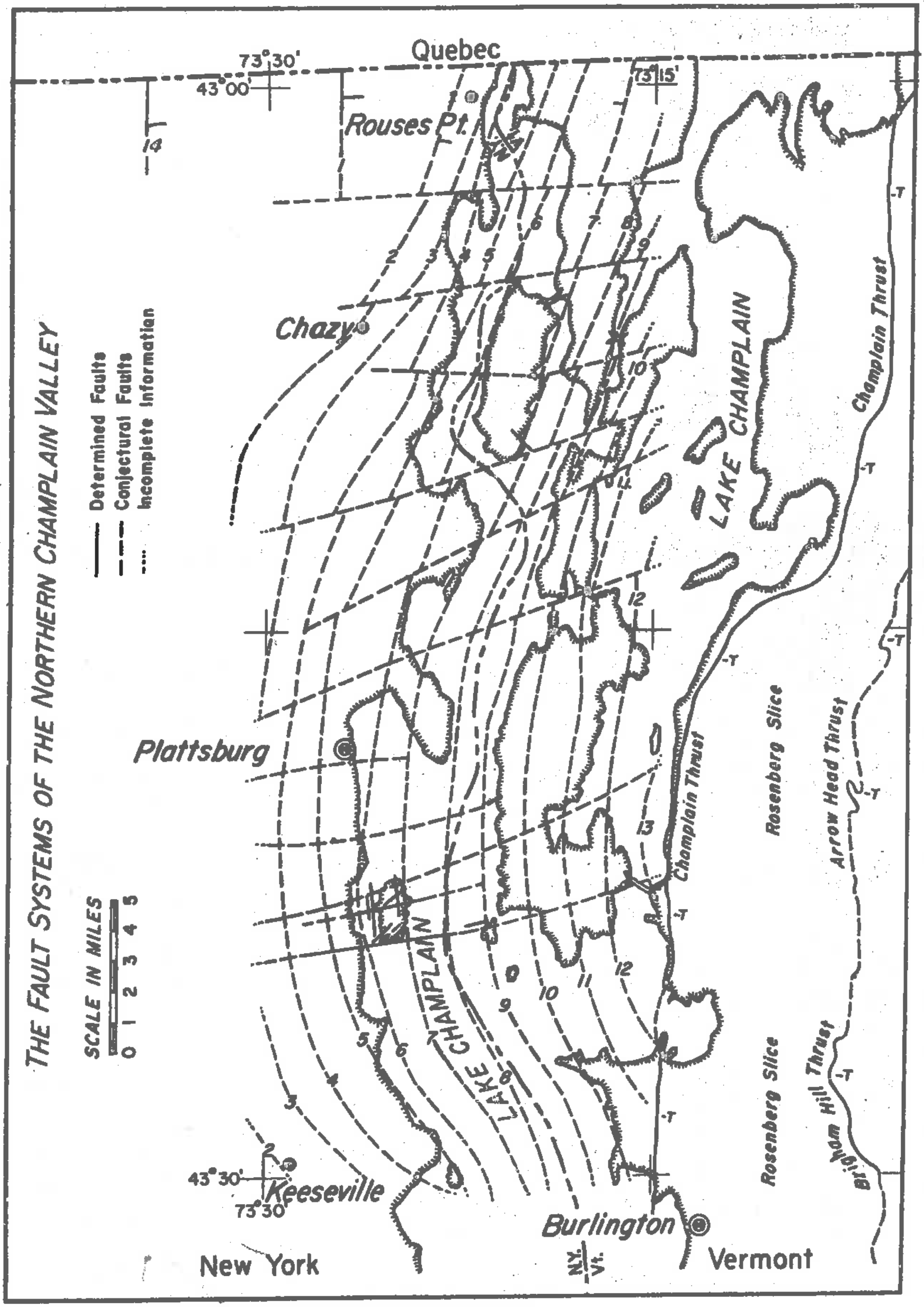

THE FAULT SYSTEMS OF THE NORTHERN CHAMPLAIN VALLEY
Determined Faults
Conjectural Faults
Incomplete Information
SCALE IN MILES
0 1 2 3 4 5
Quebec
73°30'
43°00'
73°15'
Rouses Pt.
Chazy
Plattsburg
Keeseville
43°30'
73°30'
Burlington
New York
Vermont
N.Y.
Vt.
LAKE CHAMPLAIN
LAKE CHAMPLAIN
Champlain Thrust
Champlain Thrust
Rosenberg Slice
Rosenberg Slice
Arrow Head Thrust
Brigham Hill Thrust

Plate III

The general picture of the area between the Adirondacks and the Green Mts. is that of a pre-Cambrian massif on the west, overlain by a thick series of early Cambrian sandstones and limestones. These have been step-faulted downward to the east and have also been overridden from the east by major over-thrusting, the evidence of which may be seen across the lake in Vermont.

The average competence of the Paleozoic beds has prevented any major folding, even under the major compressive stresses which must have developed in the rise of the Adirondacks and Green Mountains. Apparently, relief by thrusting accommodated these stresses. The result is that strong folding can be seen only in weak beds such as the Trenton Cumberland Head shale which is highly contorted at certain outcrops along the lake shore. The limestones and sandstones typically crop out with very flat dips.

The major set of normal faults which cut the Paleozoic rocks have been termed "meridional faults" for they trend close to north-south. Another set have a more northeasterly trend, but a single fault may vary from one direction to the other and no definite evidence has been presented which will date one before the other. The average dip of these meridional faults is 65° to the east and they have sliced the Paleozoic rocks in a stairlike fashion, with the treads tilting backward somewhat to the west. One of these faults, the Tracey Brook fault, strikes in a northeasterly direction in the Chazy-Rouses Point area and is estimated to have a throw of at least 3000 feet.

Later than the north-south faults are east-west normal faults which offset them. These are the cause of many of the bays in the shoreline of the mainland and of the Champlain islands. Cushing estimated that some of these faults had a throw of 2000 feet.

The major overthrust of Cambrian rocks over the Ordovician on the Vermont side of the lake is known as the Champlain fault. Evidence has been adduced at different times to make this thrust both older and younger than the normal faulting. Its extremely regular trend is offered as evidence that it is not cut by normal faults, but has overridden them. On the other hand, large masses of fault breccia along the normal faults are indicated as remnants of the overthrust's sole plane which have been protected from erosion by downward block faulting. The Pleistocene cover has so far prevented the tracing of any normal faults to the overthrust contact. If the major thrusting, therefore, is dated as Taconic, the normal faults are dated as either just before or just after this event.

GLACIAL GEOLOGY

The history of the Pleistocene in the lower Champlain basin is characterized more by the detail exhibited by deposits of the waning ice sheet than it is by a well-rounded general sequence of Wisconsin glaciation.

In general, the direction of glacial striae in the Plattsburg area indicates a southerly flow which was controlled by the direction of the valley and of the depressions between the Green and Adirondack Mountains. In the Mooers quadrangle, northwest of Plattsburg, some of the glacial scratches strike n.e.-s.w. and were formed as the ice rode up out of the valley over the Adirondack foothills. Grooving and polishing of the massive limestones and resistant sandstones may be seen rather commonly.

For the greater part of Wisconsin time, the Champlain region and the Adirondack foothills lay buried beneath ice and little or no record of this interval remains. When the ice did melt away from the upland areas, a thin layer of till, predominantly pre-Cambrian and Potsdam in lithology, was left behind. This is seldom greater than 20 feet in thickness. At lower elevations, such drift has been reworked by water, or covered by water-laid sediments.

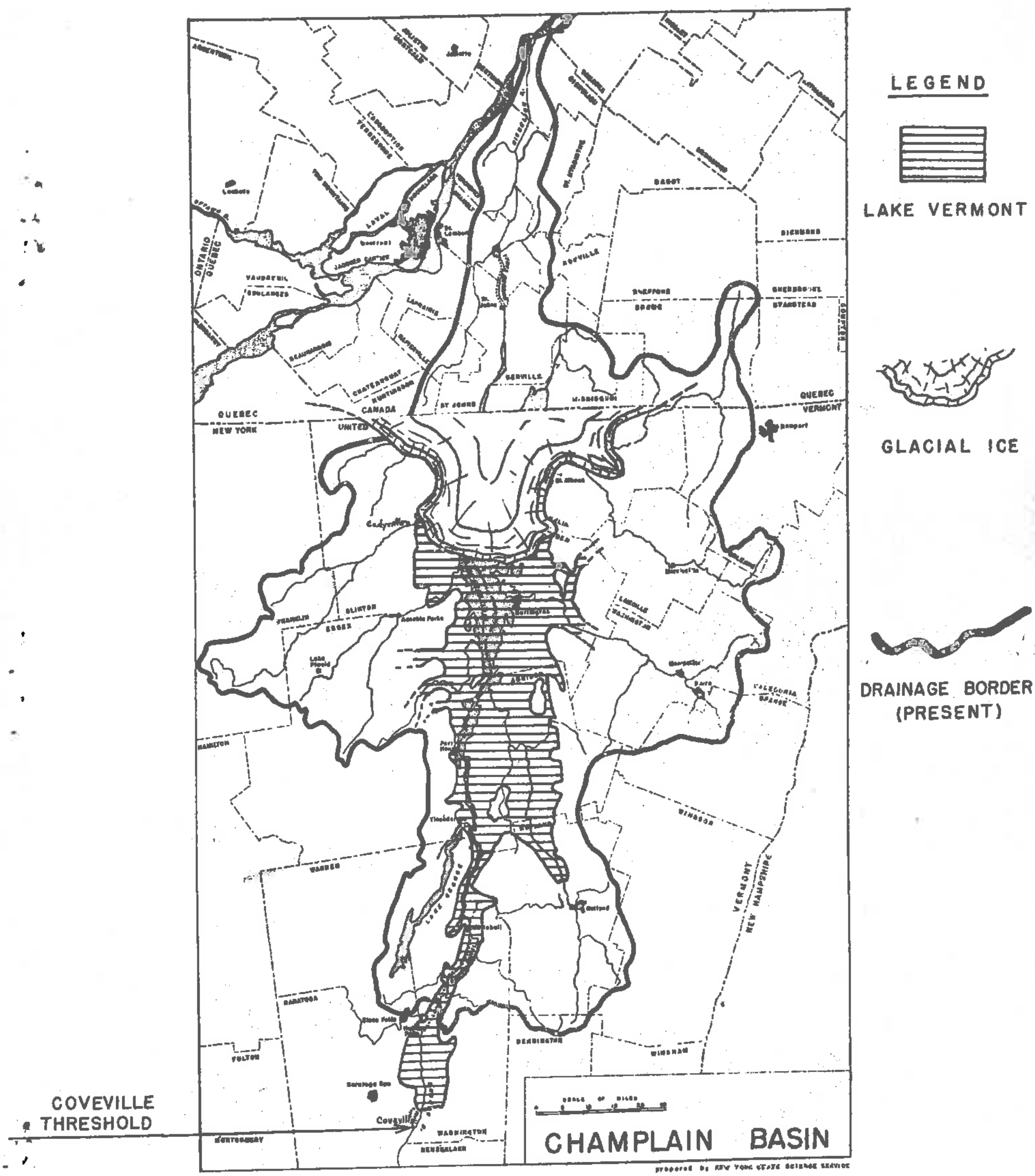
The depositional history of the last glacial period is lower and more completein the valley proper than in the bordering Adirondack foothills areas. While a major lobe of the melting ice sheet lay in the Champlain Valley, the stagnation of ice in the tributary valleys, such as the Ausable and the Saranac, resulted in the development of local irregular lakes of progressively lower elevation, in which for the most part, sand and gravel were deposited as deltas in the lakes or as kame terraces against the side of the rotten ice. Two features, seen on the first afternoon's trip, are typical of these deposits. The flat area at High Bank on the road between Standish and Clayburg is part of a major kame terrace, deposited while the ice lay in the Saranac Valley. This extends with scarcely an interruption for 12 miles in a northeasterly direction across the Lyon Mountain quadrangle. The ravine cut through this deposit, south of High Bank, shows it to be almost entirely sand and gravel, with only an occasional boulder. The steep regular southward slope of this feature is interpreted as an ice contact. A particularly well-developed delta lies at an elevation of 1000 feet just north of Moffitsville in the Saranac River valley. This was deposited in one of the high-level local glacial lakes.

The most completely documented phase of the glacial history in this area is the sequence of glacial waters, both fresh and marine, in which were formed the thick glacio-lacustrine deposits of the valley. On the basis of recent detailed work by D. H. Chapman, it has been demonstrated that the glacial waters in the Hudson and Champlain valleys were never continuous. Glacial "Lake Albany" antedated glacial "Lake Vermont." Apparently regional uplift of the upper Hudson valley in late "Lake Albany" time developed a divide between the two valleys before the ice front had receded any distance in the Champlain area. The first true threshold of Lake Vermont waters was a rock ledge at Coveville, N. Y. which is indicated on page *opp*.. Glacial phenomena such as beaches, deltas and wave-cut and wave-built terraces have been correlated to show that this "Coveville stage" of Lake Vermont persisted until the ice lobe front had receded as far north as Cadyville, on the Saranac river, where a well-developed delta with kettle holes may be seen at El. 729 feet. The Coveville outlet, south of Schuylerville, today overhangs the Hudson River valley by better than 100 feet.

The deepening of the Hudson River resulted in a wider divide and the use of a lower threshold just north of Fort Ann, N. Y. where there is today a narrow stream pass with well-developed pot holes in pre-Cambrian rock. This new "Fort Ann" stage lasted until the ice front had receded well back to the present Canadian border, and because of the magnitude and duration of this stage, the shoreline features are particularly well-developed. Amongst the most spectacular on the New York side are the beaches at 561-575 feet west of Peru, the Morrisonville delta in the Saranac River at El. 630 feet and the cobblestone beaches of Cobblestone Hill and Pine Ridge, so well pictured by Woodworth in New York State Museum Bulletins 83 and 84.

A side feature of considerable interest was the drainage of Lake Ontario basin waters through Covey Gulf, south of Covey Hill (see glacial maps) and thence southeastward along the Adirondack foothills. In the late Coveville and early Fort Ann stages of Lake Vermont, this tremendous flow of water was confined between the Adirondack upland areas and the ice front. The result was the stripped and desolate area of Altona "Flat Rocks" (central part-Mooers quadrangle). The semi-angular boulders of Potsdam sandstone which are seen south of West Chazy on the second afternoon are undoubtedly native to the stripped area. Later, as the ice withdrew from the north slopes of Covey Hill, Lake Iroquois waters mingled with those of Lake Vermont.

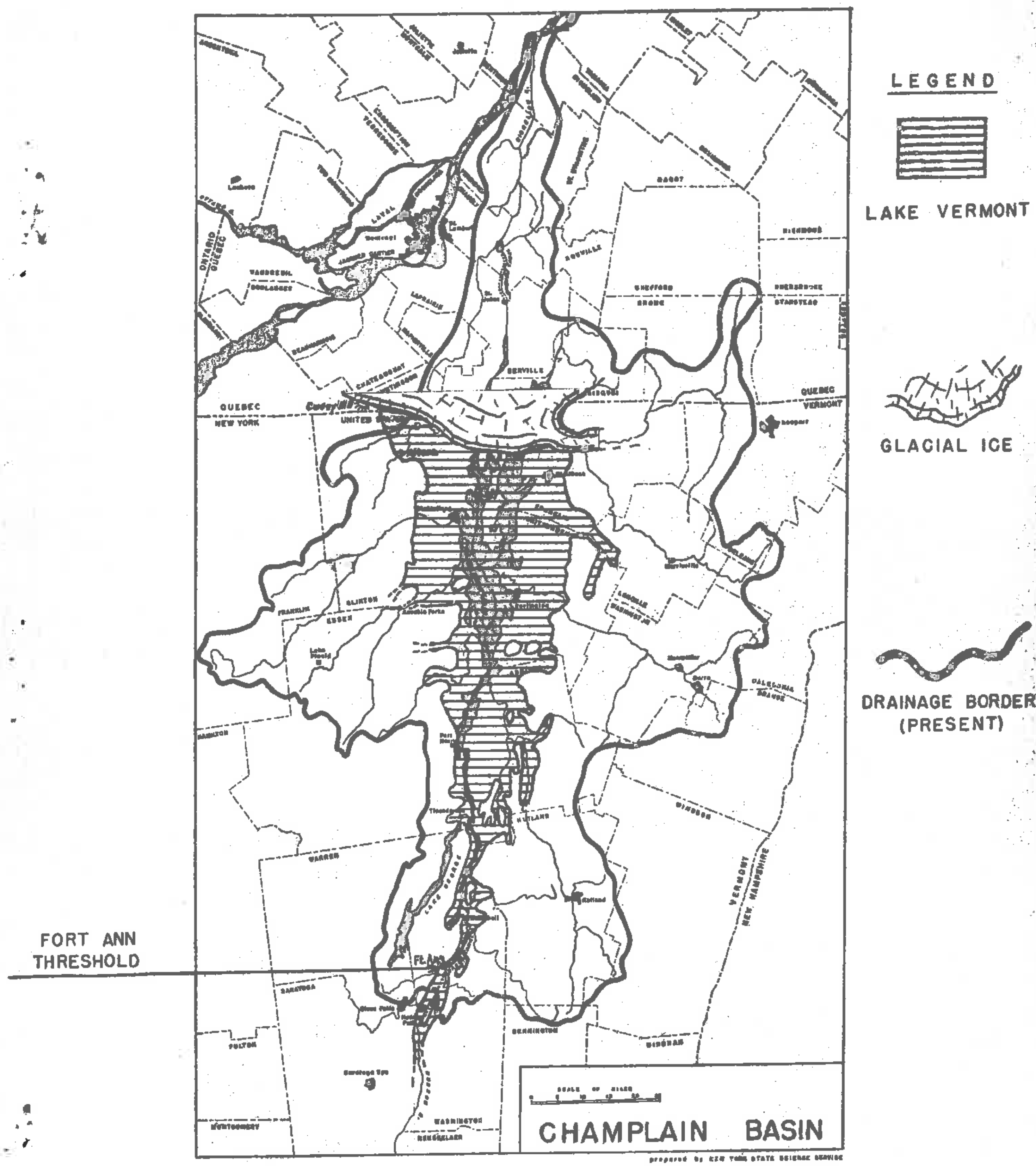
Toward the end of Fort Ann time, the Lake Vermont waters began to leak through the thin and spongy ice in the lower Champlain valley, with the results that the water level slowly fell. Eventually, the complete disappearance of the ice allowed the marine waters in the St. Lawrence valley to flow into the Champlain valley probably as far south as Whitehall. Almost all of the marine shoreline features are best developed in the lower Champlain valley, for southward there was only a narrow estuary. The most prominent one to be seen on this field trip is the delta at El. 425 feet at Morrisonville on the Saranac River.



LAKE VERMONT — COVEVILLE STAGE

after CHAPMAN

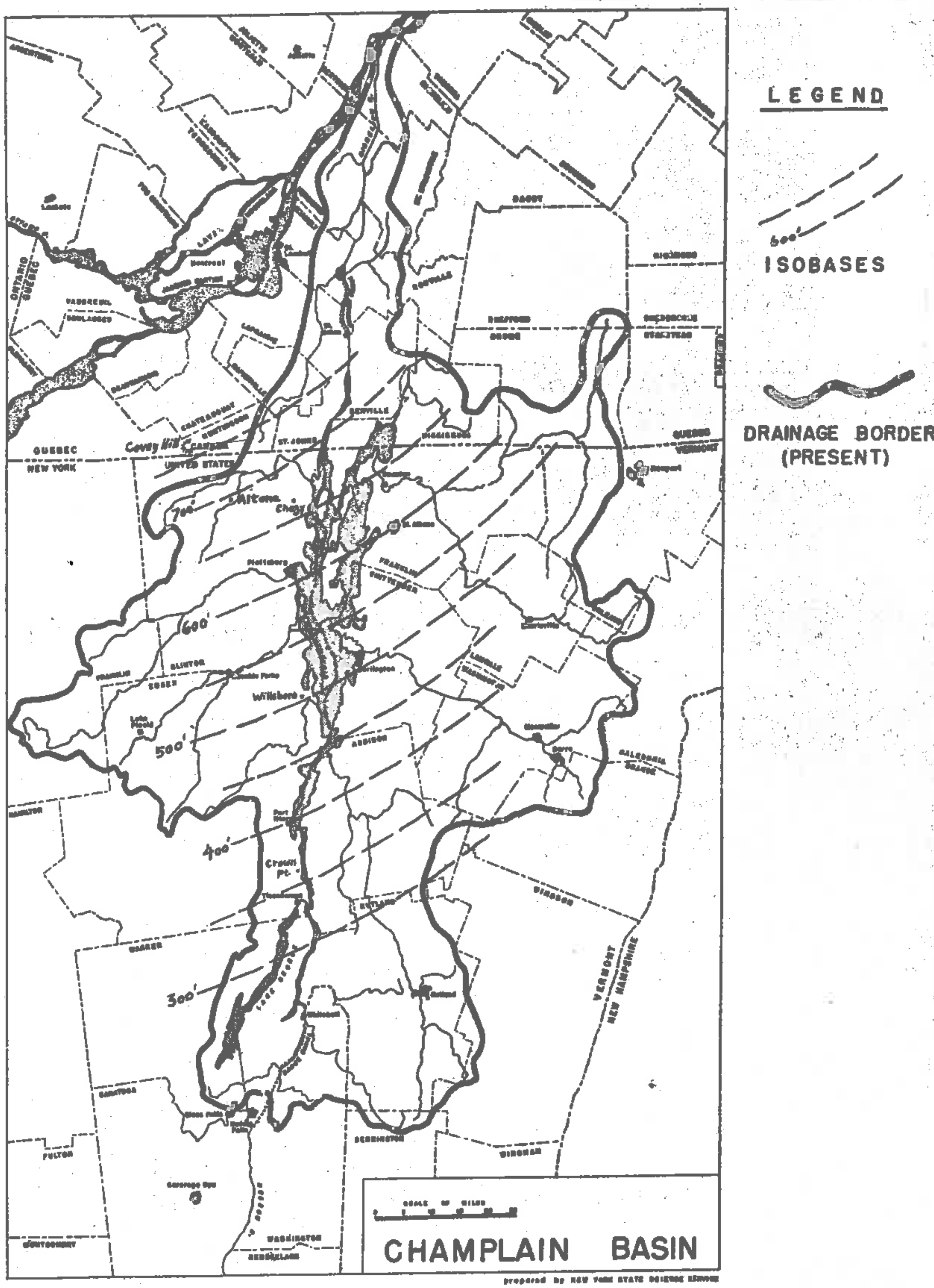
Plate IV



LAKE VERMONT – FORT ANN STAGE

after CHAPMAN

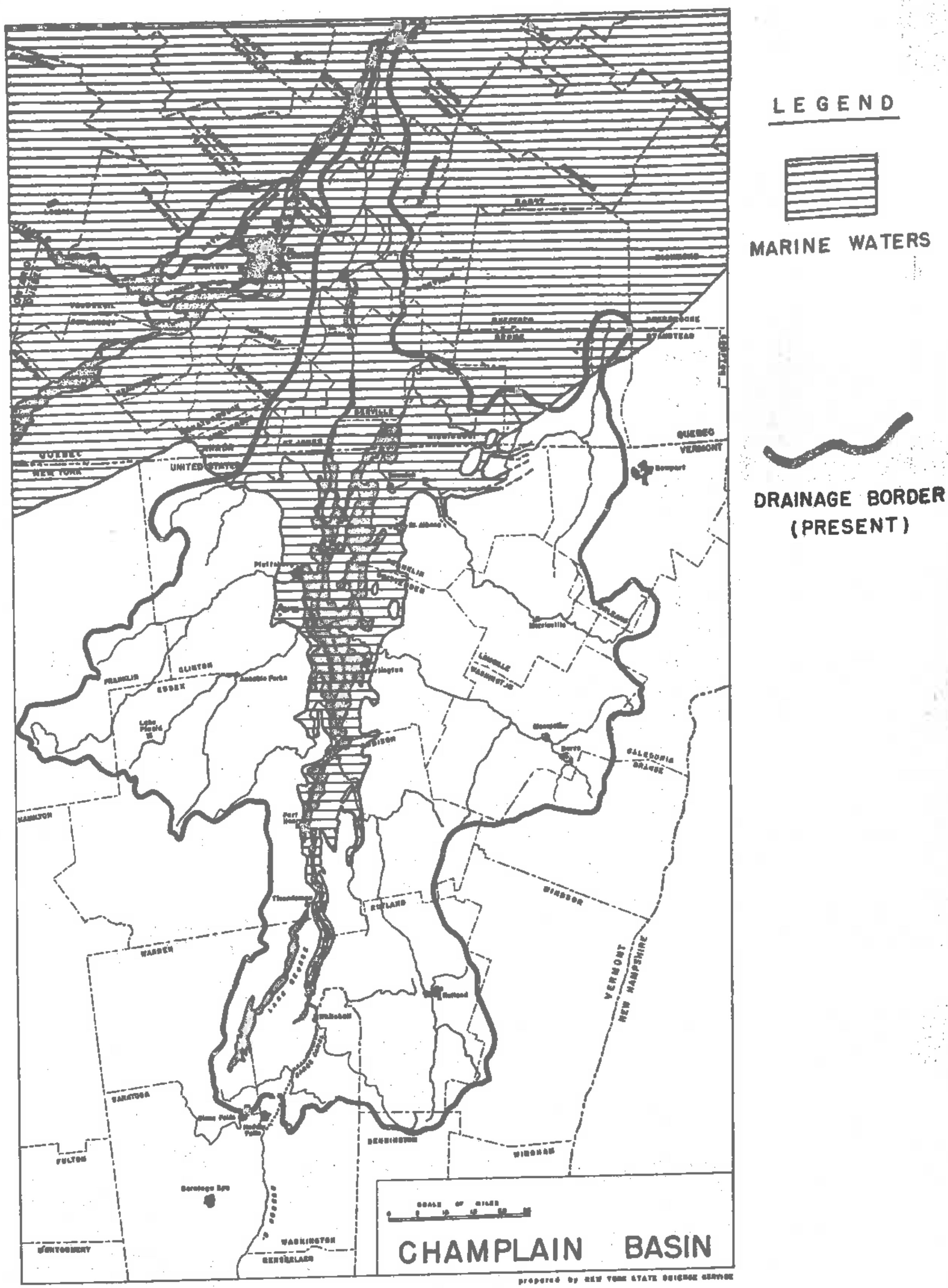
Plate V



ISOBASES DRAWN ON UPWARPED SURFACE of FORT ANN STAGE OF LAKE VERMONT

after CHAPMAN

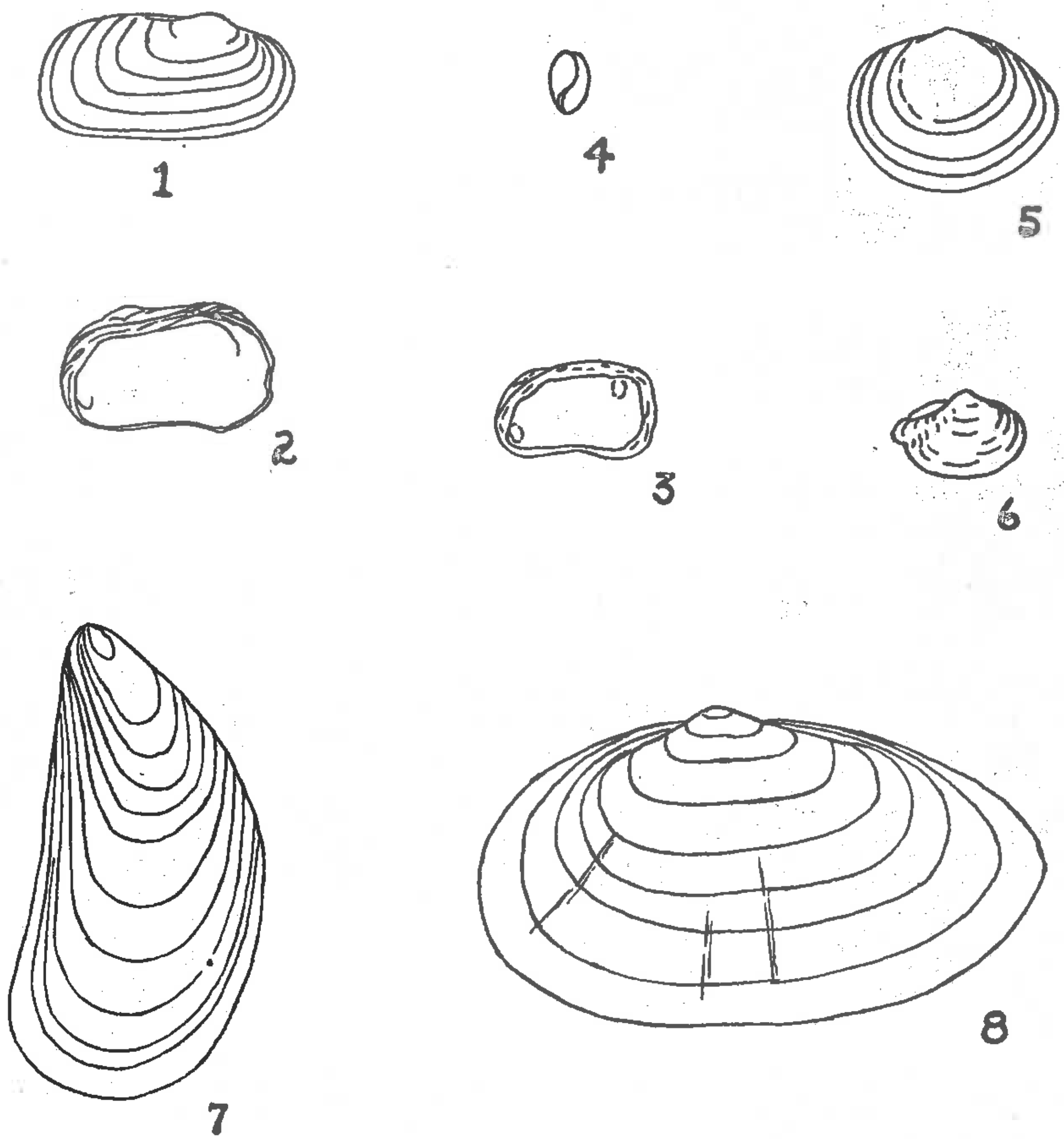
Plate VI



MAXIMUM MARINE INVASION

after CHAPMAN

Plate VII



1. Saxicava rugosa Linn.; 2,3. The same, thick shells from Montreal; 4. Cylichna alba Brown; 5. Macoma groenlandica Beck; 6. Yoldia arctica Gray; 7. Mytilus edulis Linn.; 8. Mya arenaria Linn.

Pleistocene Marine Fossils

Plate VIII

From the formation of Lake Vermont until the major marine features were developed, the whole valley area was stable. This is indicated by the parallelism of shoreline features of the Coveville, Fort Ann and Marine stages. Later in the period of marine submergence, however, differential uplift began with a greater uplift on the north than on the south. This continued during the falling marine stages so that their shoreline features lie along diverging profile lines and the sequence is somewhat confusing. At the time when uplift of the northern end of the valley brought the Richelieu threshold to a level where it barred the entrance of marine waters, the glacial history came to an end and the modern physiographic history of the valley began. Continued tilting has reflooded the upper end of the valley and some of the later marine shoreline features have been drowned.

Chapman states, ". . . a tilt of but fourt-tenths of a foot per mile would be necessary to make the water of Lake Champlain once again flow south across the Fort Ann divide into the Hudson valley. The amount is one-half that which has taken place since the exclusion of marine waters, and but one-tenth of that which has taken place since the first invasion of the marine waters."

Pleistocene Marine Fossils

Marine Pleistocene invertebrate fossils have been found in the Champlain Valley in New York State at Mooers, Chazy, West Chazy, Cumberland Head (Plattsburg), Lapham Corners, Port Kent, Willsboro, Essex, Port Henry, Crown Point and the Crown Point station area. The most southerly occurrence of marine shells in the Champlain Valley is at a locality two miles south of Crown Point Station where only _Macoma groenlandica_ is found. The common fossils of the Pleistocene deposits are the pelecypods _Myra arenaria_, _Mytilus edulis_, _Saxicava rugosa_, _Macoma greonlandica_ and _Yoldia arctica_ and the tiny gastropod _Cylichna alba_. All of the forms are not found in one locality, but four of them: _Mytilus_, _Saxicava_, _Yoldia_ and _Macoma_ extend south through the greater part of the Champlain Valley. The Lapham Corners locality, one of the stops along our route, has yielded, in numbers, _Mytilus edulis_ and _Macoma groenlandica_. Marine Pleistocene shells have been reported from numerous localities in Vermont and also in Canada. In the latter area, at the mouth of Green's Creek, Ottawa River, about 8 miles below Ottawa, shells, such as _Saxicava rugosa_, and the small fish _Mallotus villosus_ (abundant) are found in nodules in the Pleistocene clay.

Collecting in Canada, New York and Vermont soon makes evident the fact that going westward and southward there is a steady decrease in size, thickness and numbers of the shells of the various species of fossils. _Macoma groenlandica_, the only species found extending the entire length of the Champlain Valley, at its most southern occurrence is about one-third the size of recent specimens found off the New Jersey coast and about one-half the size of specimens found at Montreal; and the shells are so poor in lime and thin that they break easily in one's fingers. This dwarfing and thinning of the shells has led to the conclusion that the character of the Champlain Pleistocene fauna is due in large part at least to decreased salinity, that is, freshening of the waters westward and southward in the Pleistocene Marine Sea. The Baltic Sea, today, shows a similar condition. There is a striking decrease in salinity eastward; and, as the salinity of the water decreases from that normal for sea water, the fauna changes from one typically marine to one in which only a few marine groups are represented and finally to a freshwater fauna. Each phylum is affected and the decrease in numbers of species eastward is very rapid. In addition there is dwarfing of forms and dwarfed shells become poor in lime. Examples of dwarfing and decrease in thickness in shells (in the case of mollusks) due to freshening of sea water have also been noted in the British estuaries and in the Black and Caspian Seas.

ECONOMIC GEOLOGY

General

The geology of the northeastern Adirondacks has been, and is now, the controlling factor in the development of the mineral industries in the vicinity of Plattsburg. The pre-Cambrian igneous areas, with their rich magnetite deposits, have been the scene of a long history of iron mining, while the Ordovician limestone areas have provided the raw material for the various lime and stone industries. Both these areas have also contributed to the building stone trade. Some of the areas described below, and some of the rock formations of economic interest, will be visited and examined. This brief account of the development of the mineral industries is intended to provide a better understanding of the close relationship of geology and economics in the Plattsburg area.

The Iron Industry

History: Magnetite is a common constituent of the Adirondack rocks and local concentrations, plus access to transportation facilities, gave rise to numerous prospects very early in this nation's history. Nearly all of these early mines were located on the borders of the Adirondacks with only a very few further inland. This was due not only to lack of transportation from the interior, but also to the fact that the borders, especially the Champlain Valley area, were better known, while the interior had been very little explored. Before 1800, the iron workings were all on a small scale. In 1798, a member of the Platt family erected what was apparently the first forge in the area on the Saranac River in Plattsburg. Soon afterward, in 1801 and 1802, other ironworks were erected in the vicinity, and the iron industry was born. This infant industry did not really begin to grow until 1840, and the period from 1840 to 1880 saw a considerable and rapid increase in iron production. It was during this period that some of the famous iron mines of the district were developed: Chateaugay, 81 Mine, Arnold Hill, and Palmer Hill. These are described below. In the next ten years the Adirondack ores played an important part in the economy. At the same time the industry became more concentrated, with those mines away from railroads or water navigation closing down, but the more favorably situated ones expanding and increasing production. In 1890 the eclipse of the Adirondack iron industry came with the discovery of the Lake Superior ores, and for several years afterward iron-mining in this area was practically non-existent. There was a slight resurgence soon after 1900, due to improved milling methods, but it was not until 1939 that a real come-back was made. In that year the Republic Steel Corporation leased the ore lands of Lyon Mountain to usher in the modern era of iron mining in the Plattsburg area.

The Mines: Arnold Hill Mines - Arnold Hill, located 3½ miles northwest of Clintonville, Ausable township, Clinton County, is the site of a group of mines which were worked for a period of about 100 years, from 1806 to 1906. The ore outcrops are in parallel series along the southern ridge of the hill and have a general strike of N20°E. The dip at the surface is approximately 70°NW but flattens out to about 50°NW at depth. There are pinches along both the dip and strike, more pronounced to the north. Faulting has been on a relatively small scale, with the fault planes cutting across the ore outcrops and shifting them laterally. The maximum offset at the surface was found to be about 15 feet. The country rock is granite gneiss which has been considerably altered at the contact with the ore with the development of chlorite and biotite from original augite.

After the discovery of the ore in 1806, there were only small-scale operations until the year 1812, when the property was purchased by Arnold, Stickney and Howe. This company maintained possession for over 50 years. The mines were only intermittently active from 1805 to 1900. The Hussey and Howe Mining Co. worked the mines from 1864 to 1881, previous to which they had been idle for some time. In 1881 the Arnold Iron Ore Co. took over, and the last production was made by that company in 1906 from the Nelson Bush mine.

There were several openings in the ore, notably the Finch pit, the Chalifon pit, and the Nelson Bush mine, but the biggest and most productive was the Arnold mine. Three parallel veins occur here which are termed "the Gray," "the Black," and "the Blue." They strike N35°E and dip 70°NW at the surface, but flatten out to 55°NW at a depth of 325 feet. There is a northward pitch of about 40°. These veins are separated by gneiss at intervals of 40 feet or less. The "Gray" vein, furthest to the east, varies from 3 to 25 feet in thickness, and derives its name from the admixture of light gangue material with the magnetite ore, which gives it a gray appearance. The "Black" vein, in the middle, varies in thickness from 3 to 27 feet, and contains a black, friable magnetite ore, associated with apatite. The "Blue" vein, whose thickness is about the same as that of the "Black" vein, is composed of martite and some magnetite ore, with the steel-blue martite color giving the name to the vein. Martite is the result of replacement of magnetite by hematite and can be distinguished from magnetite by its reddish streak.

To work these three veins, two shafts were driven on the dip of the "Gray" vein, about 500 feet apart, and cross-cuts driven into adjacent veins. The deepest workings were about 800 feet. The ore was shipped via Plattsburg to furnaces in New York, Pennsylvania and Ohio, and averaged about 60% iron, 0.2% phosphorus, 0.2% manganese, and 0.15% titanium.

A cave-in and loss of the main shaft around 1897 put an end to underground mining at the Arnold mine. The Republic Steel Corp. now holds the mineral rights.

Palmer Hill Mines: One and one half miles north of Ausable Forks, on the southern end of Palmer Hill, are a group of operations which were first worked around 1825. The ore consists of a zone or band impregnated with magnetite. Local concentrations, or veins, were prospected for and mined in preference to mining the whole deposit. The trend of these shoots is NE-SW, with a dip to the northwest and a pitch to the north. The wall rock is a massive, low-quartz granite and is made up mostly of microcline and orthoclase, with a little augite and biotite. Besides magnetite there is also some martite ore. An unusual mineralogical association here is the occurrence of fluorite, apparently of primary origin. It is intergrown with the quartz and feldspar in irregular grains, and constitutes up to 50% of the rock in places. It is especially noticeable in the Big pit.

Several pits were opened on Palmer Hill including the Elliot, and the White Flint on the western side; the Big, the Summit and the Lundrigan pits in the central portion; and the Little pit and Lot 29 on the east. The two most important of these are the Big pit and the Little pit. The Big pit is the deepest, going down 2200 feet on the dip, which is about 60° at the surface and flattens out almost horizontally at the bottom. There are two diabase dikes which intersect the ore, each about 15' thick. One of these runs to the west of the main excavations, the other one intersects the deposit at the Big pit. A noticeable contact effect is the development of black garnet, formed from magnetite and feldspar.

The Big pit was the principal mine of the J. & J. Rogers Iron Co. who operated from around 1844 to 1890. The Peru Steel Ore Co. operated the Little pit at about the same time. The ore from these two companies was shipped to forges at Black Brook and Clintonville. It should be noted that it was at the Palmer Hill operations that the first magnetic concentrater to be operated in the Adirondacks was installed in 1836. An average analysis of the ore from the mines of the Peru Steel and Iron Co. showed: iron 50%; phosphorous 0.005%; sulfur 0.012%; MnO_2 0.06%. The last iron from Palmer Hill was produced around 1890. The ore lands are now held by Republic Steel Corp.

Chateaugay Mines - Situated on the north slope of Lyon Mt., at the village of Lyon Mt., this deposit was said to have been discovered by a trapper in 1823, but the location was remote and development was not started until 1868. The operations were small for the next few years, with the ore going to forges in Russia, Clayburg, Altona and Belmont.

It was not until a railroad connection with Lake Champlain, via Plattsburg, was completed in 1879, that the output from Lyon Mt. began to increase. In 1881, the Chateaugay Ore and Iron Co. took possession, and further increased production and development. In 1885, a blast furnace was erected at Standish, four miles south, and in 1893 the company moved their forges from Belmont to Standish to concentrate their shipping operations. The old-type forges were abandoned soon afterward. The Delaware & Hudson Railroad took over and operated the mines in 1903, and between 1903 and 1907 there were new improvements, including a change from charcoal to coke in the blast furnaces, conversion to heavier equipment, and a central electric power station. A sintering plant was built in 1921, and in 1925 a large concentrator and separator was built. In 1939 the Republic Steel Corporation leased the ore lands and now operated these mines. The blast furnace at Standish is now abandoned and ore and sinter is shipped to blast furnaces at their steel plants in Buffalo and Cleveland.

All of the magnetite deposits of the Lyon Mountain district lie within the Lyon Mountain granite mass and characteristically are associated with small amphibolite zones locally called "gray bands." The "gray bands" are believed to be remnants of partially assimilated Grenville sediments. Numerous basic dikes have been exposed in the mine workings.

The ore occurs in several parallel folded bands which strike generally northeast-southwest and dip about 45° northwest, although sharp flexures modify this structure locally. The entire mineralized belt is about five miles long and extends northeast from Standish through Lyon Mountain and beyond. Most of the early mines have long been shut down, but the Chateaugay Mine at the north base of Lyon Mountain and the open-cut Standish (No. 81) Mine near Standish are still of considerable importance.

More or less disseminated magnetite is present in almost all rocks of the district, but only locally has there been enough concentration to make ore. Chateaugay ore, as mined, averages 25-30 percent iron, but milling and magnetic separation produce shipping concentrates that run around 68% iron. The magnetite is low in impurities, especially phosphorous. Traces of ilmenite and pyrite accompany the ore, but the titanium content is still relatively low.

The mineable ore occurs only in the gneissic Lyon Mountain granite, with which the mineralized zones are in relatively sharp contact. The ore deposits conform closely to the structures in the gneissic wall rock, and it seems probable that the mineralization was controlled by pre-existing deformation in the granite. The granite is flexed into larger anticlines and synclines hundreds of feet across, upon which are superimposed abundant minor folds which complicate the structural picture considerably. In general the ore thickens in the troughs of the synclines and thins along the axes of the synclines.

The deposit at Lyon Mountain comprises three main veins, the largest of which extends almost a mile in a continuous ore-body. This is known as the "front," or "main" vein, and the Weston and Hammond openings are in the southern part of it. Numerous other openings extend northward along this vein. One of the other veins, known as the "back," or Dickson vein, outcrops parallel to the main vein for a distance of about 200 feet. This "back," vein has been opened in the Burden, Cannon and Dickson pits. West of the main veins, another group of deposits occur, known as the Phillips vein. The NE-SW strike and the NW dip corresponds to that of the main deposits. This may be a displacement of the main veins by faulting.

There are two series of intrusives, rather common near the ore bodies, an older granite dike series and a younger diabase series. The granite dikes vary from a few inches to several feet in width and resemble the surrounding gneiss, but can be distinguished by their finer and more massive texture. The diabase dikes range up to 15 feet in thickness. Most of them trend E-W, but a great many of them strike N30°E.

<u>"81" Mine</u>: This mine is located about 2 miles southwest of Lyon Mountain village, still in the Lyon Mountain granite area, and the ore occurrence and associations are similar to that at the Chateaugay Mine. An extension of the ore body, along the strike, would bring it in line with the Phillips vein, west of the main deposits at Lyon Mountain. It gets its name from the number of the lot upon which it is located. It was opened up in 1878, although it may have been worked as early as 1800, but it was not operated for any length of time. In 1902 the mine was idle again. Republic Steel Co. now is starting to develop these workings, which are presently confined to open-pit operations. The past workings extended to a distance of 100 feet or more along the NE-SW strike of the ore-bodies. Several drifts were driven and two shafts went down to a depth of 400 feet. A series of levels had been opened shortly before the mines were abandoned. The ore-body averages about 18 feet in thickness, with only minor pinches and swells, and stands nearly vertical, dipping slightly west in some places and slightly east in others.

Another site of a former iron mine, which need only be mentioned, is on the state property at Dannemora prison, which has been idle for about 80 years. The ore was lean and sulfurous.

Limestones, Lime and Marble Industries

The role of the limestone industries in the economy of the Plattsburg area is not as spectacular and therefore not as well known generally as is that of the iron industry. Nevertheless the area has produced stone products both useful and decorative, and these occupations once supported a large number of people. The earlier quarries produced largely for the building grades and for furnace flux, but now the main part of the production is for building and agricultural lime, concrete, crushed stone for road metal, and chemical uses.

<u>Beekmantown Formation</u>: Since the Beekmantown is generally not pure it has not been quarried as extensively as the other limestones in the area. However, there have been a few building stone quarries opened in the Beekmantown, notably in the neighborhood of Willsboro, Essex Co.

<u>Chazy Formation</u>: The Chazy limestone has been widely quarried around Plattsburg: at Isle La Motte, Valcour Island, Chazy and Willsboro Point. Its high $CaCO_3$ content makes it an excellent lime material, but it has also been quarried for furnace flux, portland cement manufacture, rough building stone and decorative marble.

It is not known exactly when the first quarrying activities started but one of the earliest was at Ligonier Point, on Willsboro Point. Stone was taken from this quarry around 1823 for construction of some of the local houses, and building stone was quarried until 1879. Stone from this quarry was used in the piers of the Brooklyn Bridge and in the State Capitol in Albany. Another quarry on Willsboro Point produced building stone from the Chazy and also produced lime, which was burned in nearby kilns. These two quarries had the advantage of easy and cheap water transportation on Lake Champlain.

About three miles south of Plattsburg, at Bluff Point, the Chazy was once quarried for decorative marble, and some of the buildings in Plattsburg were built of this stone. Here the grey limestone contained red and pink crinoid stems, and some dark brachiopods. The stone took a good polish and was sold under the name "Lepanto marble" for interior decorating. The quarries here have not produced since the 1930's.

Another beautiful "marble" is the black, fossil "marble" from Isle La Motte, the fossils principally the large <u>Maclurites logani</u>. The formation is Black River in age.

The old abandoned quarry that we shall see near Cooperville was said to have been last worked about 100 years ago. It is in the Upper Chazy limestone.

At the present time there are two operating companies in the Plattsburg area. In Plattsburg itself there is the Plattsburg Stone Products Co. which produces limestone for concrete and road metal. This company started operations in 1934, before which time the Plattsburg Limestone Co. operated. This quarry is known as the Behan, and it may be the same one that was operated around 1910 by a Hugh Behan of Plattsburg.

South of the village of Chazy, the Chazy Lime and Stone Co. produces building lime, flux, agricultural lime and lime for chemical use in paper mills. Before 1943 the operations were conducted by the Chazy Marble Lime Co. The quarry was first opened up around 1900. The rock quarried here is exceptionally well suited for lime uses since it is very high in calcium and low in magnesium.

Black River and Trenton Formations: These two formations have been worked only very sparingly in the Plattsburg area. The Trenton limestone, in other areas an important quarry stone, is usually thin-bedded and shaly here and not a desirable quarry material. It has, however, been quarried on Isle La Motte and was locally known as "Isle La Motte Marble."

Potsdam Sandstone

The Potsdam sandstone was quarried at one time near Kent Falls for the manufacture of glass by the Redford Glass Co. The rock was the common gray variety but burned white and was used in the manufacture of Redford crown glass, which was known for its beauty and strength. The glass works have been idle for many years. There are now very few of the Redford crown glass pieces in existence, and these are valuable collector's items.

Granite, Syenite and Anorthosite

The term "granite" is used loosely in the quarrying industry and is used for almost all the crystalline silicate rocks suitable for architectural or monumental stone. In the Plattsburg area this would include granite, syenite and anorthosite, all of which have been quarried in the vicinity.

The principal producing district in the area has been the locality around Ausable Forks and Keeseville. Quarry sites were located along both sides of the Ausable River, above and below the village of Ausable Forks, where a green variety of Syenite was marketed under the name "Adirondack green granite" or "Killarney green granite." The syenite area was first worked about 1910, and the first quarry was located about a mile northeast of Ausable Forks. It was operated by the Ausable Granite Company, which later consolidated with the Adirondack Granite Co. A sphere 7 feet in diameter, fashioned from the green syenite of this area used to stand in front of the library at Columbia University.

Anorthosite outcrops to the south of Ausable Forks, around Keeseville and near Augur Lake, and quarries were operating at these points around 1880, the product being known under the name, "Ausable granite," Stone from this area was used in buildings in Keeseville, New York City, Burlington, Vt., Cleveland, Ohio, and Saranac Lake.

On the Clintonville road, and two miles east of Ausable Forks there was a quarry from which a limited amount of monumental stone was taken. This stone was true granite and carried a large amount of magnetite. The color is purplish brown to dark red.

At Dannemora State Prison there is a granite quarry from which architectural stone was taken and used in the construction of the prison, but which has not been worked in a good many years.

Garnet and Wollastonite

Garnet has never been an important product of this area. The American Garnet Co. operated a deposit south of Keeseville, where garnet occurred in marble and anorthosite, but mining was suspended during World War II. It was during the quarrying for garnet that large commerical deposits of wollastonite ($CaSiO_3$) were discovered recently near Willsboro, although the presence of wollastonite had been known in the area since 1810; The first limited production of wollastonite was in 1938 from the Burnham property, located about 2½ miles SW of Willsboro. The Titanium Alloy Manufacturing Co. leased the property for the year 1945, and in 1947 the holdings were purchased by Northern Minerals, Inc., who now operate the quarrys. One of the early uses of wollastonite was in the preparation of coated welding rods. New uses are continually being sought in various industries, some of which are: in paint, rubber, linoleum, asphalt tile, as insulating material, fertilizers, mineral wool and as substitutes for talc. This is a new industry and most of the production is being used experimentally. It should be noted that this is the only deposit of commercial wollastonite known in the eastern United States. Only one other deposit is known in the country and that is in California.

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New York State Geological Association

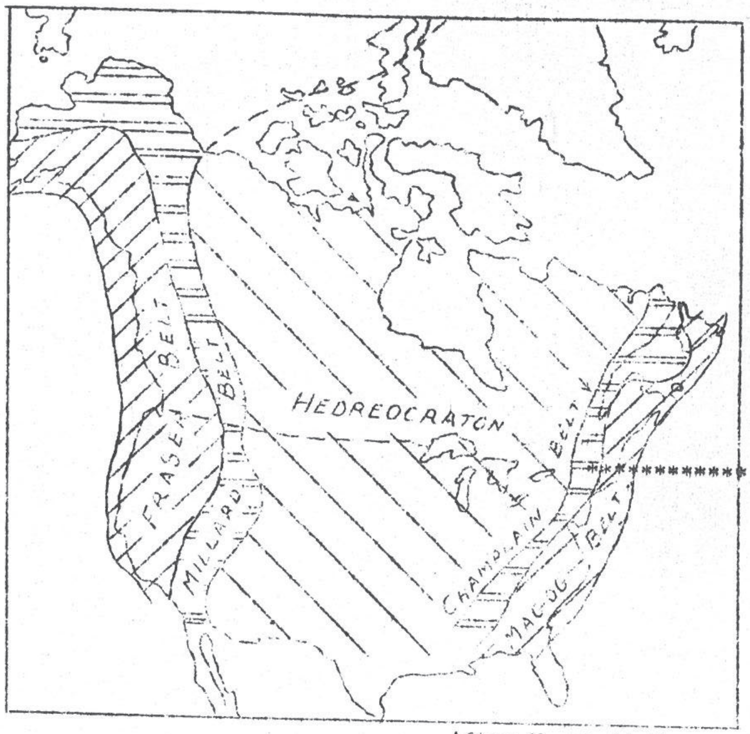
Twenty-~~Sixth~~ Third Annual Field Meeting

Plattsburg, New York. May 18-19, 1951

SUPPLEMENTARY GUIDEBOOK
TO
CHAZYAN STRATIGRAPHY

Philip Oxley
Hamilton College
Clinton, N. Y.

Professor Marshall Kay has developed concepts and nomenclature of Early Paleozoic stratigraphic Belts which are useful in systematic description and particularly in comparative stratigraphic studies. The following summary and map are taken from Kay, but are subject to the writer's errors in interpretation.



After Marshall Kay

Eugeosyncline

Miogeosyncline

Craton

Figure 1. EARLY PALEOZOIC STRATIGRAPHIC BELTS

The Chazy group of the Champlain Valley is part of a primarily limestone and dolomite sequence of Early and Middle Ordovician sediments. Upper Cambrian Potsdam sandstone lies beneath and later Middle Ordovician is dark shale and argillaceous limestone. Early Paleozoic rocks of the Champlain Valley contrast in lithology and/or thickness with sediments of similar age to the east and west, but may be traced in similar character southward along the Appalachian structural trend to Alabama. These sediments are of geosynclinal thickness measured in thousands of feet and comprise the Champlain Belt, a miogeosyncline (Fig. 1).

West of the Champlain Belt Early Paleozoic sediments are of similar character but relatively thin with numerous gaps in the depositional record. These are deposits of the stable central shield, the hedreocraton, from which Early Paleozoic seas frequently retreated.(Fig. 1). The hedreocraton, not the traditional crystalline "borderlands", was the source of terrigenous detritus deposited in the Champlain Belt.

East of the Champlain Belt Early Paleozoic subsidence was similar in pattern but of greater magnitude and deposits are argillites and coarser clastics with intercalated volcanic flows and fragmentals. Volcanic and tectonic islands, like modern island arcs, were present from time to time in the Magog Belt, a eugeosyncline (Fig. 1)

These three stratigraphic belts outline the tectonic framework of Early Paleozoic eastern North America. In Middle Ordovician Trenton time the pattern was modified by introduction of dark shales and

LOWER MIDDLE ORDOVICIAN CHAZY STRATIGRAPHY AND STRUCTURE

Saturday Afternoon, May 19th

Plattsburg - Ingraham - Sheldon Lane - Coopersville - Chazy
Clinton County, New York

Introduction

Chazy limestones are intermittently exposed in gently tilted fault-blocks between similarly faulted Adirondack crystallines to the west and allochthonous Cambrian and Ordovician sediments east of the Champlain Thrust, which closely parallels the eastern, Vermont shore of Lake Champlain north of Burlington. Pleistocene clays and gravels obscure large areas of the Ordovician bedrock in the Champlain Lowland. The rocks are cut by two major fault systems, one trending approximately north-south, the other east north-east. Best exposures of the Chazy limestones are in shoreline ledges of the northern Champlain islands and the neighboring New York mainland. Inland outcrops are scattered and discontinuously exposed where faults or less-resistant members underlie marshy lowlands.

Summary History of Chazyan Classification

The Chazy limestone was first described from exposures southwest of Chazy, New York by Ebenezer Emmons in his report on the Second Geological District in 1842. This description included only the 250 feet of middle, Maclurites-bearong strata. Limestones below were assigned to the Calciferous (Beekmantown) and those above to the Birdseye (Black River). These were later found to be erroneous correlations and through the work of James Hall, Brainerd and Seely, Cushing, and Percy Raymond the Chazy was expanded to include some 700 feet of fossiliferous limestones overlying a basal quartz sandstone. The boundaries were placed at the top of the underlying Beekmantown dolomite and at the base of overlying calcilutite called Lowville and thought to be of Black River age.

Cushing proposed the names Day Point for the lower Chazy, Crown Point for the middle or Maclurites beds, and Valcour for the upper. Raymond, after extended study of the faunas, recognized three major faunal divisions nearly equivalent to Cushing's units. Present usage treats the three as formations of the Chazy group and the Champlain Valley section as the standard for Lower Middle Ordovician classification in North America.

Present Provisional Classification of the Type Chazy

Recent study by the writer has confirmed the usefulness of the threefold division of the Chazy group. Middle Chazy Crown Point overlaps the Day Point south of Valcour Island. Upper Chazy Valcour offlaps the Crown Point northward and in the Champlain Valley shows areal distribution similar to that of the Day Point.

Further vertical division of the formations as members and faunal zones makes for more precise correlation. The Head member (Table 1) is a transgressive basal sand growing younger southward. Lingula brainerdi persists despite the age variation of the member. Other members and faunal zones seem to be at least roughly age-equivalent throughout the Champlain Valley.

The most interesting and perplexing problems of Chazy stratigraphy arise from lateral variations in lithology and concommitant variations in fossil content. A few such facies changes are illustrated in the course of the present trip. The upper Day Point, upper Crown Point, and lower Valcour show greater ranges of variability than other horizons. The stratigraphic section in Figure 3 illustrates relations found in the vicinity of Plattsburg and emphasizes the interdependence of lithology, fossil content, and thickness; all in turn controlled by a complex of physical and biological factors. Of the latter, differential

TABLE 1

Provisional Classification of the Type Chazy

Black River?	"Lowville" formation		
Upper Chazy	Valcour formation	Beech member up to 156 ft.	Zone of *Rostricellula plena* (Hall), biozone
		Hero member up to 101 ft.	Zone of *Glaphurus pustulatus* (Walcott), biozone
Middle Chazy	Crown Point formation	100 to 300 ft.	Zone of *Maclurites magnus* (Le Sueur), epibole
Lower Chazy	Day Point formation	Fleury member up to 220 ft.	Zone of *Raphistoma striatum* Emmons, epibole
			Zone of *Lamottia heroensis* Raymond, biozone
		Wait member up to 25 ft.	
		Scott member up to 86 ft.	
		* Head member up to 40 ft.	Zone of *Lingula brainerdi* Raymond
Beekmantown	Bridport dolomite		

* N. B. Head member is transgressive basal sand overlain by successively younger rocks southward to Crown Point, N. Y. Retains lithology and fossil content despite decreasing age.

Areal Distribution

Chazyan sediments of lithology and fossil content similar to the type are known from Crown Point northward through the Champlain Valley to Montreal, thence westward to the vicinity of Ottawa and eastward into the Gulf of St. Lawrence. It is improbable that Early and Late Chazyan deposits were ever continuous in the Champlain Belt southward into Pennsylvania, however the Middle Chazy, which persists in undiminished thickness near the head of Lake Champlain, may link with Chazyan deposits of the southern portions of the Champlain Belt. Taconic thrust sheets obscure relations between

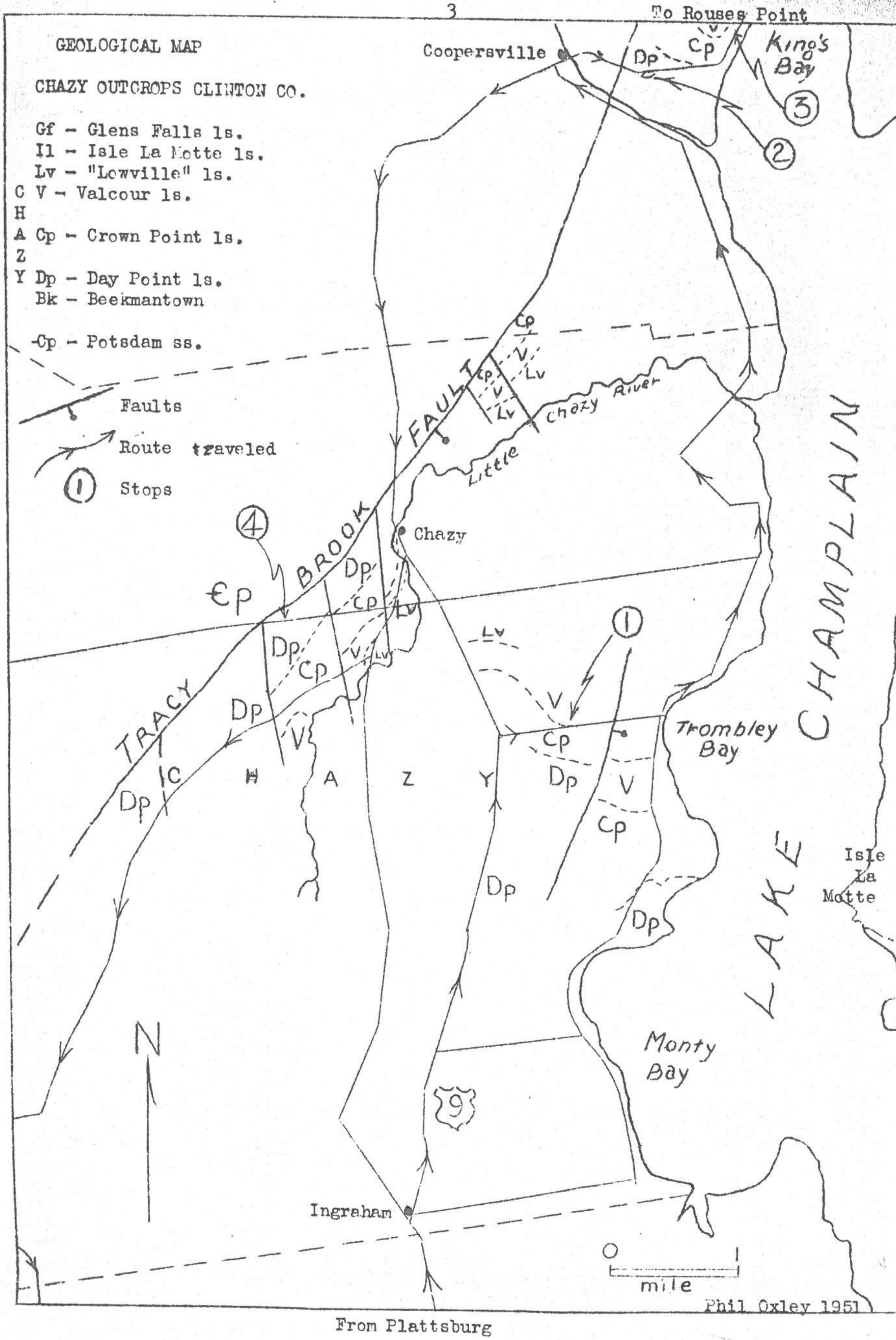


Figure 2. Geological Map Chazy Outcrops, Clinton County, New York

Notes on Sections Visited

N. S. G. A. Trip   Saturday Afternoon

May 19, 1951

Plattsburg – Ingraham – Sheldon Lane – Coopersville – Chazy, Clinton Co.
New York

STOP ONE: Sheldon Lane (Little Monty Bay)

Rocks Exposed

The exposed section dips gently northward from ledges of upper Day Pt. Fleury calcarenite about 400 yards south of Sheldon Lane. 43 feet of Fleury is strongly cross-laminated near the contact with overlying Crown Point, which is of normal facies in the lower 72 feet. The upper 29 feet of Crown Point are of Stromatocerium reef facies. Contact with the overlying Valcour lies approximately at the road. Uppermost Crown Point is exposed in the small quarry north of the road. Basal Valcour Glaphurus-bearing reefs form low knolls on higher ground; probably no more than 5 feet are exposed.

Lists of More Common Fossils

Valcour formation:
Beech member – not exposed
Hero member – Glaphurus reef facies

Stromatocerium sp.
Billingsaria parva (Billings)
Dactylogonia incrassata (Hall)
Tetralichas minganensis (Billings)
Bumastus globosus (Billings)
Isotelus harrisi Raymond
*Glaphurus pustulatus (Walcott)

Numerous cephalopods (see Flower) and several species of bryozoans

* Glaphurus pustulatus is found only in the light gray, purest calcilutite (sub-lithographic limestone) at the top of the exposed section.

Crown Point formation:
Reef and normal facies

Stromatocerium sp.
Zittelella varians (Billings)
Dactylogonia incrassata
Öpikina (Rafinisquina) champlainensis (Raymond)
Multicostella platys (Billings)
Maclurites magnus (Le Sueur)

Day Point formation:
Fleury member

Plectorthis exfoliata Raymond
Raphistoma striatum Emmons
Cystid and trilobite fragments

STOP TWO: Coopersville

Rocks Exposed

Southeast of the road is a small mound of breccia composed of a variety of angular limestone, dolomite, and shale fragments set in more or less magnesian limestone matrix. Raymond (1906) referred to the mass as a glacial boulder. Subsequent study by the writer and D. S. Stone of Cornell University

Raymond (1906) reported Rafinisquina alternata and a brachiopod, possibly Triplecia extans from fragments in the breccia and therefore dated them as Trenton. He also identified a typical Day Point faunal association in other fragments.

STOP THREE: Quarry on Kings Bay north of Coopersville

Rocks Exposed

Outcrops east of the quarry proper comprise the upper 10 feet of the Crown Point formation, here in its normal facies. Beds in the quarry are the overlying basal Valcour Glaphurus reef rocks and associated calcite detritus.

Lists of More Common Fossils

Valcour formation:
Hero member- Glaphurus reef facies

Stromatocerium eatoni Seely
Zittelella varians
Billingsaria parva

Glaphurus pustulatus

Numerous bryozoans, cystid fragments, brachipods and trilobites

Crown Point formation:

Normal facies

Stromatocerium sp.
Zittellela v.
Maclurites magnus

STOP FOUR: Type Section of Chazy group, southwest of Chazy, New York

Rocks Exposed

All members of the Chazy formations are here exposed except the Head and Wait sandstones. Beds dip to the southeast at from 10 to 25 degrees. Several faults disrupt the section and their presence is easily discernable from offsets of ridges and from anomalous thicknesses. The normal facies of the Crown Point, a dolomite-calcilutite facies of the basal Valcour Hero, and the typical impure calcarenites of the Rostricellula-bearing Beech member are of particular interest. Reference to the map (Fig. 2) aids in identification of horizons viewed.

Notable Fossil Localities

Valcour formation:
Beech member

Near Route 348 the Beech member yields great numbers of well-preserved Mimella vulgaris (Raymond) and Rostricellula plena (Hall).

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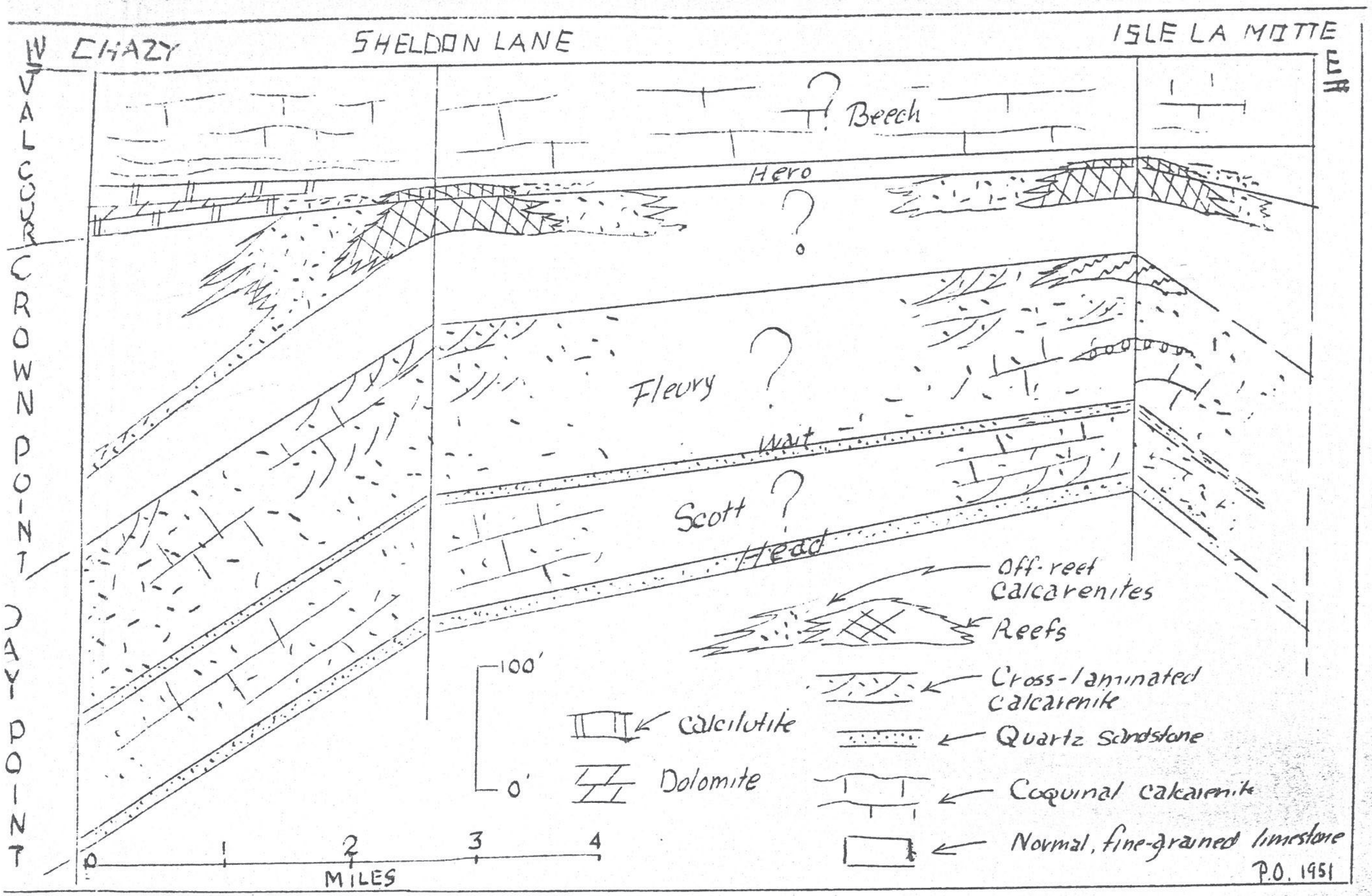
Excellent specimens of Maclurites are relatively easily obtained at the quarry southwest of Route 348 in an horizon at the top of the Crown Point formation


W
E
CHAZY
SHELDON LANE
ISLE LA MOTTE
VALCOUR
CROWN POINT
DAY POINT
Beech
Hero
Fleury
Wait
Scott
Head
Off-reef Calcarenites
Reefs
Cross-laminated calcarenite
Quartz Sandstone
Coquinal calcarenite
Normal, fine-grained limestone
Calcilutite
Dolomite
100'
0'
0
1
2
3
4
MILES
P.O. 1951