



Subsurface Cambrian and Ordovician Stratigraphy of the Trenton Group— Precambrian Interval in New York State

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MAP AND CHART SERIES: NO. 8

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KEY TO SYMBOLS



No sample



Sample not examined

SANDSTONE



Fine (including siltstone)



Medium to coarse



Bedded

SHALE



Non-calcareous



Calcareous



Sandy

LIMESTONE



Fine



Medium to coarse



Arenaceous



Dolomitic

DOLOMITE



Fine



Medium to coarse



Arenaceous



Calcitic

BASEMENT COMPLEX



A Anhydrite

== Argillaceous

B Bentonite (greasy clay)

anx Black vitreous inclusions in quartz

cc Calcite crystals

cm Carbonaceous matter

☞ Chert

cf Conchoidal fractures

◇ Dolomitic rhombs

ec Euhedral crystals

fsp Feldspar

ee Fossils

H Halite crystals

oo Oolites

T.D. Total depth

var Variegated shales

☼ Gas show

○ Fresh water

● Salt water

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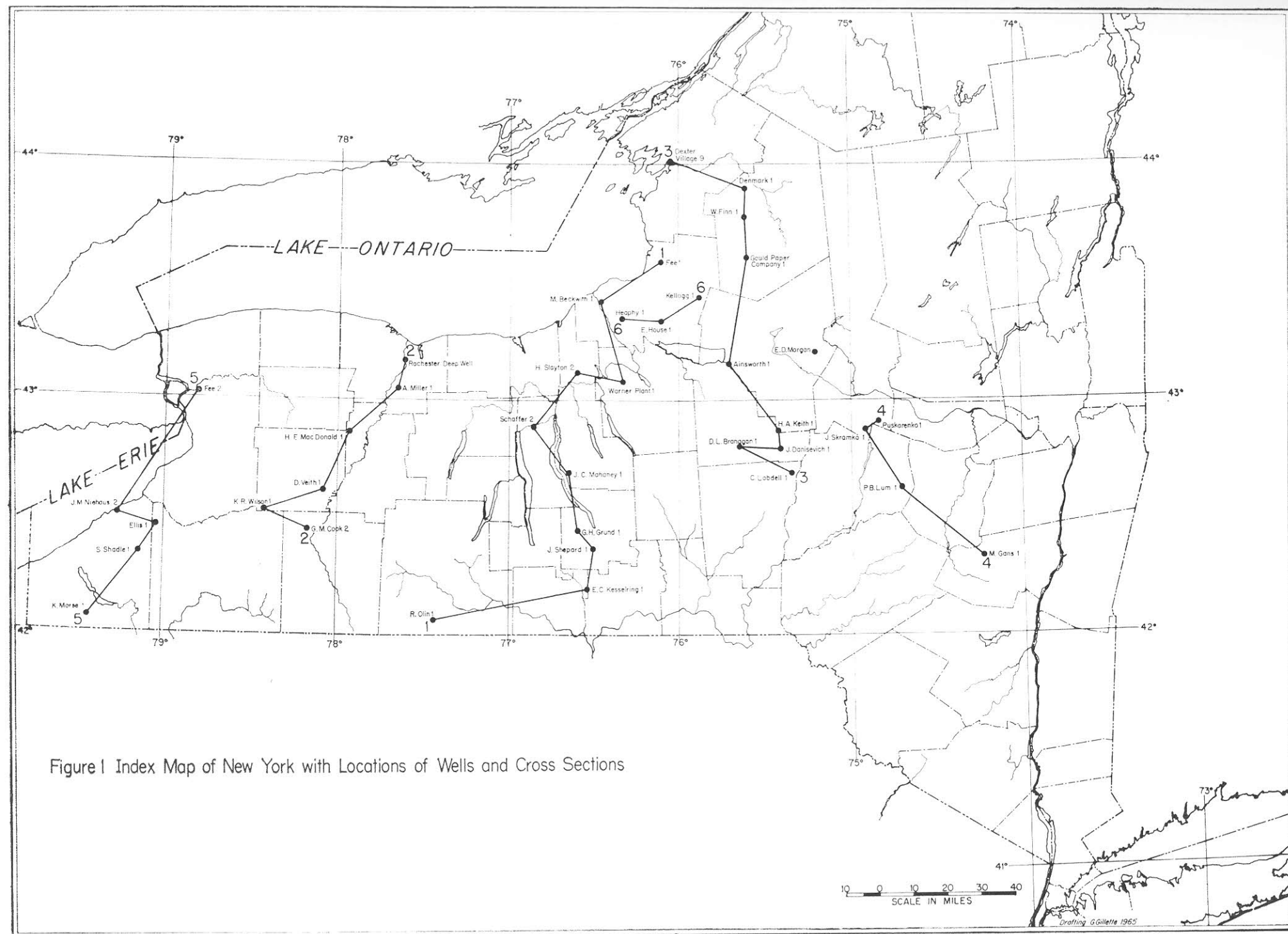
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FOREWORD

IN RECENT YEARS, DATA HAVE been accumulating which can be used in an interpretation of the Black River-Beekmantown unconformity, the stratigraphy of the Ordovician and Cambrian section beneath, and the nature of the Precambrian basement complex surface.

The synthesis of sub-surface stratigraphy is, at best, a difficult art. It becomes almost impossible if the various data and the correlations are a compilation of the work of many. The Geological Survey felt that at least one variable would be eliminated if all of the available wells were restudied and the correlations drawn by a single competent geologist. Mr. Flagler was particularly well qualified for the task and approached the problem with no regional or scientific prejudice. His sub-surface stratigraphic conclusions, therefore, may not be definitive, but do represent an integrated and unbiased attempt to make sense out of the available mass of data. Hopefully, this will stimulate further discussion and research.

JOHN G. BROUGHTON
State Geologist



PREFACE

THIS REPORT IS CONFINED largely to consideration of the sub-surface lithology, thickness, distribution, and correlation of units recognized from drill cuttings from 38 key wells throughout the State (Figure 1). There is no consideration of controversial aspects of Cambrian and Ordovician intrasystemic correlations nor of the paleontological evidence for these.

Because of the confidential status of recently drilled wells in southeastern New York (Delaware and Ulster Counties), it has been necessary to delete isopachous and structure contour lines across this area, as well as any discussion of the sections penetrated therein.

ACKNOWLEDGMENTS

The writer wishes to thank the staff of the New York State Museum and Science Service, Geological Survey, for guidance and criticism throughout the duration of the project. Special thanks are due W. Lynn Kreidler, Senior Scientist, Geology, for his close cooperation and careful review of the text, maps, and supervision of illustration preparation.

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Subsurface Cambrian and Ordovician Stratigraphy of the Trenton Group—Precambrian Interval in New York State¹

by Charles W. Flagler²

ABSTRACT

Cuttings of 38 key test wells in New York State have been examined to determine lithology, thickness, distribution and correlations of rock-stratigraphic units present in the subsurface between the top of the Trenton Group and the Precambrian basement complex.

The Trenton limestones were found to grade laterally eastward into the calcareous shales of the Canajoharie and the calcareous shales and argillaceous limestones of the Dolgeville, as at the outcrop. The Black River Group is easily recognized by the occurrence of light tan lithographic limestones correlative with the Lowville and highly variable lithologies characteristic of the Pamelaia. The uppermost, or Chaumont unit of the Black River was not specifically identified in the well cuttings, but could be present. Certain rocks in contact with the basement at the base of the Group east of Lake Ontario and previously considered Potsdam are believed, on the basis of observed lithology, to be correlative with the Black River. Dolomitization has occurred in the lower Trenton and the Black River although limestones are the predominant lithology. The regional unconformity at the base of the Trenton-Black River can be traced throughout the subsurface except in the basinward area where the section appears to be completely transitional.

Down dip below the unconformity, the Beekmantown is represented by a wedge of cherty dolomite, correlative with the Chuctanunda Creek dolomite, and interbedded limestone, dolomite, and siltstone correlative with the Tribes Hill. The beds here assigned to the Chuctanunda Creek have previously been grouped with the Little Falls but evidence is presented suggesting that they can be assigned to the Chuctanunda Creek with reasonable certainty.

The Saratoga Springs Group is complete with Little Falls, Theresa and Potsdam present over much of the map area. However, difficulty was encountered in placing the contacts between the various formations because of the high variability of the dolomite/sand ratio and resulting transitional nature of the contacts. Nevertheless, by utilizing minor lithologic characteristics and considering overall stratigraphic relationships, it is possible in most instances to pick the various contacts satisfactorily. While the lithology of the Little Falls is reasonably uniform, that of the Theresa was found to be highly variable both laterally and vertically, changing from a predominantly dolomitic facies in the eastern part of the State to a predominantly sandy facies in the west. The Potsdam consists largely of orthoquartzite, and the upper contact with the Theresa has been arbitrarily placed at points where the quartz content exceed 50% of the sample material.

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PART I

Summary Statement of Subsurface Stratigraphy (Trenton and deeper)

Lithostratigraphic units involved in the report encompass the following groups and formations:

Trenton Group

Utica shale
Canajoharie calcareous shale
Dolgeville calcareous shale and limestone
Trenton limestone undifferentiated

Black River Group

Chaumont—missing or included with the Trenton
Lowville lithographic limestone
Pamelia limestone; oolitic limestone; dolomite; sandstone

Beekmantown Group

Chuctanunda Creek cherty dolomite, shale
Tribes Hill limestone, dolomite, siltstone

Saratoga Springs Group

Little Falls dolomite
Theresa dolomite, sandstone, orthoquartzite
Potsdam orthoquartzite, sandstone

Precambrian

TRENTON GROUP

The subdivision of the Trenton Group as shown on the Ordovician chart (Fisher, 1962) published by the New York State Museum and Science Service, Geological Survey, is followed. Sample examination was limited for the most part to intervals near the Utica-Trenton and Trenton-Black River contacts as study of the entire Group was not a part of the present assignment. Nevertheless, it is felt that sufficient subsurface information was obtained to make the following general discussion worthwhile.

Utica shale

Lithology: Sample examination was confined to the basal interval incidental to the determination of

the top of the Trenton limestone. The formation consists of a sequence of dark gray to black, non-calcareous shales indistinguishable, superficially at least, from one end of the State to the other. Locally, as at the Branagan test, the shales become silty. In the eastern segment of the area concerned, the shales become slightly calcareous downward, and eventually grade into the underlying highly calcareous Canajoharie shale through a transition zone of variable thickness and extent.

Thickness: Not determined. Logged thicknesses of all formations are tabulated in Table 1 on page 15.

Distribution: Utica shale, or correlative equivalents thereof, overlie the "Trenton" limestone throughout the State except in the eastern area where it is locally in contact with the Canajoharie. (Plate I, Section A-A').

Correlation: The shales here designated as Utica are correlative with the type Utica and with black shales in similar stratigraphic position outside the type area. They are not laterally equivalent to, but overlie or are transitional vertically with the underlying Canajoharie where this formation is developed.

Canajoharie calcareous shale

Lithology: Dark gray to black calcareous to highly calcareous shale is the dominant lithology. The shale is occasionally arenaceous, and finely crystalline pyrite nodules are locally common. The carbonate content increases downward, and the shale becomes very highly calcareous directly above the first limestones of the Dolgeville or of the "Trenton" limestone (undifferentiated) where the Dolgeville is absent.

Thickness: 0-600 feet. Sample examination through this formation was not sufficiently complete to establish its maximum thickness. From data available, the formation appears to reach a maximum thickness of 275 feet in the Branagan-Dani-

sevich-Lobdell area. Up dip, it wedges or fingers out between the Utica and "Trenton" limestone. This relationship can be seen by reference to Sections A-A', Plate I; B-B' and C-C', Plate II. Control was not established down dip, but a thick section is indicated at Lum, and 600 feet or more is present to the east, at the Skramko test location. Completion of sample examination at Puskarenko, Lum, and Gans would be necessary to resolve the question.

Distribution: Development of the formation is restricted to the eastern portion of the map area where it is transitional with and eventually replaces most of the "Trenton" limestone as at the Lum and Gans test locations. (Plates I and II).

Correlation: The Canajoharie is the lateral equivalent of the "Trenton" limestone in the subsurface as at the outcrop. However, the distinction drawn between the Utica and the Canajoharie in this report is necessarily based solely on the carbonate content of the shales. While such a distinction is properly open to criticism, and may not be acceptable for surface mapping where fossil evidence is available, it is, nevertheless, the only criterion available for subsurface mapping, and is generally satisfactory for this purpose.

Dolgeville calcareous shale and limestone

Lithology: The formation is made up of black calcareous to highly calcareous shale, interbedded with dark gray to dark brown or black finely crystalline non-fossiliferous argillaceous limestone. The shale/limestone ratio is variable, but shale generally predominates in the upper part of the formation, limestone in the lower part. Where typically developed, the ratio is on the order of 50/50.

Thickness: 0-177 feet. The maximum observed thickness is 177 feet as logged at the Keith test. The formation pinches out both up and down dip. (Sections A-A' Plate I; B-B' and C-C' Plate II.)

Distribution: As the Dolgeville constitutes a transition zone between the Canajoharie and the Trenton limestone, the areal distribution of the formation in the subsurface is about the same as that of the Canajoharie. However, because the formation pinches out both up and down dip the extent is a little more limited than that of the Canajoharie.

Correlation: Like the Canajoharie, the Dolgeville is a lateral equivalent of part of the "Trenton" limestone. Interbedding of the limestone with cal-

careous to highly calcareous shale reflects the periodic influx of argillaceous material into the "Trenton" limestone carbonate environment. This muddying of the waters seems to have driven off the shell-producing faunas as the limestones appear, from the cuttings, to be non-fossiliferous. The top of the Dolgeville, where present, has been used as the top of the "Trenton" limestone in constructing the contour and isopach maps (Plates III and IV).

"Trenton" limestone undifferentiated

Lithology: The lithology of the subsurface Trenton limestone (undifferentiated) is quite variable, although gray or brown aphanitic to finely crystalline fossiliferous limestones seem to predominate. Other types, including black argillaceous limestone, black aphanitic limestone, dark brown aphanitic limestone, brown mottled limestone, and gray finely crystalline limestone occur, and in some cases, predominate. Calcareenites were noted locally. Streaks and beds of black shale are locally common. Dolomitization has occurred in some areas, usually near the base of the formation. Rounded and frosted quartz grains are present but scarce. Oolites were noted in one or two instances, but are extremely rare. Streaks of light gray, pyritic, non-calcareous shale, or "greasy" clay-shale, were noted locally. These are no doubt the "bentonites" referred to in the literature (Kay, 1937).

(Note: In general, examination of the "Trenton" limestone samples was confined to samples from near the top and base of the unit, although in a few instances, full sections were studied. Accordingly, the foregoing comments may be incomplete as to lithologic types present in the subsurface.)

Thickness: 15-1047 feet. The "Trenton" limestone reaches a maximum observed thickness of 1047 feet at the Schaffer location in central New York, and thins to an observed minimum of 15 feet to the east at the Lum test site. Statewide, the variation in thickness of the "Trenton" limestone and the underlying Black River Group combined is shown on the isopach map (Plate IV). Configuration at the top of the "Trenton" limestone-Dolgeville is shown on Plate III.

Distribution: The unit is present in the subsurface throughout the entire area concerned.

Correlation: The subsurface limestones here included in the "Trenton" undifferentiated, including the Dolgeville where present, are presumed to be

correlative with the general Rockland to Cobourg sequence at the outcrop. No attempt was made, however, to subdivide or to equate the various lithologies to specific units or formations as defined at the surface.

BLACK RIVER GROUP

Of the three established units of the Black River Group in the Black River Valley, the Pamelia and the Lowville were recognized in the well cuttings. The Chaumont may well be present in some areas as very dark gray to black limestones overlying the Lowville-Pamelia sequence in some places. However, cherts, said to be characteristic of the unit, are extremely rare or missing at this stratigraphic level in the subsurface. In any event, no attempt was made to identify the Chaumont and if it is represented, it has been included with the "Trenton" limestone. In about one-half of the well sections examined, the Lowville is the only unit of the Black River present. In another 25 percent or so of the tests, both Lowville and Pamelia lithologies are represented, but are transitional and have not been subdivided. In the remainder, both formations are present and have been subdivided, or the Group is missing.

In the following discussion, the Black River Group is treated as a whole with the exception of the following paragraphs on lithology.

Lowville lithology: The type Lowville is a light tan-colored lithographic limestone easily recognized in the well cuttings. Variations from this type include light brown to brown aphanitic non-fossiliferous limestone with conchoidal fracture, and light tan to light gray finely crystalline dolomite derived directly by dolomitization of the lithographic limestone. These are all relatively pure non-argillaceous limestones and dolomites. The upper contact with the Trenton Group is sometimes sharp, sometimes seemingly transitional (could be in part sample contamination). The lower contact is most often transitional with the Pamelia, where this unit is present, and in some instances well defined beds of lithographic limestone are present below typical Pamelia indicating alternating environmental conditions during this period.

Pamelia lithology: Highly mixed and in some instances unique lithologies are the characteristic feature of the Pamelia. Dark colors predominate and the key to recognition, if there is one, would

be the dark gray to black oolitic limestones, although these are not always present. Varicolored arenaceous carbonates, dolomitic to calcareous sandstones, variegated shales and dark argillites are also characteristic features of the formation, particularly near or at the base. The following lithologic types were observed in the well cuttings from the Pamelia:

Limestones: Brown, dark brown to black, oolitic; gray, in part arenaceous; tan, aphanitic; brown-gray, dark gray, and black, in part arenaceous; light brown, fossiliferous; fragmental.

Dolomites: Varicolored, gray, light green, red, pink, calcareous, in part arenaceous.

Shales: Varicolored, gray, green, brown, black.

Clay-shales: Chocolate colored to red-brown, dolomitic. (Basal beds at Heaphy).

Argillites: Dark gray, hard, non-calcareous.

Sandstones: Medium to coarse-grained, calcareous or dolomitic, grayish to gray, mostly rounded and frosted quartz.

Lowville-Pamelia undifferentiated

Thickness: 0-317 feet. As a rule, the Black River Group thins down dip or basinward. The thickest observed section was up dip at Beckwith (Figure 2), from which point the Group thins and eventually pinches out down dip as for example between the Lum and Gans tests. (Section A-A' Plate I, and B-B' Plate II). Observed thickness of the Lowville varied from 14 to 183 feet; the Pamelia from 68 to 134 feet, and for sections where the two could not be subdivided, from 61 to 228 feet.

Distribution: The Black River Group, or individual units thereof, is present in the subsurface over the entire map area with the exception of the basinward portion as at the Gans and Olin test locations (Plate V).

Correlation: Correlation of the Black River Group with the outcrop section is based on the widespread occurrence in the subsurface of the diagnostic light tan colored lithographic limestones of the Lowville Formation. This limestone is easily recognized even in finely ground well cuttings. Similarly, the mixed dolomite, limestone, oolitic limestone, shale, and sandstone lithologies present below or in some cases interbedded with the lithographic lime-

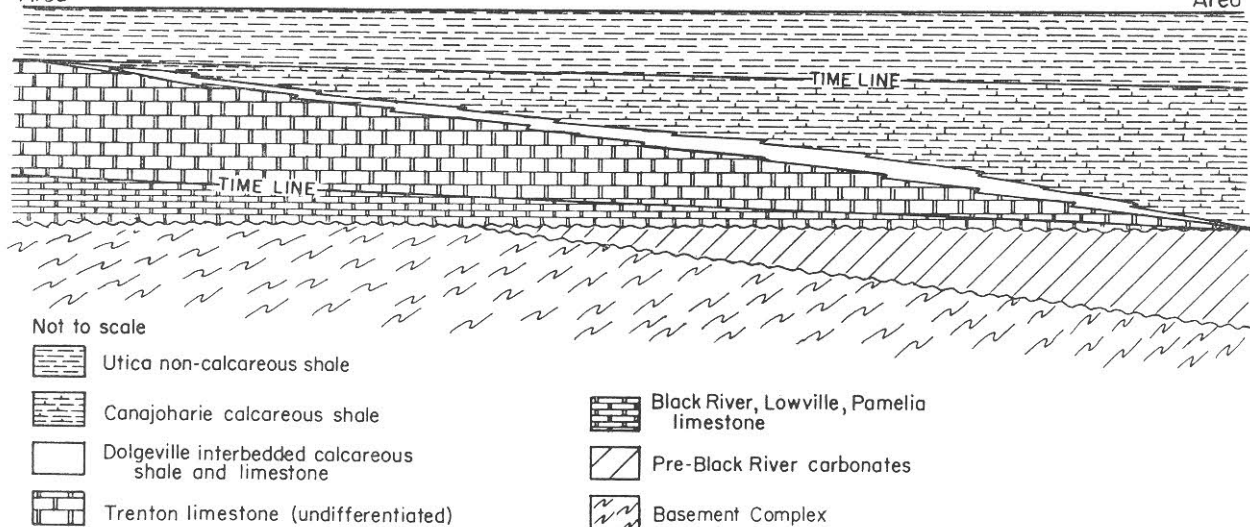


Fig. 2 Generalized NNW-SSE section showing Trenton-Dolgeville-Canajoharie facies relations

stone are diagnostic of the Pamela as at the outcrop, although these rocks, at least in part, have previously been correlated with the Tribes Hill (Rochester-Wilson-Cook). The uppermost or Chaumont unit of the Black River may well exist in the subsurface, but was not specifically identified in the well cuttings. If present, it has been included with the "Trenton" limestone on all graphic logs, contour maps, and diagrammatic sections.

This report is primarily concerned with the section lying below the Black River (Plate VI). Consequently, the nature of the basal contact with pre-Black River rocks was given special attention, and it would be gratifying to state that the contact had been accurately established in all of the well sections examined. Unfortunately, this is not the case. In the northeastern map area where the Black River rests on Precambrian metamorphic rocks, the basal beds are usually highly arenaceous dolomites or dolomitic sandstones with streaks of shale, all frequently varicolored, and here the contact is easily recognized. Elsewhere, and particularly basinward, it becomes progressively more difficult to be certain where to place the contact. In the deeper parts of the basin, as, for example, at the Olin test site, it becomes impossible to do so due to the completely transitional nature of the sedimentary sequence in this area. In any event, the figures used in the report are, for the most part, believed to be reasonably close to the actual contact. Where doubt exists,

the problem has been discussed in the individual well data reports.

Special mention probably should be made of the basal arenaceous beds directly overlying the basement rocks in the northeastern area previously mentioned. In previous reports, these beds have, for the most part, been correlated with the Potsdam. Certainly, from a strictly lithologic standpoint, such a correlation is justifiable. The sandstones consist of medium to coarse grained, rounded and frosted quartz closely resembling the Potsdam, and they are certainly in the correct stratigraphic position for a Potsdam call. However, the mixed and varicolored strata including the basal arenaceous dolomites and dolomitic sandstones extend well up into, and are interbedded with, certain Black River strata, strongly suggesting a closer relationship to the latter group than to the Potsdam. Accordingly, they are here interpreted as transgressive deposits on the pre-Black River erosion surface.

BEEKMANTOWN GROUP

The youngest pre-Black River strata present in the subsurface are believed correlative with the Chuctanunda Creek Dolomite. This formation overlies the Tribes Hill in a down dip position and, along with the Tribes Hill and older strata, was truncated by pre-Black River erosion. Only the

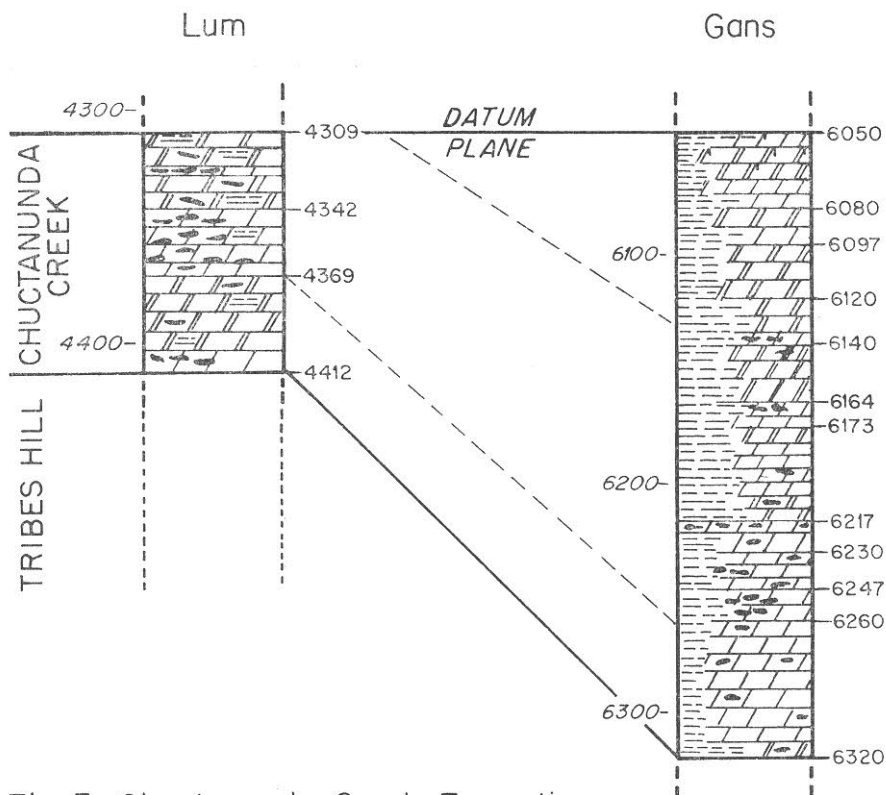


Fig. 3 Chuctanunda Creek Formation

lower portion of the formation was preserved in the subsurface, as for example between the Lum and Gans locations (Plate II, Section B-B'). Similarly, the Tribes Hill has been progressively cut out up dip and is missing over much of the map area.

Chuctanunda Creek Dolomite

Lithology: The Chuctanunda Creek was recognized in only two tests, at Lum and at Gans (Figure 3), although a thin section may also exist at Branagan. Details of the lithology are given on the lithic and written logs. It will be noted that at Lum only the lower dolomites with beds of chert are represented, and that chert locally constitutes up to 80 percent of the sample material. Black shales occur, but are limited to streaks and thin beds. Down dip at Gans, black non-calcareous to slightly calcareous shales are more abundant and frequently constitute up to 50 percent or more of the samples. Chert is common locally, but is less abundant than at Lum, and is missing altogether in the upper part of the section at this location. The following lithologies are common to the formation:

Dolomite: Light to very light gray; tan; gray-brown; dense to fine and medium crystalline; in part cherty.

Shale: Black non-calcareous to slightly calcareous; trace of green shale.

Chert: Gray to light gray to milk white non-oolitic, in part with included dolomite rhombs and quartz silt.

Quartz: Locally present as vein filling and euhedral grains, and as silt in the dolomite.

The upper contact of the formation is with light tan dense dolomite (dolomitized lithographic Lowville limestone) at Lum, and with dark brown dense "Trenton" limestone, gray-brown finely crystalline dolomite and black shale at Gans. The lower contact at both locations is with very light gray dolomitic siltstone and silty dolomite of the Tribes Hill formation.

Thickness: 0-270 feet. At Gans, 270 feet of the formation is preserved, whereas up dip at Lum only 103 feet remains below the unconformity.

Further up dip, as at Skramko, the formation has been completely removed by erosion.

Distribution: Distribution of the Chuctanunda in the subsurface is limited to the extreme eastern segment of the map area. The only control available is at Lum and Gans. To the north and west it has been removed by erosion.

Correlation: Assignment of the foregoing strata to the Chuctanunda Creek Formation is based on lithology and stratigraphic position. However, whereas the type section "along North Chuctanunda Creek is entirely dolomite," (Fisher, 1954) the subsurface equivalent is interbedded with black shale, particularly in the down dip position. As at the outcrop, "silica cement has impregnated the dolomites" (Fisher, op. cit.) locally to such an extent that the resulting rock is honeycombed with, or replaced almost entirely, by chert. Coupling the lithology as observed in the well cuttings with the stratigraphic position directly below the Trenton-Black River and above the Tribes Hill, correlation of the unit with the Chuctanunda seems relatively secure. As the formation rests on the same lithologic unit of the Tribes Hill at both locations, direct evidence of unconformity between the two formations is lacking in the only area where the Chuctanunda is represented in the subsurface. However, if the dolomitic siltstones and silty dolomites underlying the formation are Palatine Bridge, the implied absence of the Wolf Hollow and Fonda members would be good evidence of unconformity.

(Note: Rocks here assigned to the Chuctanunda have been grouped previously with the Little Falls, but this correlation appears invalid in light of information obtained during the present study.)

Tribes Hill

Unique features of the formation which are known at the outcrop, such as the glauconite-collophane bearing beds of the Palatine Bridge and Fonda members, were not observed in any of the well cuttings, and so could not be used as an aid in tying the section to the outcrop. Moreover, basinward, as at Olin and Kesselring, the formation is seemingly completely transitional with the overlying Trenton-Black River, and placing the upper contact becomes a matter of pure speculation. Accordingly, no attempt has been made here to subdivide the formation into its various members as recognized at the surface, although no doubt this

can be done, at least in part, by anyone personally familiar with the outcrop section. As the subsurface development of the formation varies from one section of the State to another, the lithology is discussed separately for the eastern, central, and western areas. Lithologic detail is shown graphically (Figures 4 and 5).

Lithology—eastern area: Up dip at Puskarenko, the top of the formation is a 17 foot bed of brown, fine to medium crystalline, calcareous, cherty, and silty dolomite (Figure 4). The remainder of the 149 feet interval consists of interbedded limestone and dolomite. The limestones are very light gray aphanitic, brown aphanitic, gray fossiliferous, or very light gray medium crystalline and dolomitic. The dolomites are brown to dark brown, or gray, dense, fine or medium crystalline, calcareous, with some silt and a little chert in the upper part. Down dip at Skramko, Lum, and Gans, the upper part consists of light gray arenaceous dolomite and dolomitic siltstone with chert and streaks of black non-calcareous shale, interbedded with relatively pure dolomite. A limestone bed marks the base of the formation in all four test sections. At Gans the upper part of the formation is highly shaly.

Lithology—central area: In the south-central part of the State, the Tribes Hill has been logged at the Grund, Shepard, Kesselring, and Olin tests (Figure 5). At Grund, light gray, finely crystalline dolomite interbedded with some light and dark gray aphanitic limestone, sandstone, and siltstone make up the lithology of the 100 foot interval assigned to the formation. Fine quartz sandstone and quartz siltstone make up about one-third of the samples in the bottom 20 feet of section. Traces of black non-calcareous shale are present. At Shepard the upper 53 feet consists of light gray, brown-gray, and dark gray calcareous dolomite. Quartz, twinned feldspar, pyrite, and milky chert are very minor accessories. The lower 35 feet is largely highly calcareous siltstone and very fine grained siltstone with some light colored, very finely crystalline dolomite. Clean limestones appear to be missing. Well down dip at Kesselring, the upper part of the section assigned to the Tribes Hill, consists of light colored limestone and dolomitic limestone interbedded with calcareous dolomite. Lithographic to sublithographic (Lowville and Trenton type) limestones are present in this interval. The lower part of the interval is made up of interbedded dark and light colored dolomite with occasional

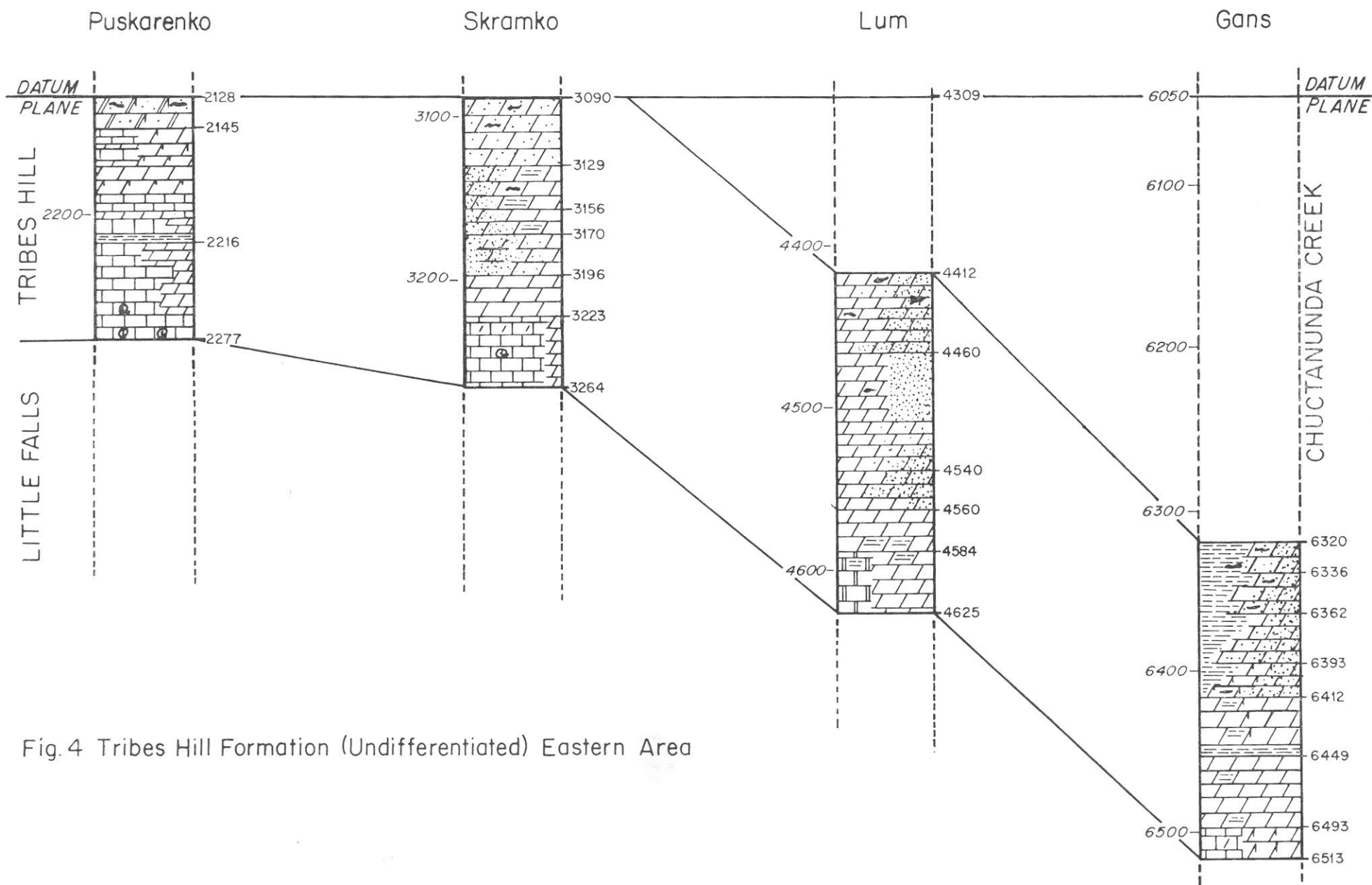


Fig.4 Tribes Hill Formation (Undifferentiated) Eastern Area

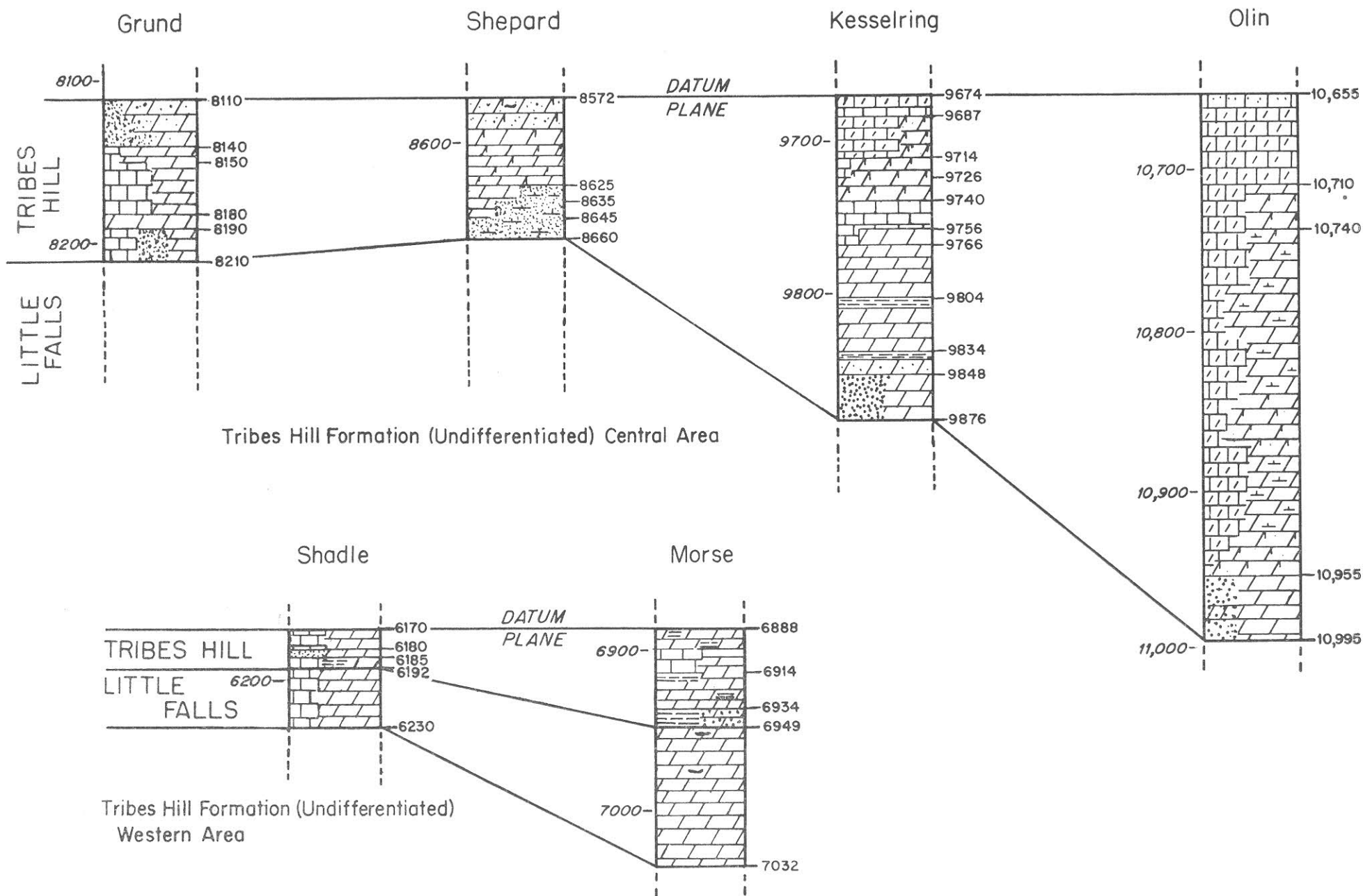


Fig.5 Tribes Hill Formation (Undifferentiated) Central Area and Western Area

streaks of black shale. There is a good sandstone unit at the base. Still deeper in the basin, at Olin, the entire 300 foot interval from 10,655 to 10,955 feet consists of interbedded light and dark colored aphanitic limestone, and light gray, fine to medium crystalline, calcareous dolomite. Dolomitization is irregular with some intervals showing up to 80 percent dolomite and others consisting of 100 percent limestone. Lithographic to sub-lithographic Trenton-Lowville type limestones extend well down into this interval. Sandstone comes into the section at about 10,955 feet and extends, interbedded with dolomite, to the base at 10,995 feet. The sandstone fraction, consisting mostly of rounded and frosted quartz and a little dolomitic sandstone, does not exceed 20 percent of the sample material.

Lithology—western area: Sediments correlative with the Tribes Hill in the western area are believed confined to the Shadle and Morse tests (Figure 5), although others have correlated relatively thin units at Rochester, MacDonald, Veith, Wilson, and Cook with this formation. (See individual well data reports on these tests.) At Shadle the 22 foot interval between 6170-6192 feet consists of interbedded dark brown aphanitic limestone and light gray, finely crystalline dolomite. A shale bed occurs in the interval 6185-6190 feet and a little quartz silt was noted, particularly at 6180-6185 feet. Down dip at Morse, the 61 foot interval between 6888-6949 feet consists of gray medium, dark gray fine, and brown medium to coarsely crystalline dolomite interbedded with black and brown shale. Brown aphanitic limestone is present between 6900-6914 feet. Shale is particularly abundant in the lower half of the unit, reaching 50 percent of the sample material below 6934 feet. Traces of chert, pyrite, and a little rounded and frosted quartz are present in some samples, some of the dolomites are arenaceous, and a little dolomitic sandstone is present.

Thickness: 0-340 feet. In the eastern area observed thickness of the Tribes Hill varies from 149 to 213 feet as follows: Puskarenko 149 feet, Skramko 174 feet, Lum 213 feet, and Gans 193 feet. The variation up dip is occasioned by erosion at the Black River-Tribes Hill contact. The slight decrease in thickness down dip between Lum and Gans may indicate the beginning of the feathering out of the formation basinward. In the central area, observed thicknesses were: Grund 100 feet, Shepard 88 feet, Kesselring 202 feet, and Olin 340 feet. The increase in thickness basinward in this area depicts

the wedge of strata preserved below the unconformity. In the western area at Shadle and Morse, thicknesses were 22 feet and 61 feet respectively, the thickest section being at the down dip location. Elsewhere over the map area, the formation was removed by pre-Black River erosion, has been grouped with other units for lack of evidence, or was never deposited.

Distribution: Restricted to the down dip position where preserved below the pre-Black River unconformity.

Correlation: Tracing the Tribes Hill Formation to and in the subsurface throughout the State is not easy or straightforward. This is due to limitations imposed by the sample material, the lack of unique lithologic features to tie the formation to the outcrop, the locally transitional nature of the upper contact, and to the long distances involved between some of the control points. Basically, the formation consists of interbedded limestone, dolomitic limestone, calcareous dolomite, dolomitic siltstone, and silty dolomite. Chert and shale are locally present, the latter being particularly common at the Gans and Morse test locations.

In the eastern area, a sequence fitting this description is present between the Puskarenko and Gans locations, as shown graphically in Figure 4. There seems little doubt but that this unit is directly correlative with the Tribes Hill based on observed lithology and stratigraphic position. In any event, the lithologic correlation *per se* as shown, is believed non-controversial and should supersede previous correlations.

In the south-central area the correlation is not as clear cut, but nevertheless the same mixed lithologies occur directly below the Trenton-Black River between the Grund and Olin test locations. In this area, arenaceous deposits are present at the base of the formation, which presumably could correlate with the basal beds of the Fort Johnson. In the deepest part of the basin at Kesselring and Olin, the upper contact is completely transitional with the Trenton-Black River, with no trace of Chuctanunda Creek lithology intervening. Up dip at Shepard and Grund, part of the formation has been removed by erosion. North of Grund it has been stripped completely, and the Black River rests directly on Little Falls.

In the western part of the State considerable doubt surrounds the possible development of the formation. Certain strata lying between sure Tren-

ton-Black River and sure Little Falls or Theresa at Rochester, MacDonald, Shadle, Morse, and other locations in the region have been assigned to the Tribes Hill by previous workers. In this report, the Tribes Hill call has been retained only at the Shadle and Morse locations. Elsewhere, the strata in question are considered, on lithologic or stratigraphic grounds, to be correlative either with the Black River or the Little Falls. The problem is covered further in the various individual Well Data Reports.

SARATOGA SPRINGS GROUP

Little Falls Dolomite

Lithology: "As restricted to the Mohawk Valley, the Little Falls consists of dolomites, variable in color and texture, frequently cherty and sandy. . . . with large (quartz) grains having a high degree of sphericity. . . ." (Fisher, 1956, p. 333). This quotation applies equally well to the Little Falls' as developed in the subsurface. Colors include all gradations from nearly white to nearly black, and from light tan through dark brown. Light pink colors are occasionally found. However, medium gray and gray-brown colors predominate. Textures range from dense through fine, medium, and coarsely crystalline, to sugary types, with the medium crystalline type perhaps being predominant. The quartz content is variable, but seldom exceeds a few percent, and thick zones of pure quartz-free dolomite are common. Medium to coarse rounded and frosted quartz is predominant, but angular quartz is also common. The cherts vary from light brown to light gray to milk white, and are in part oolitic, particularly near the base of the formation. Streaks and beds of black non-calcareous shale are present in some sections. The dolomites are generally non-calcareous, although calcareous types are not uncommon, particularly in the upper part of the formation.

Thickness: 0-755 feet. The formation reaches maximum thickness in the deepest part of the basin, as at the Olin test, and thins toward the Adirondack Mountains, and to a feather edge in the western part of the State. It is missing up dip below the pre-Black River unconformity in the northeastern area. However, the apparent thinning may be due in part to lateral gradation into Theresa-Potsdam lithologies, hence it is not possible to know just how much

of the up dip thinning is due to cut-out and how much is due to lateral change.

Distribution: The Little Falls Dolomite is present in the subsurface throughout the entire State with the exception of part of the area east of Lake Ontario, where basement rocks directly underlie the Black River, and to the northwest, where it has pinched out or graded into the Theresa. The distribution and thickness variations can best be seen by reference to the various diagrammatic sections—Plates I and II.

Correlation: Correlation of the bulk of the section assigned to the Little Falls in this report, with the type Little Falls at the outcrop, seems simple and non-controversial on the basis of observed lithology and stratigraphic position. Similarly, correlation of the formation from one well to another, and from one area to another in the subsurface is, with some exceptions, usually straightforward. However, difficulty is often encountered in picking the contacts, particularly the contact with the Theresa where this formation is low in quartz. As at the outcrop, the interbedded dolomite-sandstone sequence, which by definition constitutes the Theresa, is transitional in places with the overlying Little Falls Dolomite. Due to this transitional relationship, it is frequently difficult in any given well section to decide where to place the contact. This is particularly true down dip in the eastern area. Here the Theresa becomes progressively less and less arenaceous until it becomes impossible to pick a specific point as the contact on the basis of the sand content alone. Nevertheless, when all available lines of evidence are considered, it is usually possible to pick a position for the contact which will be consistent with the regional picture—if not with the type lithology. The oolitic chert zone frequently present near the base of the Little Falls is one useful guide in this regard. Finally, in certain well sections in the western area where the formation thins out, there are relatively thin beds of dolomite lying between sure Black River and sure Theresa, which may be correlative with the Little Falls, but for one reason or another have not been designated as such in this report.

Theresa dolomite-sandstone

Lithology: "At the type locality, near Theresa, Jefferson County, the Theresa consists of alternating beds of sandstone and sandy dolomite." (Fisher,

1956). This lithologic definition of the Theresa has been followed in tracing the unit to and throughout the subsurface. The dolomite/sand ratio varies drastically, both vertically and laterally, and many variations in lithologic detail exist, but essentially the formation is, as defined, a series of interbedded dolomites and sandstones. The dolomites vary from light to dark in color and from dense to fine, medium, or coarsely crystalline in texture, and are in part arenaceous. They are also in part dark gray and highly oolitic. The ooliths have been completely recrystallized, but the relict oolitic texture of the rock is still clearly evident in thin section. The sands vary from fine through medium to coarse grained, from angular to rounded and frosted, and from unconsolidated to extremely hard orthoquartzites. Orthoquartzites with dispersed dolomitized ooliths are occasionally met. Streaks and beds of variegated shale are not uncommon. Large halite crystals were a unique feature noted in one sample from the Theresa at the Olin test.

Samples from the upper 250 feet of the formation at Olin consist of loose quartz sand intermixed with some dolomite, shale, and limestone, with the sand content averaging 80 to 90 percent (the limestone fragments in the cuttings could be contamination from up hole). Less extensive sandstones and orthoquartzites are also present at the top of the formation in several of the well sections in the western part of the State. Judging from the Ellis test, quartz sandstones also become predominant in the lower part of the formation in the westernmost area. To the east, as at Gans, quartz becomes scarce, and the section has gone almost entirely to dolomite. It appears, therefore, from the control available, that west and southwest of a north-south line through the Schaffer test area, the Theresa becomes progressively more sandy, whereas to the east a dolomite facies predominates. The Rock-Stratigraphic fence diagram (Figure 6) is an attempt to show these facies changes within the Theresa-Potsdam sequence.

Thickness: 0-1435 feet. The thickest section of Theresa exists in the area of the Olin test, where 1435 feet has been logged. Minimum thicknesses are found in the up dip direction, where the formation is progressively cut out below the unconformity, or the formation loses identity, as in the Schaffer area.

Distribution: Strata believed correlative with the outcropping Theresa are present in the subsurface

throughout the State with the exception of the area east of Lake Ontario, where it is cut out by the unconformity at the base of the Black River, and in the Schaffer area, where it appears to grade into Potsdam type rock.

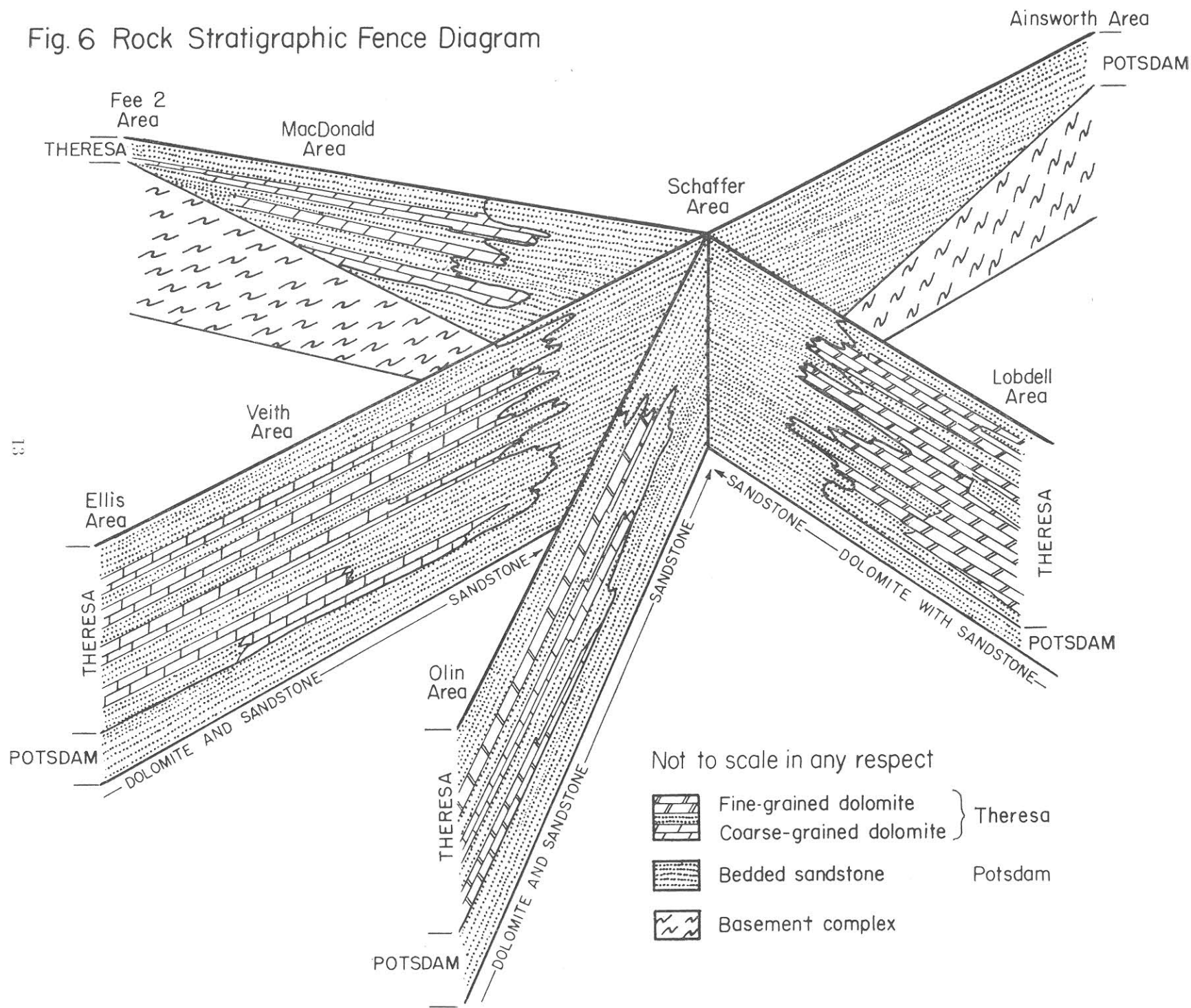
Correlation: As stated in a foregoing paragraph, the surface to subsurface correlation of the Theresa Formation is based largely on lithology and, of course, its stratigraphic position between the Little Falls Dolomite and the Potsdam Sandstone. Ideally, the formation can be thought of as a sequence of interbedded dolomites, arenaceous dolomites, sandstones and orthoquartzites. However, due to its high variability, the dolomite/quartz ratio is not a reliable parameter, and regional stratigraphic considerations must take over in some instances as the dominant factors in tracing the formation in the subsurface. Examples of this are the thick section of quartz sand logged at the top of the formation as Theresa at Olin, and, at the other extreme, the nearly quartz-free dolomite section logged as Theresa at Lum and Gans. Neither of these units answers to the lithologic description of the Theresa, yet they must certainly be logged as such on regional grounds.

The problem of fixing the upper contact with the Little Falls has been discussed previously. Placing the lower contact is less troublesome, although in a few instances the contact is controversial due to high quartz content towards the base of the formation. In this report, a decision was made to place the base at points where the average sand content crosses the line from under 50 percent, to over 50 percent.

Potsdam Sandstone

Lithology: Detailed petrographic studies were not made of the Potsdam Sandstone during the course of the present project. However, as at the surface, the sandstones consist of quartz grains with silica or carbonate cement and, for the most part, are true orthoquartzites. Minor amounts of dolomite and shale are usually interbedded with the sandstones. The quartz varies from fine to coarse and from angular to well rounded and frosted. Dispersed ooliths are occasionally observed in the orthoquartzites. Colors are generally light gray, although the so-called "transition" zone at the base of the formation at Olin is varicolored. The dolomites show all variations from dense to coarsely crystalline and from light to dark colors. Oolitic

Fig. 6 Rock Stratigraphic Fence Diagram



and arenaceous dolomites are not uncommon. The shales are usually black, or brown and non-calcareous. As similar type rocks are present in the Theresa, and locally in the Little Falls, positive recognition is not possible on the basis of lithology alone, i.e., insofar as the present study is concerned. Accordingly, in this report lithologic units averaging over 50 percent quartz and properly situated stratigraphically have been logged as Potsdam.

Thickness: 0-477 feet. The logged thickness of the Potsdam is highly variable over the map area, ranging from zero at Keith and the area east of Lake Ontario, to 477 feet at the Schaffer location. Only 14 of the 38 test sections involved reached or penetrated the formation. At Keith, basal sandstones are missing, and Theresa dolomite rests directly on the Precambrian.

Distribution: Presumably the formation directly overlies the Precambrian over the entire State, with the exception of the area where the Black River is known to rest on basement, and in the Keith area where it is missing. Control is not sufficient, however, to know whether or not it may be missing locally elsewhere than in the Keith area.

Correlation: Correlation of the formation with the outcrop section seems self-evident and non-controversial on the basis of lithology and stratig-

raphic position. The only exceptions are the arenaceous beds directly overlying the basement, which have previously been logged as Potsdam, but are here grouped with the Black River. This problem has been discussed in an earlier paragraph.

Interval between basement and Trenton-Black River:

The thickness of the rock section between the base of the Trenton-Black River (Datum Plane) and the top of the Precambrian is shown on Plate VI. North of the zero isopachous line, and specifically between the Adirondacks and Lake Ontario, the Trenton-Black River rests directly on the Precambrian. This is indicated on Plate VI by the word "none."

PRECAMBRIAN

Inasmuch as Isachsen (1962) has studied metamorphic rock lithologies in connection with a more extensive investigation of the Precambrian basement, sample examination was usually terminated at the point where metamorphic rocks make their first appearance in the well cuttings, Isachsen's placement of the Precambrian contacts are in agreement with those of the writer.

	UTICA	CANAJOHARIE	DOLGEVILLE	TRENTON LIMESTONE UNDIFF.	BLACK RIVER	TRENTON- BLACK RIVER	CHUCTANUNDA CREEK	TRIBES HILL	LITTLE FALLS	THERESA	POTSDAM	PRECAMBRIAN
Puskarenko	—	×	70	44	14	58	—	149	109—	322+	8+	—
Skramko	—	×	—	55	43	98	—	174	90	227+	—	—
Lum	—	×	—	15	30	45	103	213	182	493	55	×
Gans	—	×	—	30	—	30	270	193	321	351+	—	—
Dexter #9	—	—	—	o.c. 186+	φ 61+	247+	—	—	—	—	—	×
Denmark	—	—	—	o.c. 475+	φ 50+	525+	—	—	—	—	—	×
Finn	×	—	—	589	149	738	—	—	—	—	—	×
Gould	×	—	—	560—	φ 117+	677	—	—	—	—	—	×
Morgan	?	?	—	<—575—>		575	—	—	45	—	65+	? N.S.
Ainsworth	×	—	—	469	89	558	—	—	86	—	244	×
Keith	×	×	177	130	70	200	—	—	312	388	—	×
Danisevich	×	×	103	108	57	165	—	—	462	239+	—	—
Lobdell	×	×	141	109	24	133	—	—	511	409	62	×
Branagan	×	×	73	136	118	254	—	63	367	379	22	×
Fee #1	×	—	—	600	273	873	—	—	—	—	—	×
Beckwith	×	—	—	684	317	1001	—	—	—	—	—	×
Heaphy	×	—	—	785—	φ 160+	945	—	—	—	—	—	×
House	×	—	—	640—	φ 99+	745	—	—	—	—	—	×
Kellogg	×	—	—	715	φ 104+	819	—	—	—	—	—	×
Warner	×	—	—	674±	180±	854	—	—	50	—	—	—
Slayton #2	×	—	—	913+	127	1040+	—	—	59	—	272	×
Schaffer #2	×	—	—	1047	139	1186	—	—	161	—	477	×
Mahaney	×	—	—	846	144	990	—	—	122+	—	—	—
Grund	×	—	—	690	120	810	—	100	615	78+	—	—
Shepard	×	—	—	689	128	817	—	88	710	880	28	×
Kesselring	×	—	—	725	47	772	—	202	699	570+	—	—
Olin	×	—	—	980	—	980	—	340	760	1435	310+	—
Rochester	×	—	—	294	197	491	—	—	—	3+	—	—
Miller	×	—	—	×	×	×	—	—	×	×	139	×
MacDonald	×	—	—	786	228	1014	—	—	—	504+	—	—
Veith	×	—	—	<—850—>		850	—	—	130	730	122+	—
Wilson	×	—	—	689	110	799	—	—	184	702	117+	×
Cook #2	×	—	—	780—	φ 125+	905	—	—	214	113+	—	—
Fee #2	×	—	—	491	237	728	—	—	—	14+	—	—
Niehaus #2	×	—	—	693—	φ 43+	736	—	—	51	16+	—	—
Ellis	×	—	—	677	103	780	—	—	19	653	173	×
Shadle	×	—	—	<—725—>		725	—	22	38	51+	—	—
Morse	×	—	—	705	38	743	—	61	83	68+	—	—

Table 1—Logged Thicknesses of Key Horizons

× — Formation present—thickness not determined

— — Formation not present

φ — Top of formation not determined

o.c. — Trenton limestone outcrop at well site

+ — Where basement not reached = base of formation not reached

N.S. — Precambrian reported—no sample available

PART II

Stratigraphic Analysis by Wells

Well Name	Plate No.	Line No.	Page No.
Puskarenko	VII	4	18
J. Skramko			18
P. B. Lum			19
M. Gans			20
Dexter Village Water Well #9	VIII	3	21
Denmark			22
W. Finn			22
Gould Paper Company			23
E. D. Morgan			23
Ainsworth			24
H. A. Keith			25
J. Danisevich			26
D. L. Branagan			27
C. Lobdell	IX	6	29
T. L. Heaphy			32
E. House			32
Kellogg			33
Fee #1 (Reserve Gas Co.)			33
M. Beckwith	X	1	34
Warner Plant			34
H. Slayton #2			35
Schaffer #2			36
J. C. Mahaney			37
G. H. Grund			37
J. Shepard			38
E. C. Kesselring			39
R. Olin			40
Rochester	XI	2	42
A. Miller			42
MacDonald			44
Veith			44
K. R. Wilson			45
G. M. Cook #2			48
Fee #2 (J. F. Weinheimer, Inc.)	XII	5	48
Niehaus #2			49
Ellis			49
S. Shadle			50
K. Morse			51

Plate VII—Line 4

Puskarenko

Elevation: 1590 feet Topo.

Total Depth: 2717 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	2000—2128	128	—410
Tribes Hill	2128—2277	149	—538
Little Falls	2277—<2386	<109	—687
Theresa	<2386—2708	>322	—796
Potsdam	2708—2717 T.D.	9	—1118

Trenton-Black River Groups: 2000—2128 feet

Dolgeville Formation (transition zone) 2000—2070 feet

The top of the Trenton-Black River Group occurs at 2000 feet or higher where black argillaceous limestone becomes interbedded with the overlying Canajoharie Shale. Samples were not available above 2000 feet. The base of the Dolgeville transition zone occurs at 2070 feet (Plate VII, Line 4). (Note: Prior reports place the top of the Trenton limestone at 2070 feet and assign the Dolgeville transition zone sediments of this report to the Canajoharie.)

Trenton undifferentiated 2070—2114 feet

Typical brown-gray fossiliferous and black argillaceous Trenton-type limestones underlie the transition zone and extend to 2114 feet.

Black River-Lowville Formation 2114—2128 feet

Light brown aphanitic limestone and very light brown, very finely crystalline, silty dolomite occurs in the basal 14 feet of the group which is here considered as Lowville, although the limestone is not typically lithographic. *Pamelia*-type sediments are missing.

Tribes Hill Formation: 2128—2277 feet

The top of the Tribes Hill is placed at the top of a 17 foot bed of brown fine to medium crystalline, calcareous, cherty, and silty dolomite. The base occurs at the base of a 37 foot bed of brown aphanitic and light brown fossiliferous limestone. The intervening section is interbedded limestone and dolomite.

Little Falls Formation: 2277—<2386 feet

The upper contact with the Tribes Hill is marked by an abrupt change from limestone to dolomite. The base is indeterminate from samples as there is a sample gap from 2325 to 2386 feet, at which point the test was in Theresa.

Theresa Formation: <2386—2708 feet

The top occurs above 2386 feet, as noted in the preceding paragraph. The base is here placed at 2708 feet, at the top of an 8 foot bed of medium-grained, mostly angular quartz sand and ortho-quartzite. Previous reports show the base at 2637 feet, but since the section is predominantly dolomite (65 to 93 percent) down to 2708 feet, it seems more logical to extend the Theresa to at least 2708 feet. This bottom sand may be a stray sand in the Theresa, and the test may not have reached the Potsdam.

Potsdam Formation: 2708—2717 feet T.D.

The bottom sand may be Potsdam, but could as well be Theresa (see above).

J. Skramko

Elevation: 1560 feet

Total Depth: 3581 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	2992—3090	98	—1432
Tribes Hill	3090—3264	174	—1530
Little Falls	3264—3354	90	—1704
Theresa	3354—3581 T.D.	227	—1794

Trenton-Black River Groups: 2992—3090 feet

Trenton undifferentiated 2992—3047 feet

Trenton limestone lies directly below Canajoharie shale without an intervening transition zone. The base rests on Lowville.

Black River-Lowville Formation 3047—3090 feet

Non-fossiliferous brown and light brown aphanitic limestone extends from 3047 feet to 3090 feet. This limestone is probably correlative with the Lowville, although it is not typically lithographic in aspect. No *Pamelia* is present at this location.

Tribes Hill Formation: 3090—3264 feet

The Lowville-Tribes Hill contact is marked by a sharp break between limestone and a fairly thick sequence of arenaceous dolomite and dolomitic siltstone. The base is also well defined at the base of a 41 foot interval of interbedded limestone, dolomite, and shale in contact with dolomite.

Previous reports place this contact at the base of a dolomitic siltstone interval at 3196 feet. However, the underlying limestone is here considered Tribes Hill, and the contact accordingly placed at 3264 feet.

Little Falls Formation: 3264—3354 feet

The top of the formation is placed at the above-mentioned limestone-dolomite contact, and the base at the top of the first good sand which is used to mark the top of the Theresa. Cherts occurring in the interval 3300—3339 feet are in part oolitic.

Other reports show the basal contact at 3300 feet, which would put these cherts in the Theresa, but regional considerations suggest they belong in the Little Falls.

Theresa Formation: 3354—3581 feet T.D.

The top of the formation is placed at 3354 feet, where the first good sand occurs in the section. The base was not reached. Dark brown medium crystalline oolitic dolomite is present in the bottom 13 feet of hole.

P. B. Lum

Elevation: 1979 feet Grd.

Total Depth: 5521 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	4264—4309	45	—2285
Chuctanunda			
Creek	4309—4412	103	—2330
Tribes Hill	4412—4625	213	—2433
Little Falls	4625—4807	182	—2646
Theresa	4807—5300	493	—2828
Potsdam	5300—5355	55	—3321
Precambrian	5355—5521 T.D.	166	—3376

Trenton-Black River Groups: 4264—4309 feet

Trenton undifferentiated 4264—4279 feet

The Canajoharie shales rest directly on brown fossiliferous Trenton limestone at the Lum site.

These limestones are only 15 feet thick, and they in turn rest on light tan to brown dolomite.

Black River-Lowville Formation 4279—4309 feet

The designated interval consists of light tan to brown, dense to fine, and medium crystalline dolomite. This is believed to be dolomitized lithographic limestone correlative with the Lowville. The base at 4309 feet has been used previously as the base of the Trenton. Pamela-type sediments are missing.

Chuctanunda Creek Formation: 4309—4412 feet

The upper contact is marked by an influx of non-oolitic milk white chert, pale green non-calcareous pyritic shale, and black shale interbedded with tan-brown dolomite. Chert is particularly abundant between 4342 and 4369 feet, where cuttings may run to 75-80 percent chert. Between 4369 and 4412 feet, chert averages 2 to 5 percent, and quartz 1 to 5 percent. The lower contact is with a dolomitic siltstone-dolomite sequence.

Sediments in this interval have previously been grouped with the Little Falls, but this correlation appears invalid in light of information submitted in a following paragraph. During the course of the present study, the beds were thought to be equivalent to the Palatine Bridge member of the Tribes Hill Formation. However, during discussions with the Geological Staff at Albany, it developed that they are more likely correlative with the Chuctanunda Creek.

Tribes Hill Formation: 4412—4625 feet

The sequence below 4412 feet begins with very light gray, nearly white dolomitic siltstone interbedded with light brown to very light brown, medium crystalline dolomite, and ends at the base of an alternating 50 foot sequence of light brown fossiliferous limestone and very dark gray-brown dense dolomite with streaks of shale. The limestone-dolomite ratio is on the order of 65/35. There can be no question but that this interval is equivalent to the interval 3090—3264 feet at Skramko, which in turn is equivalent, at least in part, to the interval 2128—2277 feet at Puskarenko, and hence must be considered Tribes Hill.

The entire interval has previously been included with the Little Falls, but this correlation is believed invalid for the foregoing reasons.

Little Falls Formation: 4625—4807 feet

The top of the formation is placed at the limestone-dolomite contact previously mentioned, and the base more or less arbitrarily at 4807 feet. The necessity for assigning an arbitrary point as the Theresa-Little Falls contact is discussed in the following paragraph.

The interbedded dolomite-sand sequence, which by definition constitutes the Theresa Formation, is transitional with the Little Falls Dolomite. Due to this transitional relationship, it is frequently difficult in any given well section to decide where to place the contact. This is particularly true down dip in the eastern part of the State, as for example on Plate VII, line 4, southeastward from the Lum location. Here the Theresa becomes progressively less and less arenaceous, until it becomes impossible to pick a specific point as the contact on the basis of the sand content alone. To maintain correlation between the wells in this area, it therefore becomes necessary to resort to factors other than the dolomite-sand ratio. Fortunately, this is usually possible. The point picked for the contact at Lum is at the base of a thin shale bed and near the top of the first significant sand stringer. It is also below the oolitic chert zone which occurs in the Little Falls both up and down dip from Lum. The above-mentioned shale and the oolitic chert zone persist down dip at least as far as the Gans test, and since they fall in the proper stratigraphic position, the correlation as shown on the profile is considered valid. Picking the Little Falls-Theresa contact in this area thus becomes a matter of convenience for correlation purposes, rather than of stratigraphy, as there is no really good lithologic basis, apart from regional geology, for placing the contact at 4807 feet.

Theresa Formation: 4807—5300 feet

The top is arbitrarily placed at 4807 feet, as discussed above. The base is placed at 5300 feet, at which point the dolomite-sand sequence of the Theresa gives way to orthoquartzite. Dolomites with relict oolitic texture were noted below about 4940 feet.

Potsdam Formation: 5300—5355 feet

Typical Potsdam orthoquartzite, quartz sand, and dolomitic sandstone occupy the designated interval. Some 5 to 10 percent of the cuttings consist of arenaceous dolomite.

Precambrian: 5355—5521 feet T.D.

The Precambrian was reached at 5355 feet. The samples were not examined.

M. Gans

Elevation: 1928 feet Grd.

Total Depth: 7185 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton	6020—6050	300	—4092
Chuctanunda			
Creek	6050—6320	270	—4122
Tribes Hill	6320—6513	193	—4392
Little Falls	6513—6834	321	—4585
Theresa	6834—>7185	>351	—4906

Trenton Group: 6020—6050 feet

Trenton undifferentiated 6020—6050 feet

The Canajoharie-Trenton contact is recognized by the presence of dark gray, finely crystalline, highly pyritic dolomite in the sample taken at 6018—6029 feet. The dolomite was derived from fossiliferous limestone, as evidenced by the relict skeletal texture observed in the cuttings. The base of the formation is placed at 6050 feet also on the basis of one sample (6044—6050 feet), which consists of one-third dark brown, dense limestone, one-third gray-brown, finely crystalline dolomite, and one-third black, non-calcareous to slightly calcareous shale. There is a sample gap between 6029 and 6044 feet. Clearly these sediments represent a feather edge of the Trenton, partially dolomitized and interbedded with shale.

Chuctanunda Creek Formation: 6050—6320 feet

(Note: The formational subdivision of the Gans section, below the top of the Trenton as presented in this report, varies rather drastically from previous reports. For example, the section down to 6140 feet has formerly been grouped with the Trenton; from 6140—6230 feet, with the Black River; and from 6230—6830 feet, with the Little Falls. In considering the subdivision here presented, reference should be made to Plate I, Section A-A', where the lithology and correlation can be compared directly with the section up dip at Lum and Skramko.)

In this report, the Trenton-Chuctanunda Creek contact is placed at the top of an alternating se-

quence of light gray to brown, fine to medium crystalline dolomite interbedded with black and gray non-calcareous to slightly calcareous shale. Gray chert comes in below about 6135 feet and reaches up to 33 percent in the interval 6247—6260 feet. Cherty dolomites are locally present. Insoluble residues show some silt. The base of the formation is placed at the top of an alternating sequence of very light gray, dolomitic siltstone and gray-brown, finely crystalline dolomite. The lower part of the cherty zone is believed equivalent to the chert zone at Lum between 4309 and 4369 feet, whereas the remaining upper portion of the formation is missing up dip. As at Lum, the sediments in this interval were originally thought to be equivalent to the Palatine Bridge (*see* Lum).

Tribes Hill Formation: 6320—6513 feet

The top of the formation is placed at the top of a sequence of interbedded gray-brown, fine to medium crystalline, silty dolomites, very light gray dolomitic siltstones and black non-calcareous shales. The base is at the base of a 20 foot bed of light brown dolomitic limestone and calcareous dolomite. The interval is obviously correlative with the interval 4412—4625 feet at Lum and is accordingly considered as Tribes Hill.

Little Falls Formation: 6513—6834 feet

The top and base of the Little Falls at Gans were picked on the same basis as at Lum, the top being similarly well defined, and the base arbitrarily placed at the base of a series of shale beds interbedded with dolomite. Oolitic cherts occurring in the interval 6612—6804 feet strengthen the correlation.

Theresa Formation: 6834—7185 feet T.D.

The lithology of most of the interval here designated as Theresa is in fact more akin to the Little Falls. The beds are very lean in quartz down to 7147 feet and hence do not fit the definition of the Theresa. The presence of occasional chert beds is also suggestive of the Little Falls. Additionally, the first good sand appears at 7147 feet, hence the top of the formation should logically be placed at this point, i.e., close to the point used as the top of the formation in previous reports. However, since 6834 feet is believed approximately correlative with 4807 feet at Lum, and the beds containing oolitic chert

occurring above this point are believed to be Little Falls, this depth is used arbitrarily as the top of the Theresa. Theresa-type lithology does, nevertheless, exist near the bottom of the hole.

Perhaps a more logical solution to this problem would be to group the Theresa-Little Falls formations in this area and not attempt to pinpoint the contact. In such case, the correlation points established during the course of the present study could be used strictly as such and without further confusing the nomenclature.

Plate VIII—Line 3

Dexter Village Water Well No. 9

Elevation: 340 feet Topo.

Total Depth: 701 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	14—261	>261	+340
Precambrian	261—701	440	+79

Trenton-Black River Groups: 14—261 feet

Trenton undifferentiated 14—<200 feet

Dexter Village was spudded on the Trenton outcrop. The first sample at 14—19 feet consists of brown, mottled, aphanitic limestone with some fossil fragments and calcite crystals—typical Trenton lithology. The base occurs above 200 feet, but was not determined.

Black River Groups: 200—261 feet

Lowville-Pamelia undifferentiated

The first sample examined, 200—205 feet, consists of light brown to brown aphanitic limestone, not typically lithographic, but probably Lowville equivalent. Lowville and Pamelia-type limestones interbedded with dolomite extend from this depth to 250 feet. Light brown, skeletal, fragmental, and oolitic limestone occurs at 215—220 feet. The basal 11 feet of the formation consists of variegated shale and variegated arenaceous dolomite with some rounded and frosted quartz. Reds, browns, grays, and greens predominate. The basal contact is with the Precambrian (Plate VIII—Line 3).

Precambrian: 261—701 feet T.D.

“White granulite composed of magnetite-quartz-feldspar” described by Y. W. Isachsen (1962).

Denmark

Elevation: 1050 feet Topo.

Total Depth: 652 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	0—525	>525	(?)
Precambrian	525—652	127	+525

Trenton-Black River Groups: 0—525 feet

Trenton undifferentiated 0—<475 feet

No samples were available over this interval, but the Trenton presumably outcrops at the location.

Black River-Pamelia <475—525 feet

The Trenton-Black River contact lies above the depth of the first available sample. The base is in contact with the Precambrian.

Light brown aphanitic limestones interbedded with light gray-brown, finely crystalline dolomites extend from 475—500 feet. These carbonates are not diagnostic and could be either Lowville or Pamelia. They are here assigned to the Pamelia on regional stratigraphic grounds. The 10 foot interval from 500—510 feet consists mostly of red, brown, and green shale interbedded with lesser amounts of light green arenaceous dolomite. This sequence is underlain by 15 feet of loose, coarse-grained sand, light green arenaceous dolomite, and variegated shale in roughly equal amounts, in contact with basement rocks.

(Note: The interval 510—535 feet is shown as “granite wash” on the well data cards. Isachsen (1962) puts the top of the Precambrian at 540 feet. Since the sample at 520—525 feet consists wholly of sedimentary rocks, and the next one at 525—530 feet contains much pink quartz and feldspar, the contact is here placed at 525 feet.)

Precambrian: 525—652 feet

Samples not examined. They are described by Y. W. Isachsen (1962) as follows: “pink quartz-feldspar granulite.”

W. Finn

Elevation: 1752 feet Topo.

Total Depth: 1476 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	726—1473	747	+1026
Precambrian	1473—1476	—	+ 279

Trenton-Black River Groups: 726—1473 feet

Trenton undifferentiated 726—1324 feet

Black, non-calcareous Utica shale rests in sharp contact with dark brown and dark gray fossiliferous limestone at 726 feet. The base is less well defined, but there is a lithologic change at about 1324 feet which is here used as the Trenton-Lowville contact. The upper half of the Trenton (undifferentiated) at Finn consists of gray, dark gray and dark brown-gray fossiliferous limestone. Below 1076 feet, 35 to 40 percent of very dark gray to black aphanitic limestone is interbedded with the fossiliferous limestone.

Black River Group: 1324—1473 feet

Lowville Formation 1324—1405 feet

The upper contact appears to be transitional with the Trenton, as some fossiliferous Trenton-type limestone is interbedded with brown aphanitic limestone and tan lithographic Lowville-type limestone below 1324 feet. The base is placed at the base of a 25 foot bed of light tan-colored lithographic limestone in contact with arenaceous limestone and fine to coarse-grained sandstone.

Pamelia Formation 1405—1473 feet

The Pamelia at Finn is made up of a variety of lithologies, which is a characteristic of the formation elsewhere, although oolitic limestone, generally present, was not observed in the cuttings. The following sequence, from top to base, is present:

1405—1417 feet—Light gray arenaceous limestone and tan aphanitic limestone mixed with about 15 percent fine, medium, and coarse round and frosted quartz sand. A little brown non-calcareous shale is present.

1417—1459 feet—One-third brown to very dark brown aphanitic limestone; one-third gray to gray-brown arenaceous limestone; one-third light brown

to brown non-calcareous shale. Quartz is scarce in this interval.

1459—1473 feet¹—25 percent gray, red, and greenish-colored arenaceous dolomite; 25 percent gray, red, and green shale with dolomite rhombs; 25 percent gray, aphanitic limestone; 25 percent medium to coarse-grained, rounded and frosted quartz sand. These variegated and mixed lithologies directly overlying the basement were observed up dip at Denmark, and down dip at Gould Paper, and are said to be present at the outcrop where Black River rests directly on the basement.²

Precambrian: 1473—1476 feet

Samples not studied. Described by Isachsen (1962) as “pink quartz feldspar granulite, sparsely chloritic.”

Gould Paper Company

Elevation: 1788 feet DF

Total Depth: 1789 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	1055—1732	677	+733
Precambrian	1732—1789	57	+ 56

Trenton-Black River Groups:

Trenton undifferentiated 1055—>1615 feet

Black, slightly calcareous Utica Shale rests directly on Trenton Limestone at approximately 1055 feet. The base was not determined, but appears to be transitional with the Black River due to the presence of Trenton-type fossiliferous limestone interbedded in the section below 1615 feet.

Black River Group:

Lowville-Pamelia >1615—1732 feet

Sample examination began at 1615 feet in medium gray, aphanitic limestones, which are probably Lowville, although they are not typically lithographic. Downward, these limestones are interbedded with gray, mottled, fossiliferous limestone and gray arenaceous limestone to about 1690 feet. Traces of light gray, highly calcareous, arenaceous

dolomite were noted at 1661 feet, and some of the limestones below this point are probably dolomitic, while others are dark gray in color.

Below 1690 feet, very light gray, medium crystalline, arenaceous, calcareous dolomites are interbedded with very dark gray to black aphanitic, arenaceous limestone, and the basal bed between 1725 and 1732 feet is characterized by variegated dolomite; brown, gray and black limestone, with up to 10-15 percent medium to coarse, rounded and frosted quartz sand. Some light green, slightly dolomitic shale is present between 1703 and 1712 feet. Hence, the Lowville-Pamelia contact appears to be transitional through the interval 1661—1690 feet. The “basal Pamelia sand,” as listed on the well data card between 1725 and 1732 feet, consists of:

1725—1729 feet	60% Dolomite, gray, light green, brown, arenaceous with an aphanitic ground mass; quartz in large rounded and frosted grains
	20% Limestone, black, aphanitic
	20% Limestone, very light gray, gray and light brown, aphanitic

and is correlative with the basal beds overlying the basement at the Finn and Denmark locations.

Precambrian: 1732—1789 feet

“Garnet-biotite-quartz-feldspar gneiss” at depth of 1763 feet, by Isachsen (1962).

E. D. Morgan

Elevation: 880 feet Topo.

Total Depth: 1000 feet +

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	<300—875	>575	—
Little Falls	875—920	45	+ 5
Potsdam	920—>985	>65	—40
Sample gap	985—>1000		
Precambrian (?)	“reached granite”		

Trenton-Black River Groups: 300—875 feet

The first available sample at 300 feet consists of light gray-brown to brown aphanitic fossiliferous Trenton limestone; hence, the top of the Trenton

¹ calcite limestone of others.

² Verbal—Albany staff meeting 8/7/63.

Group must be above 300 feet, and not at 320 feet, as shown on the well data card. The sample collection below 300 feet is limited to samples at 500 feet, 590 feet, 750 feet, and 850—875 feet. The first three consist of gray to dark gray Trenton limestone with some shale, and the last of tan lithographic Lowville limestone. There is a sample gap between 875 and 920 feet, and the base of the Black River Group as previously placed at 875 feet is used in this report.

Little Falls Formation: 875—920 feet

This 45 foot interval has previously been assigned to the "calciferous" and is here assumed to be Little Falls, although no samples are available. A Little Falls call fits the regional picture (see Plate II Profile B-B').

Potsdam (?) Formation: 920—>985 feet

The sample 920—925 feet consists of 85 percent coarse to medium-grained, rounded and frosted quartz sand and 15 percent gray, highly arenaceous dolomite. Samples at 950 feet, 970 feet, and 980—985 feet consist of very light gray, finely crystalline calcareous dolomite with 5-8 percent quartz silt. The first sample certainly looks like, and may be, Potsdam, but the presence of 35 feet of dolomite below the sand throws some doubt on this call. No samples are available below 985 feet. If the interval is not correlative with the Potsdam, it could be Theresa or a transitional facies between the Theresa and Potsdam. Any of the various possibilities could be introduced on Profile B-B' without changing the general picture.

Precambrian (?): >1000 feet

The test is said to have "reached granite," but no samples were available to confirm this call.

Ainsworth

Elevation: 430 feet Topo.

Total Depth: 2795 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	1507—2065	558	—1077
Little Falls	2065—2151	86	—1635
Potsdam	2151—2395	244	—1721
Precambrian	2395—2795	400	—1965

Trenton-Black River Groups: 1507—2065 feet

Trenton undifferentiated 1507—1976 feet

Samples are not available for pinpointing the top of the Trenton. The samples available at 1265 feet and at 1350 feet are Utica shales, while the next available sample at 1520 feet is Trenton limestone. Hence, the top of the formation lies between the latter two samples. It has previously been placed at 1507 feet on the basis of information not available during this study, and this depth is accepted as valid. The base is placed at 1976 feet, although there appears to be a transition zone down to 2000 feet, at which point good Lowville-type lithographic limestone comes into the section.

Black River Group: 1976—2065 feet

Lowville Formation 1976—2065 feet

This interval consists of typical Lowville-type, tan and brown lithographic limestone. The basal contact is with very light gray, finely crystalline calcareous dolomite. Pamela-type rocks are missing.

Little Falls Formation: 2065—2151 feet

Very light gray, finely crystalline, and gray-brown, medium crystalline calcareous, and in part arenaceous dolomites occur in this interval. They are assigned to the Little Falls on the basis of lithology and stratigraphic position. The Tribes Hill, or equivalent, is missing; the very minor amounts of limestone present in the samples are here considered as contamination from up-hole. The base is in contact with orthoquartzite and medium to coarse-grained, rounded and frosted quartz sandstone. (Actually, the contact lies between the sample at 2151 feet, which is arenaceous dolomite, and the next sample at 2170 feet, which is orthoquartzite and sandstone. The shallower depth is used on the well card and is here accepted.)

Potsdam Formation: 2151—2395 feet

The sample record is incomplete, but, judging from samples available, the formation appears to consist largely of orthoquartzite and quartz sand from 2151 to 2360 feet, and of very light gray, nearly white, medium crystalline highly arenaceous dolomite and gray medium to coarsely crystalline dolomite from 2360—2395 feet. At and below 2322 feet, the quartz is mainly angular, in contrast to the rounded and frosted quartz sand present above.

Minor amounts of black shale were noted in most of the samples.

The top of the formation is placed at 2151 feet (see under Little Falls). The base is here placed at 2395 feet, as the sample at 2390 feet consists of gray, medium crystalline arenaceous dolomite with some dolomitic sandstone and a little black shale, whereas the sample at 2395 feet consists of dolomite and black shale mixed with igneous rock fragments. On the well card the interval 2395—2409 feet is listed as “granite wash,” and 2409 feet is used as the top of the Precambrian. Isachsen places the top of the Precambrian at 2405 feet.

Precambrian: 2395—2795 feet

The samples at and below 2395 feet were not examined during this study. They have been described by Isachsen (1962) as “white quartz-feldspar gneisses, sparsely biotitic, muscovitic, hornblendic.” The top of the Precambrian is placed at 2395 feet. (See preceding paragraph.)

H. A. Keith

Elevation: 1319 feet Grd.

Total Depth: 4366 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Utica-Canajoharie	<2800—3223	—	—
Trenton-Black River	3223—3600	377	—1904
Little Falls	3600—3912	312	—2281
Theresa	3912—4300	388	—2593
Precambrian	4300—4366	66	—2981

Utica-Canajoharie Shales: <2800—3223 feet

Although the post-Trenton was not included in the present assignment, the Utica and Canajoharie shales were examined in a few of the wells in the eastern area in order to demonstrate the nature of the Trenton shale-out in the subsurface. It was found that the essentially non-calcareous shales of the Utica are transitional downward with the Canajoharie calcareous shales, and that the latter are in turn transitional with the Trenton through a sequence of interbedded limestone and black, calcareous shale, much as in the outcrop sections. At Keith, the Utica-Canajoharie contact is in the vicinity of 3000 feet. Below this depth, the carbonate content increases, and the shales become very calcareous

directly above the first limestone at 3223 feet. The limestone-shale transition zone below 3223 feet at Keith, and where present elsewhere, is included with the Trenton. The Trenton shale-out is discussed in more detail in the accompanying report.

Trenton-Black River Groups: 3223—3600 feet

Dolgeville Formation (transition zone) 3223—3400 feet

The top of the Trenton occurs at 3223 feet, at the top of the first dark-colored limestone bed below the Canajoharie Shale. Shale predominates between 3223 and 3290 feet, whereas shale and limestone are interbedded in about equal amounts from 3290 to 3400 feet.

Trenton undifferentiated 3400—3530 feet

Dark gray, highly fossiliferous Trenton Limestone, with streaks of black shale, extends from 3400 to 3530 feet. The base at 3530 feet rests on Lowville.

Black River-Lowville 3530—3600 feet

Gray-brown aphanitic limestones with conchoidal fracture occupy the interval 3530—3600 feet. While not typically lithographic, these limestones are believed correlative with the Lowville.

Little Falls Formation: 3600—3912 feet

The formation as developed at Keith consists largely of light gray fine, medium, and coarsely crystalline dolomite, with occasional beds of black shale and streaks of silt. Oolitic cherts are present at the base. The upper contact is with aphanitic limestone of the overlying Lowville. Tribes Hill-type lithology appears to be missing. The base is placed at 3912 feet, below the oolitic cherts and at the top of a bed containing up to 20 percent medium-grained, rounded and frosted quartz sand, which point is considered as the top of the Theresa Formation.

(Previous reports assign the interval 3614—3708 feet to the Tribes Hill. The basis for this call is not readily apparent as the lithology is typically Little Falls, and no lithologic break was noted at 3708 feet. Additionally, the base has previously been called at 3860 feet. However, as the first good sand comes in well below this depth, and the oolitic cherts are believed on regional grounds to be Little Falls, the basal contact is here placed at 3912 feet.)

Theresa Formation: 3912—4300 feet

The Theresa is rather typically developed, ortho-quartzite being interbedded with dolomite down to 4010 feet, and with brown-gray, fine, medium, and coarsely crystalline dolomite in part showing relict oolitic texture present below this point. Below 4010 feet, the section is lean in quartz, with the exception of a bed of sandstone at 4121 feet and a little silt at the base. There are two anomalous situations, however. A little white, oolitic chert occurs between 4057—4080 feet; and the sample at 4250—4255 feet contains about 45 percent very dark gray, aphanitic limestone with fossil fragments. The former is in a section derived in part by dolomitization of oolitic limestone and is therefore perhaps not necessarily anomalous. The fossiliferous limestone cuttings are probably cavings from up-hole.

The Little Falls-Theresa contact has been described in a preceding paragraph. Potsdam is missing, and the base is in contact with the Precambrian.

Precambrian: 4300—4366 feet

The samples below 4300 feet have been described by Isachsen (1962) as follows: "pink quartz-feldspar granulite, sparsely biotitic, chloritic."

J. Danisevich

Elevation: 1508 feet DF

Total Depth: 4889 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Utica-Canajoharie			
	<3393—3920	—	—
Trenton-Black			
River	3920—4188	268	—2412
Little Falls	4188—4650	462	—2680
Theresa	4650—>4889	>239	—3142

Utica-Canajoharie Shales: <3393—3920 feet

The Utica-Canajoharie and Canajoharie-Trenton are transitional. (See under Keith.) The contacts are as follows:

<3393—3537 feet	Utica, dark gray, non-calcareous shale	
3537—3650± feet	Utica-Canajoharie transition	transi-
3650—3920 feet	Canajoharie, black, calcareous to highly calcareous shale	

Trenton-Black River Groups: 3920—4188 feet

Dolgeville Formation (transition zone) 3920—4023 feet

Black, highly calcareous shale is interbedded with dark brown limestone through this interval. The limestone content is variable, but less than shale in the upper part, to about 50 percent below. The top of the formation is placed at the top of the first limestone bed. The base is in contact with brown, fossiliferous limestone.

Trenton undifferentiated 4023—4131 feet

Typical Trenton-type gray-brown, fossiliferous limestone is present in this interval. The limestone is interbedded with some shale, particularly in the upper part. The base is in contact with Lowville-type limestone.

Black River-Lowville 4131—4188 feet

Gray-brown, aphanitic limestone exhibiting conchoidal fracture makes up this interval. The color of the limestone becomes a lighter tan with depth. The base is in contact with dolomite. Pamelia-type rocks are missing.

Little Falls Formation: 4188—4650 feet

Gray, brown, and light tan-colored fine, medium, and coarsely crystalline dolomites, in part arenaceous, constitute this 462 foot interval. Cherts, including oolitic cherts, are common, locally abundant, as at 4242 feet, 4292 feet, 4330 feet, and common in the lower beds from 4562 to 4650 feet. Siltstones occur in the interval 4292—4391 feet and at 4545—4562 feet. No limestones were noted. The top of the formation is in sharp contact with Lowville Limestone. The base is placed at the base of the lower oolitic chert zone and at the top of the first good sand at 4650 feet.

Previous workers have subdivided this section somewhat differently. A comparison of the two subdivisions is shown in the following table:

	Previous reports (feet)	This report (feet)
Tribes Hill	4188—4381	—
Little Falls	4381—4562	4188—4650
Theresa	4562—4889	4650—4889

In defense of the previous Tribes Hill call, the presence of arenaceous streaks in the interval

4292—4391 feet can be cited. These are thin, siliceous siltstones and silty cherts somewhat similar lithologically to the Tribes Hill farther to the east. Had a limestone bed been present at the base, the unit could be placed in the Tribes Hill with more confidence. In the absence of limestone, however, a Little Falls call seems more reasonable as the overall impression is one of Little Falls lithology. Nevertheless, it can be argued that the limestone has phased out down dip, and the possibility that the interval is stratigraphically equivalent to the Tribes Hill cannot be ruled out.

As to the Little Falls-Theresa contact, the present call at 4650 feet seems the more logical as it keeps the lower oolitic chert zone in the Little Falls, where it has been observed elsewhere in the subsurface.

Theresa Formation: 4650—4889 feet

Typical Theresa lithology extends from 4650 feet to the bottom of the hole at 4889 feet. The test terminated in dolomite, neither Potsdam nor the Precambrian having been encountered.

D. L. Branagan

Elevation: 1544 feet Grd.

Total Depth: 5703 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Utica-Canajoharie	—	—	—
Trenton-Black River	4495—4822	327	—2951
Tribes Hill or Chuctanunda Creek	4822—4920	63	—3287
Little Falls	4920—5252	367	—3376
Theresa	5252—5631	379	—3708
Potsdam	5631—5653	22	—4087
Precambrian	5661—	(5653—5703 sample gap)	

Utica-Canajoharie Shales

Samples were examined over the 1000 foot interval from 3831—4822 feet. From 3831 to about 4141 feet was very dark gray, non-calcareous shales interbedded with gray, silty calcareous shale. From 4141 to 4365 feet, the shales become black and are very slightly calcareous, and from the latter depth to 4495 feet, they are calcareous. As the CaCO₃

content increases gradually with depth, the Utica-Canajoharie contact is difficult if not impossible to place, but is probably transitional over the interval 4141—4365 feet. The base of the Canajoharie is placed at 4495 feet, where the first Trenton limestone cuttings were noted in the samples.

Trenton-Black River Groups: 4495—4822 feet

Dolgeville Formation (transition zone) 4495—4568 feet

The accompanying Figure 7 limestone-shale percentage log has been drawn to show the transitional nature of the Canajoharie-Trenton and Trenton-Black River at Branagan. As can be seen from the log, the Dolgeville Formation is predominantly shale, although the limestone content does reach 50 percent locally. The base of the zone is placed at 4568 feet, at which point brown, fossiliferous limestone replaces the darker colored, non-fossiliferous limestone of the Dolgeville.

Trenton undifferentiated 4568—4704 feet

The carbonate-clastic ratio is quite variable in this interval, with the latter element reaching up to 80 percent well down in the formation. The possibility that the shales are cavings from up-hole can be discounted to some extent by the apparent change in lime content. The overall impression is still one of transition from an underlying carbonate to an overlying clastic environment. The base of the unit is placed at the top of the aphanitic, non-fossiliferous limestones of the Lowville.

Black River-Lowville 4704—4822 feet

Below 4704 feet, brown, aphanitic limestone is predominant (Figure 7). Below 4747 feet, the color becomes noticeably lighter, and the limestone looks more like Lowville, although it is still not typically lithographic. Some fossiliferous limestones and shale are present in this interval. It is tempting to consider these as contamination from the overlying section—and they could be. If not, then a transitional relationship exists between the Trenton and the Black River in this area. The base of the Lowville is in contact with a dolomite-shale sequence. Pamela-type rocks are missing.

Tribes Hill Formation: 4822—4920 feet

At Branagan, unlike elsewhere in this general area, a series made up of interbedded shale and

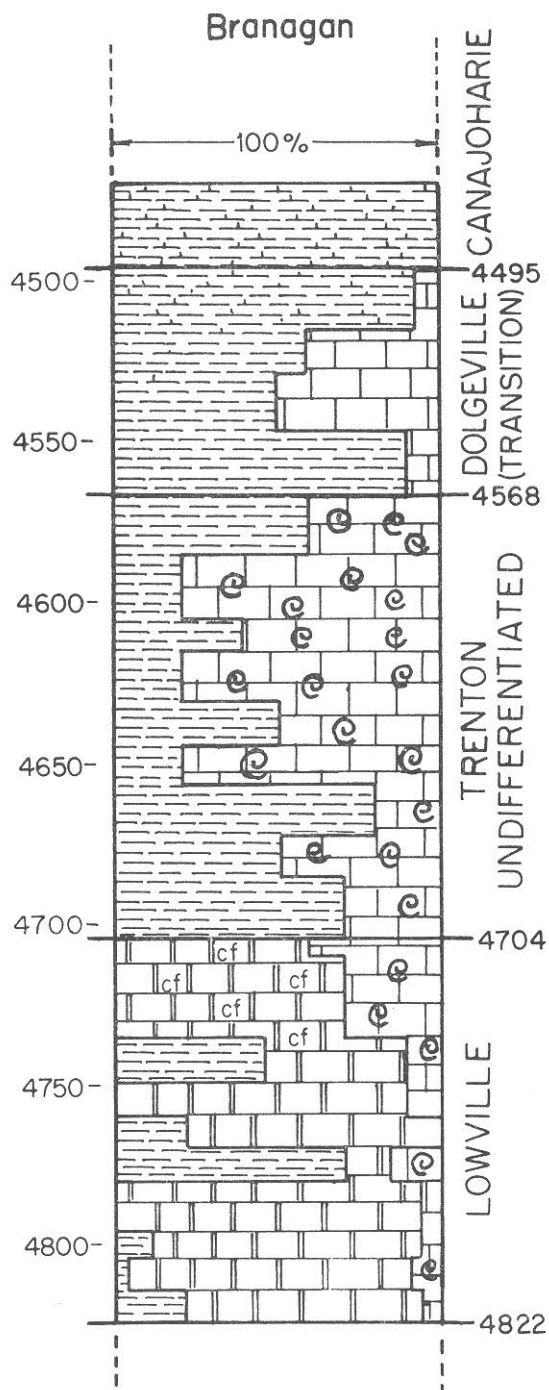


Fig. 7 Trenton-Black River Lithologic Percentage Log - D.L. Branagan

dolomite occurs directly below the Lowville. At the base of the interval, some calcareous dolomite and a little limestone was found in the cuttings. The lithologic sequence from the basal Lowville into the Little Falls is shown graphically on Figure 8. The interval has previously been assigned to the Tribes Hill, and this classification is followed here, although, excepting the calcareous elements at the base, the lithology is more akin to the Chuctanunda as found at Gans. The occurrence appears anomalous for this area.

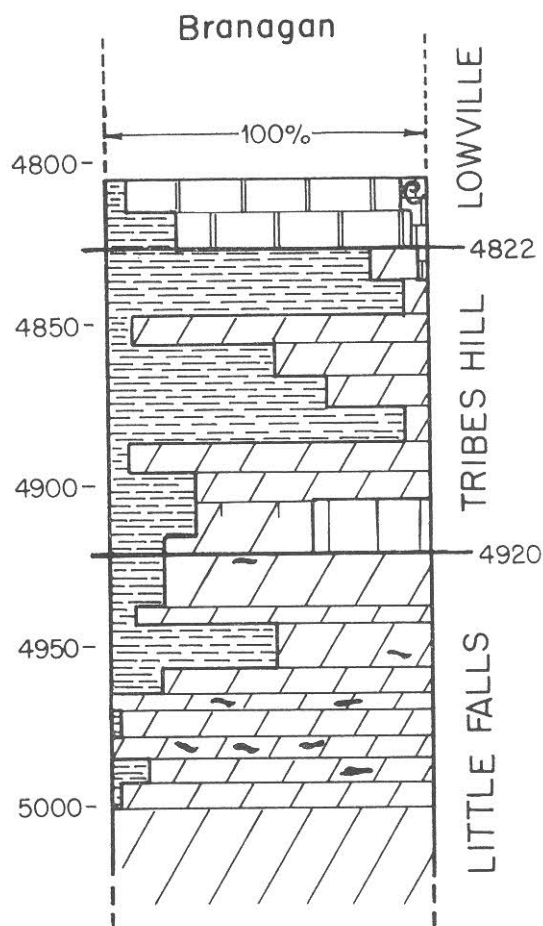


Fig. 8 Tribes Hill Lithologic Percentage Log - D. L. Branagan

Little Falls Formation: 4920—5252 feet

The top of the Little Falls is placed at the top of a section made up largely of fine and medium crystalline dolomite, and arenaceous dolomite with occasional thin streaks of sand. Cherts are present near the top of the interval, and some oolitic chert occurs near the base. On the well data sheet, the base is shown at 5203 feet. However, as in the other areas, this lower oolitic chert zone is included with the Little Falls, and the base of the formation is therefore placed at 5252 feet in this report.

Theresa Formation: 5252—5631 feet

Typical Theresa lithology extends over the designated interval, and the formation needs no special comment. Dark-colored dolomites exhibiting relict oolitic texture were noted in the interval 5543—5583 feet. Such rock types are of course frequently present in the Theresa. The top of the formation is placed at the top of a bed containing up to 10 percent medium-grained, rounded and frosted quartz sand. The basal contact is between dolomite and orthoquartzite.

Potsdam Formation: 5631—5653+ feet

Orthoquartzite and quartz sand equals or exceeds 50 percent below 5631 feet; hence the beds are assigned to the Potsdam. No samples were available for study below 5653 feet.

Precambrian:

Precambrian rocks are reported to occur between 5661 and final depth at 5703 feet. No samples are available to confirm or deny this call.

C. Lobdell

Elevation: 1373 feet DF
Total Depth: 5701 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Utica-Canajoharie	3932—4276	—	—
Trenton-Black River	4276—4550	274	—2903
Little Falls	4550—5061	511	—3177
Theresa	5061—5472	411	—3688
Potsdam	5472—5534	62	—4099
Precambrian	5534—5701	167	—4161

Utica-Canajoharie Shales: 3932—4276 feet

The only samples available for study from this interval extend from 4230—4276 feet. However, Fettke's¹ descriptions can be used to correlate the section with the Danisevich test as follows:

	This report	Fettke
3932—4002 feet	Utica)	
)	Utica
4002—4276 feet	Canajoharie)	

As for the present sample study, it can only be stated that the shales from 4230—4276 feet look like typical Canajoharie. (See Keith.)

Trenton-Black River Groups: 4276—4550 feet

Dolgeville Formation (transition zone) 4276—4417 feet

Interbedded dark gray, finely crystalline limestone and black, calcareous shale in approximately equal proportions make up the Dolgeville formation or transition zone at Lobdell. The top is placed at 4276 feet, where the first limestone comes into the section, and the base is in contact with gray-brown, fossiliferous limestone at 4417 feet.

Trenton undifferentiated 4417—4526 feet

Characteristic gray-brown, fossiliferous Trenton-type limestone with thin streaks of shale occurs in this interval. The base is in contact with Lowville limestone.

Black River-Lowville 4526—4550 feet

Typical Lowville-type, tan, lithographic limestone occupies this 24 foot interval. The base is in contact with highly cherty dolomite. The Pamela is absent.

Little Falls Formation: 4550—5061 feet

Basically, this 511 foot interval consists of light gray, fine to medium crystalline dolomite, in part arenaceous (Figure 9). Cherty zones are present at the top from 4550—4590 feet, at 4690—4774 feet, and at the base from 5001—5061 feet. Oolitic cherts were noted in all three intervals. Siltstones and silts interbedded with dolomite occur in the interval 4771—4831 feet and directly below 4980 feet. A bed of black, gray and red-brown, non-calcareous

¹ Well sample descriptions . . . Fettke, 1961, p. 459.

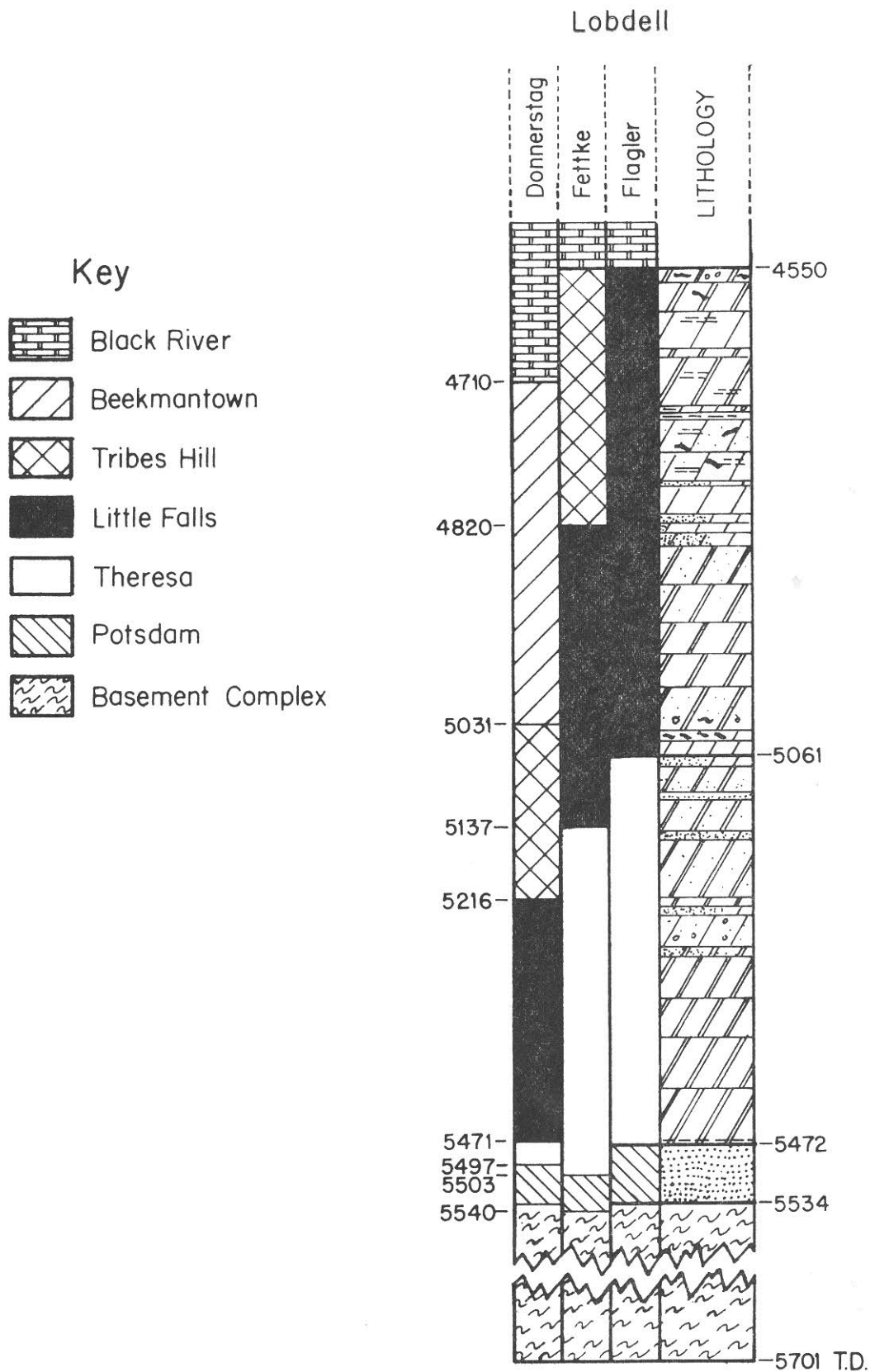


Fig. 9 Comparative Calls – C. Lobdell Well

shale occurs at about 4693 feet. Otherwise shale, including pale green shale, is scarce to common in samples from the upper half of the interval, to scarce or absent in the lower half. The topmost bed, lying directly below the Lowville, consists of about 50 percent chert and 50 percent finely crystalline dolomite with a trace of shale. The base of the formation is here placed below the lower cherty zone at the top of a bed containing up to 50 percent medium- to fine-grained, rounded and frosted quartz sand. All of the foregoing is consistent with Little Falls lithology.

Nevertheless, as at Danisevich, there is some question as to whether a part of the interval here assigned to the Little Falls is correlative with the Tribes Hill. (See under Danisevich.) Fettke (op. cit. 1961) called the interval 4550—4820 feet Tribes Hill and described all of the samples as magnesian-bearing limestones. Kreidler and Fisher (oral communication) have assigned the interval 4550—5031 feet to the Tribes Hill and considered the interval 5031—5216 feet simply as being of Canadian age. The various, conflicting calls down to basement are graphically shown on the preceding page (Figure 9) and are tabulated below:

	Donnerstag (feet)	Fettke (feet)	This report (feet)
Beekman- town	4710—5031	—	—
Tribes Hill	5031—5216	4550—4820	—
Little Falls	5216—5471	4820—5137	4550—5061
Theresa	5471—5497	5137—5503	5061—5472
Potsdam	5497—5534	5503—5540	5472—5534
Precambrian	5534—	5540—	5534—

Fettke was obviously using his magnesian limestone-dolomite contact as the base of his Tribes Hill. Some free CaCO_3 is present in this interval, as between 4693 and 4705 feet (see Figure 9), but the bulk of the material appears to be dolomite. The basis for the other call at 5031 feet is not readily apparent. On the basis of the present study, the only reason for question arises from the presence of the siltstones bottomed at 4831 feet. These could be correlative with the lower siltstones of the Tribes Hill to the east, and if such a subdivision is to be considered, the base of the formation should be placed at this depth. (See under Danisevich.)

The base of the Little Falls is shown at 5471 feet by Donnerstag, and was placed at 5137 feet by Fettke. The former call was apparently made in

order to include the thick, relatively pure dolomite sequence between 5216 and 5471 feet within the Little Falls. The basis for Fettke's call can not be deciphered from the log. As previously stated, it is here placed at 5061 feet to include the lower oolitic cherts within the Little Falls, and to place the interbedded sand-dolomite sequence below this depth within the Theresa.

Theresa Formation: 5061—5472 feet

The top of the Theresa is placed at the top of the first good sandstone and below the lowermost cherty zone of the Little Falls. The top bed (sample) contains up to 50 percent medium to fine, rounded and frosted quartz sand and dolomite. Sandstones are interbedded in the section down to 5261 feet. From this depth to the base at 5472 feet, the formation consists largely of gray to dark gray, finely crystalline dolomite. Dolomites with relict oolitic texture, a feature common in the Theresa, were noted directly below 5216 feet. The base of the formation is in contact with orthoquartzite, excepting only the presence of a basal, gray, non-calcareous shale bed between 5470 and 5472 feet.

Potsdam Formation: 5472—5534 feet

In view of previous conflicting calls for the top of the Potsdam, the lithology of the samples spanning the contact is given:

5408—5472 feet (37 samples)—Gray, finely crystalline *dolomite 100 percent*. Dolomite is very light gray toward the base and has a little more quartz—under 2 percent.

5472 feet—Bit sample—Medium to fine sand and dolomitic *sandstone 60 percent*; light gray and gray-brown, fine to medium crystalline dolomite 40 percent (sand in part rounded and frosted quartz).

5472—5483 feet—Sandstone and sand, medium to fine, mostly angular *80 percent*; dolomite, gray and light gray, medium crystalline in part, arenaceous 20 percent (few dolomitic limestone fragments).

5483 feet—Core sample—Sandstone, hard, quartzitic, medium-fine, light gray with some calcareous and dolomitic cement *90 percent*; gray, finely crystalline, arenaceous dolomite 10 percent.

5483—5534 feet (33 samples)—The remainder of the interval to basement is virtually 100 percent loose sand and orthoquartzite.

The interval 5472—5497 feet has previously been called Theresa, and Fettke placed the top of the Potsdam at 5503 feet. However, from the foregoing lithology, it seems self-evident that the top of the formation should be placed at 5472 feet.

Precambrian: 5534—5701 feet

The samples below 5534 feet were not examined. They have been described by Isachsen (1962) as "biotite hornblende granitic gneiss."

Plate IX—Line 6

T. L. Heaphy

Elevation: 465 feet DF

Total Depth: 2592 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	1614—2559	945	—1149
Precambrian	2559—2585	—	—2094

Trenton-Black River Groups:

Trenton undifferentiated 1614—<2399 feet

The Utica-Trenton contact is placed at 1614 feet, controlled by samples covering the intervals 1605—1617 feet and 1617—1627 feet. Samples between 1627—2399 feet were not examined. At 2399 feet, the test was probably drilling in the Lowville (Plate IX, Line 6).

Black River-Lowville-Pamelia <2399—2559 feet

Interbedded Lowville and Pamelia lithologies extend from <2399 to the basement contact at 2559 feet. As these beds are discussed elsewhere in the report, details will not be repeated here. Suffice to say that a bed of dark chocolate-colored and red-brown, dolomitic clay-shale, not seen elsewhere, occurs at the base of the formation between 2543—2559 feet.

Precambrian: 2559—2585 feet

The Black River-basement contact was reached at 2559 feet.

E. House No. 1

Elevation: 500 feet Grd.

Total Depth: 2241 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	1450—2195	745	—950
Precambrian	2195—2241	—	—1695

Trenton-Black River Groups:

Trenton undifferentiated 1450—<2096 feet

Black, slightly calcareous to calcareous Utica shales rest directly on fossiliferous Trenton at 1450 feet. (The previous call at 1482 feet must be based on the E-log as the sample contact is unmistakable.) Samples between 1490 and 2096 feet were not examined, and at this latter depth, the test was probably drilling in the Black River.

Black River <2096—2195 feet

Samples between 2096 and 2150 feet consist of brown, dark brown to black, aphanitic limestone with a little gray, arenaceous limestone. Free, fine- to medium-grained, rounded and frosted quartz in amounts up to 4 percent is present between 2123 and 2141 feet. A bed of brown, lithographic limestone is present from 2150—2171 feet. This is followed by brown, highly arenaceous, probably dolomitic limestone and some (3-4 percent) free rounded and frosted quartz to 2181, and this by brown, highly arenaceous, and light brown, aphanitic limestone with 4 percent free quartz to 2190 feet.

It appears from the above described lithologies that at the House No. 1 location the Lowville may be in direct contact with the basement. Certainly the varicolored limestones, dolomitic limestones, and calcareous dolomites elsewhere considered basal Pamelia are missing, and other diagnostic Pamelia lithologies are also lacking.

Precambrian: 2195—2241 feet

Basement rock cuttings are present in the sample 2190—2200 feet, and the top of the Precambrian has been placed at 2195 feet.

Kellogg

Elevation: 745 feet DF

Total Depth: 1698 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	835—1654	819	—90
Precambrian	1654—1698	—	—909

Trenton-Black River Groups:

Trenton undifferentiated 835—<1550 feet

Black, slightly calcareous Utica shale rests directly on gray-brown to dark gray, fossiliferous Trenton Limestone at 835 feet. Samples between 858 and 1550 feet were not examined, but at this latter depth the test was drilling in Black River lithographic Lowville limestone; hence, the Trenton-Black River contact is above 1550 feet.

Black River-Lowville-Pamelia <1550—1654 feet

The lithology of this interval can be summarized as follows:

1550—1585 feet	Limestone, brown-gray, aphanitic, in part lithographic.
1585—1615 feet	Limestone, varicolored, gray, dark gray, brown, gray-green, slightly pink, in part dolomitic, in part arenaceous, aphanitic to finely crystalline. Small amount of calcareous, dolomitic sandstone and loose, rounded and frosted quartz grains.
1615—1654 feet	Dolomite, varicolored, pink, green, gray, calcareous, arenaceous 50%; limestone, dark gray to black, in part sub-lithographic (1647—1654 feet a complete mixture of all lithologies present below 1585 feet, with a fair amount of free quartz).

The samples between 1550 and 1585 feet are Lowville, whereas those between 1585 and 1654 feet show affinity to both the Pamelia and Lowville. Therefore, the Black River is not subdivided at this location. These varicolored sediments are correlative with those present directly above the basement at Denmark, Dexter Village, *et al*, and are considered basal Black River. The Black River rests directly on basement.

Precambrian: 1654—1698 feet

Basement lithologies are present below 1654 feet, but the samples were not studied.

Plate X—Line 1

Fee No. 1

(Reserve Gas Co.)

Elevation: 421 feet DF

Total Depth: 1396 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	450—1323	873	—29
Precambrian	1323—1396	73	—902

Trenton-Black River Groups:

Trenton undifferentiated 450—1050 feet

The Utica-Trenton contact falls between 450 and 465 feet. The upper contact is between typical black, Utica Shale and dark gray to black, organic Trenton Limestone. The lower contact is between gray to black, fossiliferous Trenton-type limestone and brown, gray, aphanitic, non-fossiliferous limestone, here considered Lowville. The samples between 485 and 1000 feet were not examined (Plate X, Line 1).

Lowville Formation 1050—1212 feet

Most of the limestones in this interval are gray to brown-gray, aphanitic, non-fossiliferous limestones believed equivalent to the Lowville. A bed of good lithographic limestone near the base at 1176—1187 feet strengthens the correlation. The presence of some arenaceous limestone, a little sand, and a trace of oolitic limestone at 1161—1166 feet suggest a transitional relationship with the Pamelia. Some of the limestones appear to be calcarenitic.

Pamelia Formation 1212—1323 feet

Very dark gray to black, aphanitic limestone, in part oolitic; dolomitic limestone; arenaceous limestone; calcareous and arenaceous dolomites; variegated shale and finally a basal sand make up the Pamelia. The basal sand, overlain by a thin, variegated shale bed, has previously been considered Potsdam. Reasons for assigning it to the Pamelia are given in the general report.

Precambrian: 1323—1396 feet

Precambrian rocks were encountered at 1323 feet. Isachsen (1962) has described them as . . . "white calc-silicate rocks."

M. Beckwith

Elevation: 385 feet

Total Depth: 2335 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	1316—2317	1001	—931
Precambrian	2317—2335	18	—1932

Trenton-Black River Groups:

Trenton undifferentiated 1316—2000 feet

Black, aphanitic limestone is in contact with Utica Shale at 1316 feet. At about 2000 feet, there is a change from interbedded dark gray and black and lighter gray, finely crystalline limestone to tan and brown, aphanitic limestone. The colors are mostly dark gray to black below 1925 feet. Samples through the interval 1318—1903 feet were not examined. The base of the Trenton is placed at 2000 feet, although the contact with the Lowville is probably transitional.

Lowville Formation 2000—2183 feet

Tan, brown and gray, aphanitic, non-fossiliferous limestones occupy this 183 foot interval. Traces of oolitic limestone were noted. While not typically lithographic, these limestones are believed correlative with the Lowville. The scarce occurrences of oolitic limestone are probably an indication that Pamelia environmental conditions returned briefly during Lowville time, although in view of the known presence of calcarenites in the section, they could indicate redeposition. The base of the formation is in contact with Pamelia dolomite, etc.

Pamelia Formation 2183—2317 feet

Typical Pamelia lithologies including the basal shale and sandstone extend over this 134 foot interval. The basal contact is between sandstone (previously considered Potsdam) and Precambrian metamorphic rocks. (See Fee No. 1 and the general report for further details.)

Precambrian: 2317—2335 feet

Precambrian metamorphic rocks were encountered at 2317 feet. They have been described by Isachsen (1962) as . . . "pink quartz-feldspar gneiss, sparsely biotitic, chloritic."

Note: The following subdivision of the Beckwith section is given on the well data sheet:

1316—2100 feet Trenton

2100—2308 feet Black River to granite wash and Little Falls

2308—2327 feet Potsdam

2327—2335 feet Precambrian

However, the subdivision based on the present study seems rather clear-cut and should supersede the previous classification. (See lithologic log.)

Warner Plant

Elevation: 415 feet Topo.

Total Depth: 3600 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	<2696—>3550	854	—2281
Little Falls	3550±—3600	50	—3135

Trenton-Black River Groups:

Trenton undifferentiated <2696—3370± feet

The sample record is incomplete. A sample taken at 2540 feet is black, non-calcareous Utica Shale, and the next available sample at 2696 feet is black, aphanitic Trenton Limestone. Hence, the upper contact of the formation falls between these two samples, or at <2696 feet. The base is below the sample taken at 3370 feet, but probably close to this depth, based on the average thickness of the Lowville elsewhere in this area. Scattered samples through the Trenton are all black, aphanitic limestones. There is a sample gap from 3370—3500 feet.

Black River-Lowville >3370—>3550 feet

Samples available between 3500 and 3550 feet are all brown-gray, lithographic limestones correlative with the Lowville. No samples are available spanning the Trenton-Lowville contact, although this probably occurs a little below 3370 feet. (See above and cross-section.) Pamelia-type rocks are missing at this location.

Little Falls Formation: >3550—3600 feet

Gray, highly calcareous dolomite and very light gray, nearly white, finely crystalline dolomite underlie the Lowville Limestone. The first sample at 3560 feet contains some rounded and frosted quartz sand, with some lithographic limestone that is probably contamination. A sample taken at 3575 feet also contains about 50 percent light gray, aphanitic limestone, which may be in place, or possibly could be from up-hole. Although these rocks could be younger, it seems most likely that they are of late Cambrian age, based on lithology as well as regional considerations.

H. Slayton No. 2

Elevation: 476 feet

Total Depth: 3912 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	<2492—3532	>1040	—2016
Little Falls	3532—3591	59	—3056
Potsdam	3591—3863	272	—3115
Precambrian	3863—3912		—3387

Trenton-Black River Groups:

Trenton undifferentiated 2492—3405 feet

The first sample available for examination was from 2492 feet. Some Trenton-type limestone is present in this sample, indicating that the top of the formation is above this depth, hence above the depth of 2557 feet used previously for the top of the formation. This call may have been based on electric logs or other information not available during the present study, however. The samples between 2492 and 3216 feet were not examined.

The few samples available between 3216 feet and the top of the Lowville at 3405 feet show anomalous lithologies for the Trenton in this area. Black, non-calcareous shale and light gray, highly pyritic non-calcareous shale, or “greasy” clay-shale, make up the sample at 3223 feet, whereas the sample at 3230 feet consists of about 50 percent quartz sandstone with abundant biotite; 10 percent black, non-calcareous shale with pyrite and dolomite rhombs; 20 percent light gray to gray, pyritic shale and 20 percent gray and light gray limestone. The sample at 3388 feet, which is only about 50 percent soluble

in HCl, contains black, non-calcareous shale, gray “greasy” clay-shale, quartz, pyrite, the micrite from solution of calcilutite, and one fossil fragment—a ribbed specimen. The sample is probably dolomitic. The “greasy” shale could be bentonite, which has been recorded in the Trenton outcrop. The quartz sand and black, non-calcareous shales nevertheless remain anomalous. The base of the Trenton is in contact with Lowville lithographic limestone.

Black River-Lowville 3405—3532 feet

Typical brown-gray, Lowville-type lithographic limestones and brown-gray, aphanitic limestones make up this 127 foot interval. Samples at 3422 feet and 3438 feet contain about 60 percent gray, non-calcareous clay-shale (bentonite?) and black, non-calcareous shale, suggesting a thin transition zone with the basal Trenton. The base is in contact with dolomite. The *Pamelia* is missing.

Little Falls Formation: 3532—3591 feet

Samples over this 59 foot interval consist of light gray, fine and medium crystalline, and very light gray, nearly white, dolomite with streaks of black and gray shale and some sand. The aphanitic limestone present in the samples in decreasing amounts with depth is believed to be contamination. The top of the formation is in sharp contact with lithographic Lowville Limestone, and the base with sand. The previous call on the top of the Little Falls at 3464 feet is not valid since this point is well up in the Lowville limestone section.

Potsdam Formation: 3591—3863 feet

Sample coverage amounts to only 40 percent over this 272 foot interval, with two big gaps between 3678 and 3766 feet, and 3780 and 3851 feet. Otherwise, the lithology is made up largely of fine to medium grade, poorly sorted quartz sand, fine, mostly angular sand, and medium-grained sand. A little dolomite and black, non-calcareous shale is present in most of the samples. Both angular, and rounded and frosted quartz is present. The samples are loose sand, but without access to the drilling records it is difficult to know whether this is in part the result of bit abrasion. Black staining is present along fracture planes and on the surface of the sand grains through the interval 3650—3678 feet. The substance is insoluble in carbon tetrachloride and might possibly be anthraxolite.

Precambrian: 3863—3912 feet

The Precambrian was topped at 3863 feet. Isachsen (1962) describes the samples as follows . . . “pink quartz-feldspar granulite, sparsely magnetic, pyroxenic, chloritic.”

Schaffer No. 2

Elevation: 534 feet Grd.

Total Depth: 5543 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	3553—4739	1186	—3019
Little Falls	4739—4900	161	—4205
Potsdam	4900—5377	477	—4366
Precambrian (?)	5377—5540	—	—4836

Trenton-Black River Groups:

Trenton undifferentiated 3553—4600 feet

The top of the Trenton was confirmed at 3553 feet, as previously reported. The base is placed at 4600 feet, although the contact appears to be transitional over the interval 4600—4640 feet. (See sample descriptions for details.)

Black River-Lowville 4600—4739 feet

Typical lithographic Lowville-type limestone extends through the interval 4640—4739 feet. Between 4600 and 4640 feet, the black, aphanitic limestones of the overlying Trenton are interbedded with brown-gray and very dark brown, aphanitic limestone, suggesting a transitional relationship between the Trenton and Lowville at this location. The top of the Lowville is placed at the top of the transition zone. The base is in contact with dolomite. The Pamela is missing.

Little Falls Formation: 4739—4900 feet

A very uniform section of light gray to light gray-brown, finely crystalline dolomite extends over this 161 foot interval. Quartz is very scarce, but a little was noted near the top and at the base of the formation. A few fragments of chert occur in the sample at 4880—4900 feet. A little limestone contamination occurs in the upper samples. The top of the formation is in sharp contact with lithographic limestone, and the base similarly in sharp contact with sand.

Potsdam Formation: 4900—5377 feet

The entire 477 foot interval assigned to the Potsdam consists of medium to coarse-grained quartz sand and orthoquartzite. Rounded and frosted quartz grains are predominant, although angular quartz is common, particularly in the finer fractions. Very minor amounts of dolomite and variegated shale occur throughout the section. Without drilling records or cores, it is not possible to say whether the formation is predominantly sand, sandstone, or orthoquartzite, although the very large amount of loose, rounded and frosted quartz present in the samples suggests that orthoquartzite is not the dominant lithology. A detailed study of this sand body would be worth the effort, but such was not undertaken during the course of the present project. Nevertheless, the entire interval must be designated as Potsdam on the basis of known lithology, irrespective of whether or not it may be in part the time equivalent of the Theresa.

Precambrian (?): 5377—5540 feet

An abrupt change in lithology occurs between 5370 and 5380 feet. Typical Potsdam sand is present above this depth, followed by:

5377—5420 feet A loose aggregate of abraded quartz, orthoquartzite, altered feldspar, chlorite, dolomite, pyrite.

5420—5430 feet Similar, with amphibole and biotite.

5430—5520 feet Shale, variegated, black, red, brown, pale green. Traces of orthoquartzite, “dirty” sand, amphibole, aphanitic limestone, finely crystalline dolomite.

5520—5540 feet Dark gray to black amphibole 50 percent, shale as above 50 percent. Trace of sandstone.

The section above has been assigned to the Precambrian principally on the basis of the amphibolite. However, thick, variegated shale beds, such as here described, are not known in the Precambrian, hence an anomalous situation is presented. The problem was discussed at some length during a staff meeting at Albany on August 7, 1963, but was not resolved. Some of the points considered were:

1. The amphibolite present is almost certainly of Precambrian age, being too fresh to have withstood an erosion cycle.

2. No other possible post-Precambrian source is known.

3. Thick, variegated shale beds are unknown in the Precambrian of this region.

4. Shales in this volume could not be cavings from up-hole, as the only likely source was cased off. Additionally, nearly 2000 feet of limestone, dolomite, and sandstone directly overlies the shale, further negating the possibility of caving.

5. A previously unknown section of earlier Cambrian was encountered.

The foregoing points are in obvious conflict. As far as the present study is concerned, the problem is left unsolved, but a Precambrian age for the section must be questioned. Actually, a thorough study of the samples was not carried out during the present project. Perhaps such a study would turn up further clues.

Note: The well calls for the Trenton and Little Falls as shown on the Survey's well data sheet for Schaffer No. 2 are incompatible with the known lithology. The correlations as given here seem straightforward and non-controversial.

J. C. Mahaney

Elevation: 824 feet

Total Depth: 6166 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	5054—6044	990	—4230
Little Falls	6044—6166	122	—5220

Trenton-Black River Groups:

Trenton undifferentiated 5054—5900 feet

The top of the Trenton was confirmed at 5054 feet. The base is at 5900 feet, marked by a change from dark gray to black, aphanitic limestone to brown-gray, lithographic limestone. The samples between 5054 and 5789 feet were not examined.

Black River-Lowville 5900—6044 feet

Typical Lowville-type lithographic limestone occupies this 144 foot interval. A little light gray, finely crystalline dolomite and dolomitic limestone was noted at 6018—6024 feet. The base is in contact with gray, finely crystalline calcareous dolomite. The Pamela is missing.

Little Falls Formation: 6044—6166 feet (bottom sample at 6156 feet)

Gray to light gray, fine, medium, and coarsely crystalline, calcareous to non-calcareous dolomite occur from 6044 feet to total depth at 6166 feet. The medium and coarse textures are confined to the interval 6076—6077 feet, and some rounded and frosted quartz is present in the last sample taken at 6151—6156 feet. Limestone present in the uppermost samples is almost certainly cavings from up-hole.

G. H. Grund

Elevation: 1454 feet Grd.

Total Depth: 8903 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	7300—8110	810	—5846
Tribes Hill	8110—8210	100	—6656
Little Falls	8210—8825	615	—6756
Theresa	8825—8903	—	—7371

Trenton-Black River Groups:

Trenton undifferentiated 7300—7990 feet

The Utica-Trenton contact is between black, non-calcareous shale and black limestone at 7300 feet. The base of the Trenton is between black, aphanitic limestone and brown, lithographic Lowville-type limestone at 7990 feet. Samples between 7300 and 7950 feet were not examined.

Black River-Lowville 7990—8110 feet

Brown and light to dark gray aphanitic limestones, in part lithographic, occurring in this 120 foot interval are correlative with the Lowville. A little silt was noted near the base. Pamela-type rocks are missing.

Tribes Hill Formation: 8110—8210 feet

Light gray, finely crystalline dolomite interbedded with some light and dark gray, aphanitic limestone and sand and silt make up the lithology through this 100 foot interval. Fine sand and silt make up about one-third of the samples in the bottom 20 feet of section. Traces of black, non-calcareous shale

are present. The top of the formation is in contact with aphanitic limestone. The base is placed at the contact between the basal arenaceous rocks and underlying thick section made up of virtually quartz-free carbonate rocks assigned to the Little Falls.

Little Falls Formation: 8210—8825 feet

The upper 330 feet of the formation consists of light gray, medium to coarsely crystalline, essentially quartz-free dolomite. The samples contain some limestone with the percentage decreasing downward. It is not possible to know whether all, part, or none of this limestone is in situ, but the latter situation is being assumed for the purposes of this report. There is a noticeable color change at 8380 feet; the remainder of the formation consists largely of dark gray dolomite with very scarce streaks of silt and a little gray to light tan chert near the bottom. The base of the formation is in contact with a sandstone-dolomite section.

Theresa Formation: 8825—8903 feet

Fine to medium-grained, angular to rounded quartz sandstone with dolomitic cement comes into the section at 8830 feet. The sandstone is interbedded with light gray dolomite with the dolomite/sand ratio averaging out at about 60/40. The lithology is typically Theresa.

J. Shepard

Elevation: 1295 feet DF

Total Depth: 10,438 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	7755—8572	817	—6460
Tribes Hill	8572—8660	88	—7277
Little Falls	8660—9370	710	—7365
Theresa	9370—10,250	880	—8075
Potsdam	10,250—10,278	28	—8955
Precambrian	10,278—10,438	—	—8983

Trenton-Black River Groups: 7755—8572 feet

Trenton undifferentiated 7755—8444 feet

The top of the Trenton is placed at 7755 feet on the basis of some limestone found in the sample

7750—7760 feet. However, the upper part of the Trenton at this location consists largely of black, calcareous shale and the contact is not as well defined as usual. The lower third of the formation is dolomitized, resulting in a sequence of dark gray to very dark gray, aphanitic to crystalline dolomite interbedded with black, non-calcareous shale. The lower contact is with light tan-gray, aphanitic to crystalline dolomite similarly interbedded with shale. The color change reflects the original color change of the limestone from tan, lithographic Lowville-type limestone to black, aphanitic Trenton-type limestone. Sample examination through the Trenton was incomplete.

Black River-Lowville 8444—8572 feet

This 128 foot interval consists of light gray to very light tan dolomite interbedded with lesser amounts of dark gray dolomite and black, non-calcareous shale. As noted above, the light colored dolomites result from dolomitization of tan, lithographic Lowville-type limestone. The presence of the dark dolomites and black shale could indicate alternating environmental changes or contamination of the samples. Nevertheless, correlation of the interval with the Lowville seems certain. There is a sample gap between 8558 and 8580 feet which spans the Lowville-Tribes Hill contact.

Tribes Hill Formation: 8572—8660 feet

Light gray, brown-gray, and dark gray, calcareous dolomites extend from 8580—8625 feet. Quartz, twinned feldspar, pyrite, and milky chert are very minor accessories. From 8625—8660 feet, the samples are largely made up of calcareous siltstone and very fine-grained silt and some light colored, very finely crystalline dolomite. The upper contact is based on the drop out of shale and introduction of quartz, these being the only differences in lithology evident at the Lowville-Tribes Hill contact. The base is placed at the base of the siltstones which rest on a thick section of virtually quartz-free dolomite, here included in the Little Falls. Correlation with the Tribes Hill is thus dependent solely on the presence of the arenaceous beds overlying dolomite and on regional correlation with adjacent tests.

(Note: Sample examination was hindered through the Tribes Hill and Little Falls Formations by the poor quality of the samples. The interval 8580—

9500 feet was drilled (gas), resulting in samples consisting mostly of powder and fine, silt-size particles. Additionally, most of the samples were oil stained, presumably from the condensate, and required washing and treatment with carbon tetrachloride before examination. The samples were then placed in 1.54 index oil and examined with the petrographic microscope for determination of the quartz content. Many of the samples were also treated with HCl for determining the presence or absence of CaCO₃. Finally, textural changes were difficult to impossible to determine due to the fine-grained state of the samples.)

Little Falls Formation: 8660—9370 feet

Virtually the entire 710 foot interval consists of light gray and brown, very finely crystalline (?) dolomite. A very little silt is present in the upper samples, and a thin streak of silty dolomite was noted at 9105 feet; otherwise, the section is essentially free of quartz. Chert was not recorded, is probably present, but was missed in the examination. (See Note under Tribes Hill.) The base of the formation is placed at the top of the first arenaceous beds of the underlying Theresa.

Theresa Formation: 9370—10,250 feet

Typical Theresa-type lithology consisting of interbedded dolomite, silt, sand, and orthoquartzite occurs throughout this 880 foot interval. A section of relatively quartz-free, dark gray dolomite, in part showing relict oolitic textures, extends from 9650—9935 feet. Dolomite rests on sandstone at the base of the formation.

Potsdam Formation: 10,250—10,278 feet

The sandstone content equals or exceeds 50 percent below 10,250 feet; hence, the top of the Potsdam is placed at this point. The previous call at 10,228 feet appears in error, as the interval between 10,228 and 10,250 feet consists almost entirely of dolomite.

Precambrian: 10,278—10,438 feet

The Precambrian was encountered at 10,278 feet. Isachsen (1962) describes the samples as: "pink biotite granitic gneiss, biotite partially chloritized."

E. C. Kesselring

Elevation: 1077 feet

Total Depth: 11,145 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	8902—9674	772	—7825
Tribes Hill	9674—9876	202	—8597
Little Falls	9876—10,575	699	—8799
Theresa	10,575—11,145	>570	—9498

A detailed sample log prepared by James W. Wiggins is available on this well. For this reason, all of the samples were not examined during the course of the present project. Samples from the following intervals were examined, however, and descriptions recorded: 9552—9854 feet; 10,150—10,226 feet; 10,570—10,584 feet; and 10,614—10,627 feet. Additionally, many other samples were checked, but not described, and in many other instances, marginal notes have been made in the published log for reference. Accordingly, the graphic log accompanying this report is a complete log made up from both sources of information.

Trenton-Black River Groups: 8902—9674 feet

Trenton limestone undifferentiated 8902—9627 feet

The Utica-Trenton limestone contact is well defined at 8902 feet. Samples between 8902 and 9552 feet were not examined, but Wiggins shows considerable shale interbedded with the limestone throughout much of the interval. The Trenton-Lowville contact is between dark gray to black aphanitic limestone and light gray, lithographic limestone at 9627 feet.

Black River-Lowville 9627—9674 feet

Typical Lowville-type lithographic limestone is interbedded with light gray, aphanitic to finely crystalline limestone in this 47 foot interval. However, lithographic to sub-lithographic types are found interbedded with dolomitic limestone and light gray, finely crystalline dolomite down to 9740 feet, and the light colors persist to 9756 feet. Therefore, this sequence could as well be considered partially dolomitized Lowville as Tribes Hill, but inasmuch as the contact has previously been fixed at 9674 feet, this figure is being used in the present report.

Tribes Hill Formation: 9674—9876 feet

The upper part of the interval assigned to the Tribes Hill consists of interbedded light gray, finely crystalline dolomite, dolomitic limestone, and lithographic to sub-lithographic limestone. (See above.) From 9756—9848 feet, the section consists largely of gray to very dark gray, finely crystalline dolomite. A little limestone is present in the samples from the upper 10 feet; and the dolomite becomes light gray to very light gray toward the base. Thin beds of black shale were noted at 9805 feet and at 9834 feet. From 9848 feet to the base of the unit at 9876 feet, sand interbedded with light gray, medium crystalline dolomite comes into the section locally, reaching 50 percent of the sample material. The base is placed at the base of the arenaceous beds and at the top of a thick section of dolomite with streaks of chert. In the absence of any unique lithologic elements, correlation with the Tribes Hill here, as at the Shepard test, is based on stratigraphic position and the presence of basal sands which may be correlative with the basal sands of the Fort Johnson member as known at the outcrop.

Little Falls Formation: 9876—10,575 feet

Sample examination through this 699 foot interval was sketchy, but from those checked and Wiggins' log, the lithology appears to be typical Little Falls with a higher percentage of shale than present up dip. Silts and chert are occasionally present, and the usual oolitic chert zone is present at the base. The base of the formation is placed at the top of the first sandstone, here used to mark the top of the Theresa. A little oolitic chert is present below the first sand, however, and the Little Falls-Theresa contact has previously been placed at 10,614 feet, presumably to include these cherts in the Little Falls.

Theresa Formation: 10,575—11,145 feet

Light to dark-colored, medium crystalline dolomites, with occasional thin beds of shale, sand, and silt, predominate from 10,575 to 10,991 feet. Quartz reaches 50 percent in the upper 10 to 15 feet, and there is a zone with considerable chert at the bottom between 10,960 and 10,991 feet. Below 10,991 feet, to total depth at 11,145 feet, quartz is much more abundant, frequently amounting to 50 percent of the samples. Rare, relict oolitic textures were noted in the dolomite in this interval. The top of the

formation is placed at 10,575 feet on the basis of the sand, irrespective of the presence of some oolitic chert below this depth. The base was not reached.

(Note: Taking into account the relatively small amount of sand present above 10,991 feet and the existence of a cherty zone at the base, it might be argued on lithologic grounds that the Little Falls-Theresa contact should be dropped to 10,991 feet. No really good case can be made against such an argument except from a regional correlation viewpoint and from the fact that the oolitic chert zone is normally found near the base of the Little Falls.)

R. Olin

Elevation: 1645 feet Grd.

Total Depth: 13,500 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	9675—10,655	980	—8030
Tribes Hill	10,655—10,995	340	—9010
Little Falls	10,995—11,755	760	—9350
Theresa	11,755—13,190	1435	—10,110
Potsdam	13,190—13,500	310	—11,545

Trenton-Black River Groups:

Trenton undifferentiated 9675—10,655 feet

The Utica-Trenton contact occurs at about 9675 feet. Samples between this depth and 10,955 feet were not examined. The base of the Trenton is placed at 10,655 feet, at the point where dolomitization of the limestones first occurs. However, Trenton-type limestone continues for a considerable distance below this depth. (See below.)

Black River Group:

Black River lithologies are not recognizable at this location.

Tribes Hill Formation: 10,655—10,995 feet

The entire interval from 10,655 to 10,995 feet consists of interbedded light and dark-colored, aphanitic limestone with conchoidal fracture, and light gray, fine to medium crystalline, in part slightly arenaceous, calcareous dolomite. Dolomitization is irregular, with some intervals showing up to 80 per-

cent dolomite and others consisting of 100 percent limestone. Sand comes into the section at about 10,955 feet and extends, interbedded with dolomite, to approximately 10,995 feet. The sand, consisting mostly of rounded and frosted quartz and a little dolomitic sandstone, does not exceed 20 percent of the sample material and tapers off to a few percent at the top and base of the interval.

Although the foregoing lithology fits the definition of the Tribes Hill, there really is no significant lithologic change at 10,655 feet. The limestone below this point still looks like typical Trenton limestone, and the fact that dolomitization occurs below this point is not diagnostic, as such occurs elsewhere in the Trenton. Insoluble residues are similar above and below the contact, including the presence of a little rounded and frosted quartz. Additionally, there is no significant lithologic break at 10,840 feet, the point previously used for the Tribes Hill-Little Falls contact. Notwithstanding these circumstances, and taking into account the down-dip location of the test, it seems reasonable to correlate the interval with the Tribes Hill. Actually, the whole sequence from the upper Little Falls into the Trenton appears transitional, and this may also be a reasonable possibility due to the basinward position of the test.

Little Falls Formation: 10,995—11,755 feet

Typical Little Falls dolomite, dense, fine, medium, and coarsely crystalline, and in part calcareous, occupy this 760 foot interval. Chert is present locally, and some oolitic chert occurs in the interval 11,440—11,500 feet. Black, light green, gray, red, pink, and maroon-colored shales occur from 11,500 to a little below 11,530 feet. The top of the formation is here placed at the base of the overlying arenaceous beds of the Tribes Hill, and the base is in contact with a thick sand which marks the top of the Theresa.

(Note: The Little Falls-Theresa contact has previously been placed at 11,400 feet, presumably to include the oolitic cherts in the Theresa. The contact as here defined is at the base of a dolomite sequence underlying the chert and at the top of the first significant sand below this dolomite.)

Theresa Formation: 11,755—13,190 feet

The Theresa Formation is typically developed in the Olin test. Here, the samples from the upper 250 feet consist for the most part of loose sand averaging about 80 to 90 percent and 10 to 20 percent dolomite, shale, and limestone. The sand is mostly medium-grained (.1 to .5 mm), generally rounded and frosted; the dolomite, dark gray, aphanitic to fine or medium crystalline; the shale varicolored, generally red, gray, and green; and the limestone dark gray to black. Pyrite is a common accessory mineral. Below the loose sands, the rocks are mostly very hard orthoquartzite, dolomite, and variegated shale, with dolomite predominant by a ratio on the order of 3 to 1. The dolomite is in part dark gray and highly oolitic. The oolites have been completely recrystallized, but the relict texture is clearly evident. Large halite crystals were noted in the sample 12,840—12,845 feet, showing that the sequence is evaporitic at least in part. The top of the formation is placed at the top of the first good sand below the Little Falls Dolomite, and the base at the point where the interbedded dolomite and sandstone section gives way to relatively pure orthoquartzite.

Potsdam Formation: 13,190—13,500 feet

Between 13,190 and 13,478 feet, the section consists of 90 to 100 percent pure, siliceous orthoquartzite interbedded with 5 to 10 percent dark gray, oolitic dolomite and black shale. Traces of dark brown, aphanitic limestone occur in some of the samples. Below 13,320 feet, the orthoquartzite is varicolored, generally pink or rose or light green, and feldspar was common in some samples. From 13,478 feet to total depth at 13,500 feet, the samples consist of approximately 50 percent variegated orthoquartzite and 50 percent variegated (black, gray, green, brown) shale, or claystone and oolitic dolomite. No chips of igneous or metamorphic or other sure basement rocks were noted.

The varicolored beds below 13,320 feet constitute the *transition zone* of previous reports.

(Note: The sporadic occurrence of limestone in many of the Little Falls and Potsdam samples can probably best be explained by contamination, as the hole was uncased below 6532 feet. Otherwise, it is difficult to understand how these limestones could have withstood dolomitization.)

Plate XI—Line 2

Rochester

Elevation: 506 feet
Total Depth: 3100 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	2006—3097	1091	—1500
Theresa	3097—>3100	3	—2591

Trenton-Black River Groups:

Trenton undifferentiated 2006—2900 feet

The top of the Trenton occurs in the interval 2000—2056 feet and has previously been placed at 2006 feet on the basis of information not currently available. Of the two samples available which span the contact, the one at 1950—2000 feet is Utica shale, and the next, at 2056—2096 feet, is Trenton limestone. The base is here placed at 2900 feet where there is a change from dark gray and dark brown-gray limestone to tan-gray, aphanitic limestone more akin to the Lowville than to the Trenton. Intermediate samples from 2096—2660 feet were not examined. (Plate XI—Line 2).

Black River-Lowville-Pamelia 2900—3097 feet

The lithology of the interval here assigned to the Black River at Rochester and at the MacDonald test is shown in Figure 10 on the following page. The interval 2900—3000 feet at Rochester is typical Lowville, particularly the lower 30 feet. Below this point, the lithology is less diagnostic, but the dark gray argillites and variegated shales present below 3094 feet are unique and are considered as marking an hiatus or unconformity between the Theresa and the Black River. The situation is identical through the corresponding interval at MacDonald.

Nevertheless, whether or not this lower interval is in fact correlative with the Black River is open to question. The unit has previously been correlated with the Tribes Hill, and suggestions have been made that it might be correlative with the Theresa or with the Little Falls. There seems to be no sure way to resolve this question on the basis of lithology, but it can be stated with some degree of certainty that the correlation, *per se*, as shown between the Rochester and MacDonald tests, is correct. Hence, whatever designation is made at one location must necessarily apply to the other.

Theresa Formation: 3097—3100 feet

The top of the Theresa is placed at 3099 feet, but may be a trifle higher, as the overlying samples below 3094 feet contain considerable sand. The argillites and shales present in the two samples between 3094 and 3099 feet are no doubt from a single thin bed, but were mixed with sand mechanically during the drilling or sampling. The bottom sample at Rochester consists of 100 percent fine angular and rounded quartz sand with a little feldspar and a trace of variegated shale (contamination).

(Note: The basal sand has been designated as the Galesville sand on the well data card.)

A. Miller

Elevation: 540 feet
Total Depth: 3915 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	2335—3330	995	—1795
(No samples or well calls)	3330—3678		—2790
Theresa	(?)—3738		
Potsdam	3738—3877	139	—3198
Precambrian	3877—3915	—	—3337

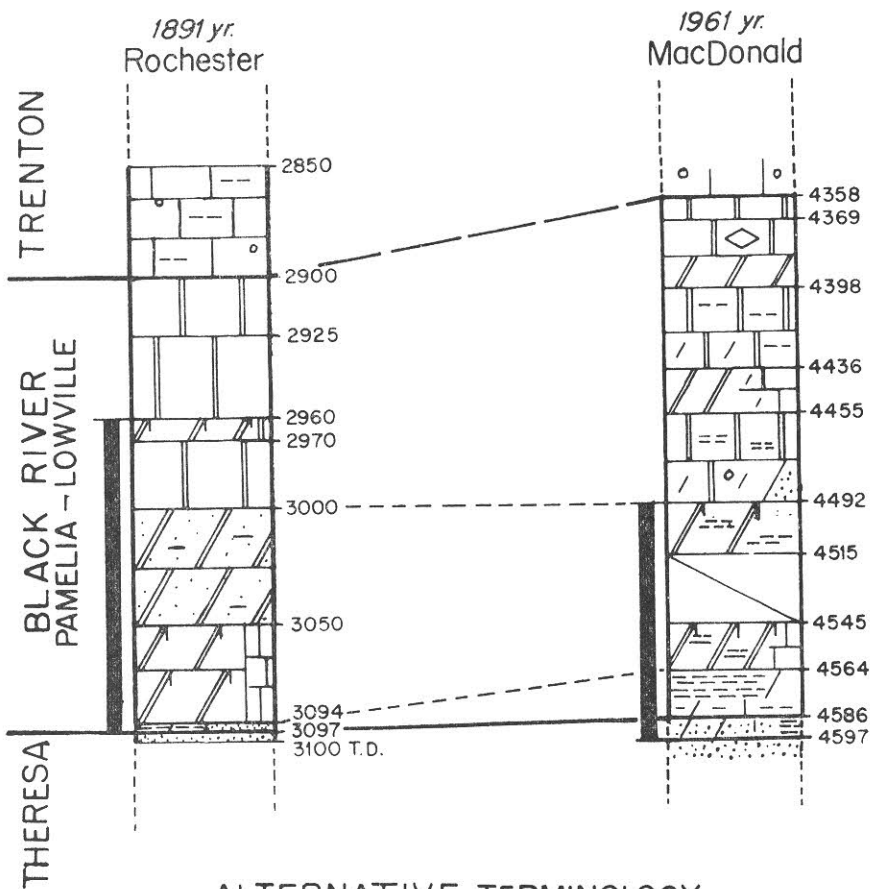
Trenton-Black River Groups:

No samples were available above 3678 feet; hence, the Trenton-Black River contacts as given on the well data card could not be confirmed or denied.

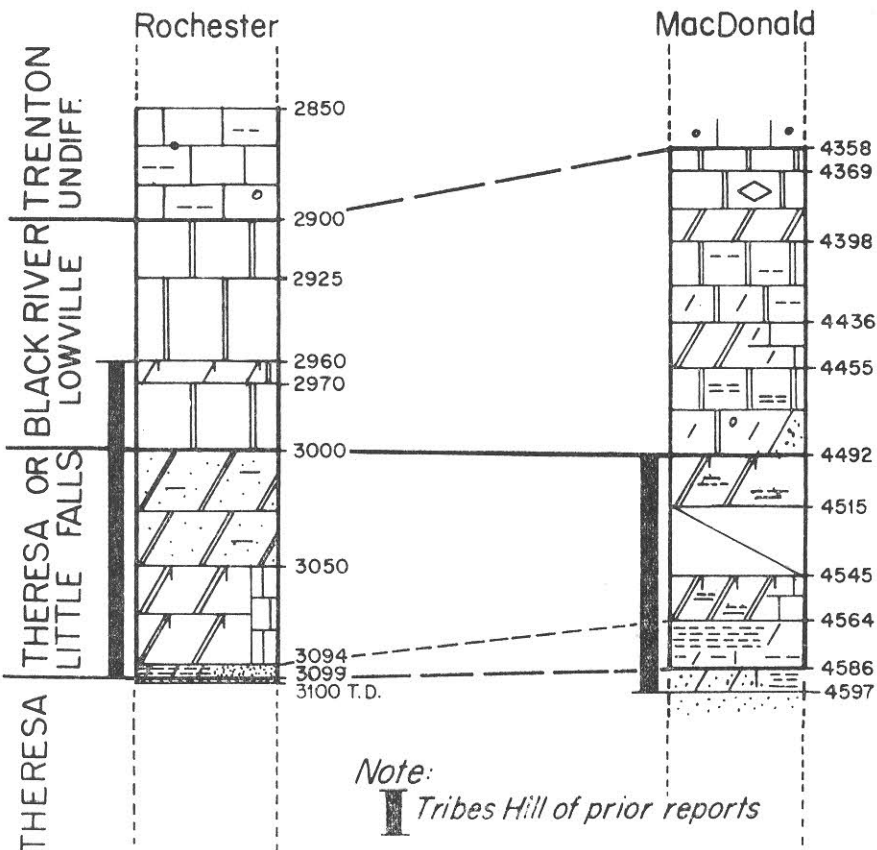
Theresa Formation: (?)—3738 feet

The first available sample, labeled (?)—3678 feet, is 100 percent light gray or tan, very slightly silty, aphanitic limestone with many small disseminated dolomite rhombs. Samples between 3678 and 3738 feet consist of dolomite interbedded with some fine quartz sand and silt. A little finely crystalline chert was noted between 3700 and 3720 feet. The dolomite is ground up to fine sand and silt size; hence, textures and color are unknown. The samples are in part heavily iron stained (from bit cuttings), and below 3715 feet, oil stained. The base of the formation is placed at 3738 feet, at which point the sand content abruptly increases to 50 percent.

PREFERRED TERMINOLOGY



ALTERNATIVE TERMINOLOGY



Potsdam Formation: 3738—3877 feet

Medium to fine-grained sand interbedded with dolomite extends from 3738—3877 feet. The sand content varies from 15 percent to 90 percent. Black shale is scarce to common in many of the samples. The base is in contact with the Precambrian; hence, correlation of the unit with the Potsdam seems reasonable.

Precambrian: 3877—3915 feet

The top of the Precambrian has been placed at 3877 feet on the basis of feldspar, chlorite, and mica present in the sample 3877—3884 feet. Isachsen (1962) puts the contact at 3908 feet and describes the rock as a "quartz feldspar gneiss, sparsely biotitic."

MacDonald

Elevation: 881 feet Grd.

Total Depth: 5090 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	3572—4586	1014	—2691
Theresa	4586—5090	>504	—3705

Trenton-Black River Groups:

Trenton undifferentiated 3572—4358 feet

The Utica-Trenton contact is well controlled at 3572 feet. The base of the Trenton is placed at 4358 feet, at which point the lithology changes from dark and light gray, aphanitic limestone to tan, aphanitic, lithographic Lowville-type limestone. A little light gray, oolitic limestone is present at the base, as at Rochester. Samples between 3582 and 4353 feet were not examined.

Black River-Lowville-Pamelia 4358—4586 feet

The lithologic correlation of this interval with the interval 2900—3099 feet at Rochester is shown in figure 10. The question of correlation with the outcrop section has also been discussed and will not be repeated here. It is enough to repeat that the argillites topped at 3094 feet at Rochester are believed directly correlative with those topped at 4564 feet at MacDonald, and additionally, that the limestone-dolomite contact at 3000 feet at Rochester is correlative with 4492 feet at MacDonald. How-

ever, the interval 4492—4597 feet has been logged in prior reports as Tribes Hill, and although the lithologic correlation between Rochester and MacDonald as presented here is believed correct, the nomenclature remains open to question.

Theresa Formation: 4586—5090 feet

Typical Theresa lithologies extend over this 504 foot interval. The top of the formation is in sharp (unconformable—?) contact with a carbonate-argillaceous sequence; the base was not reached.

Veith

Elevation: 1573 feet DF

Total Depth: 7182 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	5350—6200	850	—3777
Little Falls	6200—6330	130	—4627
Theresa	6330—7060	730	—4757
Potsdam	7060—7182	>122	—5487

Trenton-Black River Groups: 5350—6200 feet

This test was evidently air drilled through part of the Trenton and down to about 6370 feet, and sample quality is poor. Accordingly, whereas the Utica-Trenton contact can be fixed at 5350 feet, the base of the Black River Group can only be placed in a general way on the basis of a change in the dolomite/limestone ratio. Similarly, it is not possible to subdivide the Black River, although the top may conceivably be at ± 6010 feet.

Little Falls Formation: 6200—6330 feet

As noted above, and judging from the samples, there is no definite lithologic break in the section at 6200 feet. For a distance of 50 feet above 6200 feet, the dolomite/limestone ratio is on the order of 30/20. Below this depth, and down to 6270 feet, the ratio is closer to 50/50; hence, the contact is arbitrarily placed at 6200 feet. It seems likely, however, that contamination of the samples may have occurred due to drilling procedure and that a sharper contact may actually exist at some point in this general interval. Between 6270 and 6330 feet, the section is largely light to dark gray, finely crystalline, silty dolomite. The base at 6330 feet is in sharp contact with sand.

(Note: The interval 6190—6300 feet has previously been classified as Tribes Hill. If this is accepted, the limits should be between 6150 and 6270 feet. The unit is here correlated with the Little Falls more on regional-stratigraphic grounds than on lithology.)

Theresa Formation: 6330—7060 feet

The upper 40 feet of the Theresa consists of 95 percent medium-grained quartz sand and about 5 percent dolomite and black shale. This sand body is underlain by 25 feet of dark gray to black, non-calcareous shale. About 10 percent of the sample material through this shale interval consists of limestone, sand, and argillite. From 6395 to 6560 feet, the samples run 80 to 90 percent unconsolidated medium to fine-grained sand and 10 to 20 percent variegated shale, limestone in part fossiliferous, and crystalline dolomite. (Some of the minor constituents may be contamination from up hole.) Below this unconsolidated sand body, the section is made up of more normal Theresa-type lithologies down to 7060 feet, where the sand ratio again locally reaches 50 percent. The formation appears to be transitional with the Potsdam.

Potsdam Formation: 7060—7182 feet

A glance at the graphic log will suffice to show the transitional nature of the Theresa-Potsdam contact. The sand-dolomite-shale-limestone ratio is approximately as follows:

	(Feet)	Quartz	Dolo- mite	Shale	Lime- stone
	6990—7000	—	100	—	—
	7000—7020	15	85	—	—
Top Potsdam previous call					
	7020—7030	40	40	20	—
	7030—7040	tr	20	80	tr
	7040—7050	10	45	45	—
	7050—7060	20	40	40	—
Top Potsdam this report					
	7060—7090	50	50	tr	—
	7090—7110	43	42	15	—
	7110—7130	—	—	90	10
	7130—7140	40	—	55	5
	7140—7150	40	tr	60	tr
	7150—7160	50	5	40	5
	7160—7180	95	tr	5	tr

From this table, it is apparent that picking the top of the Potsdam is a matter of fielder's choice.

The figure 7060 feet is used in this report because of the consistently higher percentage of sand (quartz) below this point and the fact that the resulting thickness figure fits the regional picture in this area. The fossiliferous limestone present in some samples is believed to be downfall from the Trenton.

K. R. Wilson

Elevation: 1483 feet Grd.

Total Depth: 7144 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	5342—6141	799	—3859
Little Falls	6141—6325	184	—4658
Theresa	6325—7027	702	—4842
Potsdam	7027—7144	—	—5544

Trenton-Black River Groups:

Trenton undifferentiated 5342—6031 feet

From samples available, the top of the Trenton is known to fall between 5325 and 5343 feet. A depth of 5342 feet has been used previously, and this depth is accepted as correct. The base of the formation is placed at 6031 feet, at the contact between light brown, fossiliferous Trenton-type limestone and gray, finely crystalline dolomite. Samples between 5394 and 5994 feet were not examined.

Black River-Lowville-Pamelia 6031—6141 feet

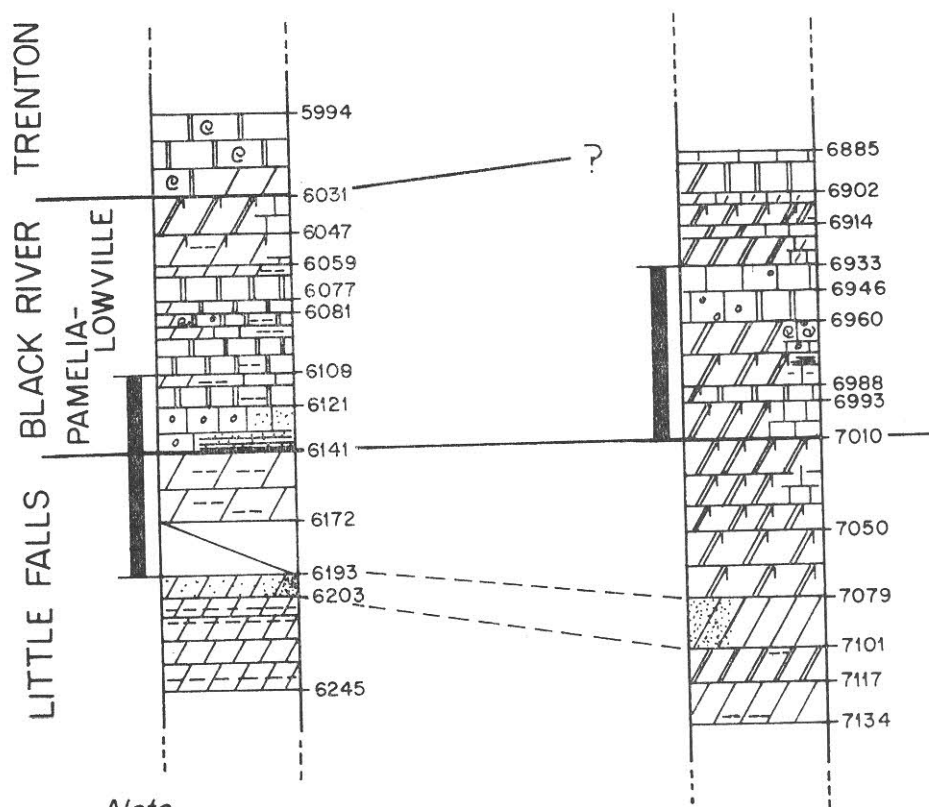
This 110 foot interval consists of alternating beds of light gray-brown, finely crystalline dolomite; gray, tan and dark gray, oolitic limestone, and light tan, lithographic limestone. A thin bed of dark gray argillite is present at some point in the interval 6112—6119 feet, and there is a bed of black, gray, and brown shale and argillaceous siltstone at the base. These are typical Lowville-Pamelia lithologies, but they are so interfingered as to constitute a completely transitional relationship down nearly to the base of the unit. At the base, the basal shales and siltstone rest on gray, crystalline dolomite. (See Figure 11 on page 46.)

Little Falls Formation: 6141—6325 feet

Foreword: Whereas the various lithologic correlations between the Wilson and Cook tests, as shown in Figure 11, appear valid, there is some doubt re-

Wilson

Cook #2



Note:

I Tribes Hill of prior reports

Fig. 11 Correlation of Black River Group
in Wilson and Cook #2

garding the proper classification of the upper portions of the two sections here shown as Little Falls. The interval 6141—6203 feet at Wilson appears to be correlative with the interval 7010—7101 feet at Cook No. 2, but in some respects the lithology is more akin to the overlying Black River than to the underlying Little Falls. Previously, at the Wilson test, the interval 6104—6193 feet has been called Tribes Hill. Such a subdivision would include some typical Lowville-type lithographic limestone and dark oolitic Pamela-type limestone in the upper Tribes Hill and would extend the formation into the arenaceous beds present between 6193 and 6203 feet. At the Cook test, the interval 6933—7010 feet is called Tribes Hill. Here again, this would include some typical Lowville and Pamela-type limestones in the upper Tribes Hill but would put the base some 69 feet above the arenaceous zone. These correlation points are indicated by bars on the correlation chart. In the event the existence of Tribes Hill is accepted in this area, it would appear from the present analysis that it should be confined to the interval 6141—6203 feet at Wilson and 7010—7101 feet at Cook No. 2.

At the Wilson test, the interval 6141—6172 feet (7 samples) consists of 85 percent gray, crystalline calcareous dolomite and 15 percent gray, non-calcareous shale. Some quartz and a little limestone are present in the samples. There is a sample gap from 6172—6193 feet. From 6193—6203 feet, the samples consist of 85 percent dolomitic siltstone and gray, finely crystalline, arenaceous dolomite; 10 percent black, brown, and gray shale; and 5 percent very fine sand, plus a little limestone. The upper dolomites are highly argillaceous, and the lower ones in part highly silty. Below 6203 feet, light colored, medium and coarsely crystalline, non-calcareous dolomite make up about 95 percent of the sample material. The argillaceous and silty dolomites with stringers of limestone of the above described upper interval admittedly answers to the description of the Tribes Hill Formation; hence, sure classification remains an open question. The base of the formation is in contact with Theresa orthoquartzite.

Theresa Formation: 6325—7027 feet

As at the Veith test, the upper part of the Theresa is mostly sandstone, with the difference that the upper 53 feet or so is hard sandstone and orthoquartzite; and the overall thickness is only about

140 feet, in contrast to the 230 feet present at Veith. Thin shale beds are present in the sand body at 6353 and 6400 feet. Below 6466 feet, normal Theresa lithologies prevail to 7027 feet. A basal dolomite is in contact with sand at 7027 feet.

Potsdam Formation: 7027—7144 feet

The Theresa-Potsdam contact might be considered as transitional, although quartz sand does predominate below 7027 feet. As previous reports place the contact at 6968 feet, the following quartz/dolomite percentage estimates are given to show the basis for using the deeper figure:

Sample (feet)	Percent Quartz	Percent Dolomite
6949—6961	10	90
6961—6968	2	98
Previous top		
6968—6978	20	80
6978—6982	50	50
6982—6985	60	40
6985—6994	25	75
6994—7000	25	60 (py—15)
7000—7002	50	50
7002—7019	30	70
7019—7025	35	65
7025—7027	20	80
Top—this report		
7027—7029	90	10
7029—7033	80	10 (shale—10)
7033—7038	30	70
7038—7041	40	60
7041—7043	90	10
7043—7045	50	50
7045—7048	90	10
7048—7055	98	2
7055—7144	mostly sand— streaks of dolomite	

Special attention is called to the bottom samples between 7133 and 7144 feet. The samples are light pink colored, fine grained sand with much white mica. Much of the quartz is of the fine-grained mosaic type; the remainder, clear angular quartz. Some grains show both types with a crenulated contact between the two. A composite sample was treated in hot HCl and separated with bromoform. Most of the heavies (2-3 percent of the sample) consisted of a gray mineral, presumed at the time to be ilmenite, and traces of pyrite, zircon, tourma-

line, and pale green chlorite. The light fraction showed mosaic and clear quartz, mica, and a small percentage of feldspar. It was assumed from this that the rock was metamorphic and probably Precambrian. However, Isachsen (1962) later examined the samples and thinks the hole bottomed in the Potsdam. It can only be said that no sandstones of this sort were seen in the Potsdam in any of the other tests.

G. M. Cook No. 2

Elevation: 1672 feet DF

Total Depth: 7337 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	6105—7010	905	—4433
Little Falls	7010—7224	214	—5338
Theresa	7224—7337	—	—5552

Trenton-Black River Groups:

Trenton undifferentiated 6105—<6885 feet

The first sample available at 6092 feet has considerable Trenton-type limestone mixed with Utica shale, and samples down to 6103 feet contain increasing amounts of limestone, giving the impression of a transitional contact. However, the sample at 6103—6118 feet is mostly limestone, and the top of the Trenton as previously placed at 6105 feet is probably close to the actual contact.

Black River-Lowville-Pamelia <6885—7010 feet

Typical lithographic Lowville-type limestone appears to be missing above the Pamelia, but the first sample examined at 6885 feet is a brown, aphanitic limestone showing some dolomitization, which could be Lowville. Typical brown to black, oolitic Pamelia-type limestone occurs in the interval 6933—6971 feet, and a streak of lithographic limestone is present between 6939 and 6946 feet. Interbedded limestone and dolomite continue to around 7010 feet, although the basal contact is not sharp, and some limestone continues to around 7027 feet. From the foregoing, it is evident the Black River can not be subdivided at this test location.

Little Falls Dolomite: 7010—7224 feet

The correlation problem existing in this area with

regard to the Black River and top of the Theresa has been discussed under the Wilson test and will not be repeated here. (See Figure 11.) The rocks below the arenaceous zone and above the Theresa appear to be Little Falls. There is a little more shale throughout the interval than at Wilson, however, and some chert was noted. The basal contact with the Theresa is good.

Theresa Formation: 7224—7337 feet

Orthoquartzite with some dolomite and streaks of black shale extend over this 113 foot interval. The interval is directly correlative with the upper sand body at Wilson and at Veith. The test bottomed in this upper Theresa sand body.

Plate XII—Line 5

Fee No. 2

(J. F. Weinheimer, Inc.)

Elevation: 583 feet

Total Depth: 3168 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	2390—3118	728	—1807
Theresa	3118—3132	—	—2535
Sample gap	3132—3168		

Trenton-Black River Groups:

Trenton undifferentiated 2390—2881 feet

The Utica-Trenton contact falls in the sample interval 2385—2395 feet and is here placed at 2390 feet. The base at 2881 feet is marked by a change from brown, aphanitic limestone and brown, fossiliferous limestone to light tan, lithographic limestone (Plate XII—Line 5).

Black River-Lowville 2881—2993 feet

A bed of good, light tan colored lithographic limestone of the Lowville type extends from 2881—2928 feet, followed by brown, aphanitic and brown, finely crystalline, (probably dolomitic) fossiliferous limestone down to 2993 feet. The bottom 30 feet is about 50 percent brown-gray, finely crystalline dolomite. Whereas the upper contact is sharp, the lower contact appears to be transitional with the Pamelia.

Black River-Pamelia 2993—3118 feet

Mixed lithologies, typical of the Pamelia, and consisting of gray to black, oolitic limestone, fossiliferous limestone, dolomitic limestone, dolomite, and traces of black shale extend from around 2993—3118 feet. The base of the formation is in sharp contact with coarse sandstone and orthoquartzite.

Theresa Formation: 3118—3132 feet

Orthoquartzite with dolomitic cement and fine, medium, and very coarse-grained, poorly sorted sandstone, with much rounded and frosted quartz, constitute 80 percent of the sample material in the interval 3118—3124 feet. The remaining 20 percent is made up of limestone, dolomite, and black shale. From 3124—3132 feet, orthoquartzite with both dolomitic and siliceous cement and loose, coarse-grained, well sorted, rounded and frosted quartz sand make up 85-90 percent of the sample material. The remainder consists of brown limestone, gray crystalline dolomite, and black shale. There is a sample gap from 3132 feet to total depth at 3168 feet. These rocks could be Potsdam insofar as the lithology is concerned but are here classified with the Theresa on rather weak, regional stratigraphic grounds.

Niehaus No. 2

Elevation: 610 feet

Total Depth: 4517 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	3714—4450	736	—3104
Little Falls	4450—4501	51	—3840
Theresa	4501—4517		—3891

Trenton-Black River Groups:

Trenton undifferentiated 3714—<4407 feet

No samples were available for determining the top of the Trenton; hence, the previously reported top at 3714 feet is used. Sample examination was begun at 4407 feet in the Pamelia; hence, the base of the Trenton is not known but is above 4407 feet.

Black River-Pamelia <4407—4450 feet

Only two samples are available between 4407 and 4450 feet. The upper sample (4407—4417 feet)

consists of very dark brown, aphanitic limestone and brown mottled, fossiliferous, and in part oolitic, limestone of the Pamelia type. The lower sample from 4442—4446 feet is 50 percent light brown to tan, aphanitic, in part dolomitic, limestone, and 50 percent light brown, medium crystalline dolomite more similar to Lowville than to Pamelia. Streaks of Lowville-type limestone are present elsewhere in the Pamelia, however. There is a sample gap between 4446 and 4458 feet spanning the Black River-Little Falls contacts, placed here at 4450 feet.

Little Falls Formation: 4450—4501 feet

Light gray, gray and dark gray, fine to medium crystalline, arenaceous dolomites make up most of this 51 foot interval. The upper 25 feet contains up to 20 percent brown to very dark brown limestone, whereas the lower 25 feet is characterized by considerable amounts of white, oolitic chert, black to variegated shales, and thin streaks of orthoquartzite. Excluding the limestone, which may well be contamination, the lithology of the interval is typically Little Falls. The white, oolitic chert zone is particularly characteristic of the lowermost Little Falls farther to the east. Alternatives would be to group the beds with either the Theresa or the Black River, but in view of the presence of so much white, oolitic chert, the Little Falls call seems to be the more logical.

Theresa Formation: 4501—4517 feet

The bottom 16 feet of hole consists of alternating beds of orthoquartzite, arenaceous dolomite, and variegated shale. The samples contain considerable fine to medium-grained, loose sand, possibly freed from the dolomite by bit abrasion. Rounded and frosted quartz is more common at top than bottom.

Ellis

Elevation: 1328 feet Grd.

Total Depth: 6528 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	4825—5605	780	—3497
Little Falls	5605—5624	19	—4277
Theresa	5624—6277	653	—4296
Potsdam	6277—6450	173	—4949
Precambrian	6450—6528	—	—5122

Trenton-Black River Groups:

Trenton-undifferentiated 4825—5502 feet

The Utica-Trenton contact lies between samples collected at 4821 feet and at 4836 feet, and has been placed at 4825 feet. The base is less well defined but is placed at 5502 feet on the basis of some oolitic and pellet limestone in the samples at 5502 feet and directly below. Samples between 4836 and 5428 feet were not examined. Some dolomitic limestone and dolomite is present between 5428 and 5502 feet.

Black River-Lowville-Pamelia 5502—5605 feet

With the exception of the uppermost bed, which contains the oolites, this interval appears to be made up of interbedded brown, aphanitic to finely crystalline dolomitic limestone, brown fossiliferous limestone, light tan lithographic limestone, and dark gray to black, finely crystalline dolomite. This suggests interfingering of all three lithologies, i.e., Trenton, Lowville, and Pamelia; hence, the Trenton-Black River contact is not very definite, and the Black River itself can not be subdivided.

Little Falls Formation: 5605—5624 feet

Light gray-green, medium crystalline dolomite and gray, arenaceous dolomite make up about 98 percent of the two samples available from this interval. The remainder consists of gray, arenaceous pyritic, non-calcareous shales; light green, non-calcareous shale; black, non-calcareous shale; and a little medium-grained, rounded and frosted quartz (about 25 percent of the two samples consist of light tan limestone and dolomite—almost certainly cavings or contamination from the overlying section). The upper contact with lithographic Lowville-type limestone is very sharp, but there is room for doubt as to whether this thin dolomite is in fact correlative with the Little Falls. Variegated shales and pale green dolomite extend into the underlying Theresa, and this unit could probably as well be grouped with this formation.

Theresa Formation: 5624—6277 feet

The Theresa Formation at Ellis can be divided into three units based on the quartz/dolomite ratios. The upper unit, extending from 5624—5800 feet, consists of orthoquartzite interbedded with light

colored dolomite. Several shale beds are also present in this interval. The quartz/dolomite ratio is highly variable, but would probably average out at roughly 50/50. The middle unit, extending from 5800—6062 feet, consists largely of light brown or gray, medium crystalline dolomite, with only occasional streaks of sandstone. Shale beds appear to be missing. The lower unit, from 6062—6277 feet, consists of fine, medium to coarse-grained sandstone and orthoquartzite interbedded with lesser amounts of dolomite, the average ratio here being on the order of 3/1. However, the upper part of this lower unit (6062—6211 feet) is mostly sandstone with streaks of dolomite, whereas the lower part (6211—6277 feet) is mostly dolomite with streaks of sandstone. (Note: On the well data card, the interval 5605—5799 feet is correlated with the Tribes Hill, and the interval 5799—5980 feet with the Little Falls. Although the lithology of the lower (5799—5980 feet) interval admittedly looks much like Little Falls, the overlying beds are typically Theresa, and regional correlation with borehole sections to the east clearly support the thesis that the entire section up to, or at least nearly to, the base of the Black River is correlative with the Theresa.)

Potsdam Formation: 6277—6450 feet

Below 6277 feet, the section is mostly fine, medium, or coarse-grained, angular to rounded sandstone and orthoquartzite, with streaks of dolomite and shale. As in the overlying Theresa, some of the dolomite shows relict, oolitic textures.

Precambrian Formation: 6450—6528 feet

The Precambrian was topped at 6450 feet. Isachsen (1962) describes the rock as "gray quartz-feldspar gneiss, sparsely biotitic."

S. Shadle

Elevation: 1617 feet DF

Total Depth: 6281 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	5445—6170	725	—3828
Tribes Hill	6170—6192	22	—4553
Little Falls	6192—6230	38	—4575
Theresa	6230—6281	—	—4613

Trenton-Black River Groups: 5445—6170 feet

The "sample" top of the Trenton is placed at 5445 feet as there is a sharp break from shale to limestone between the samples 5440—5445 feet and 5445—5450 feet. However, the top has previously been placed at 5429 feet, presumably on the basis of the electric log. If the latter depth is correct, there must have been an error in pipe measurement, which is not recorded on the well card or data sheet. Lacking this information, the deeper figure is used in this report. The base of the Trenton-Black River Group is placed at 6170 feet between what appears to be partly dolomitized, lithographic limestone and light gray, finely crystalline dolomite. The samples between 5450 and 6110 feet were not examined; hence, a breakdown of the Group is not possible. However, no Pamela-type limestone was noted in the bottom interval 6110—6170 feet, and Lowville-type limestone is present at the base.

Tribes Hill: 6170—6192 feet

Samples through this interval consist of light gray, finely crystalline dolomite interbedded with dark brown, aphanitic limestone. A black shale bed is present in the interval 6185—6190 feet, and a little quartz silt is present between 6180 and 6185 feet. The shale bed is believed correlative with shales present in the interval 6934—6949 feet at the Morse location. While these strata fit the general description of the Tribes Hill and are here assigned to that formation, it is nevertheless questionable whether or not they should be so logged or should perhaps be grouped with the Black River or possibly with the underlying Little Falls-Theresa sequence.

Little Falls Formation: 6192—6230 feet

Samples throughout this interval consist of about 90 percent very light gray, finely crystalline dolomite, and 10 percent brown, aphanitic limestone. Quartz is extremely scarce. (As this hole was apparently air-drilled, and the resulting samples mostly fine powder, it is assumed the limestone content is contamination resulting from the drilling procedures). The interval is here correlated with the Little Falls mainly on the basis of the near absence of quartz, and stratigraphic correlation with the Morse test (Plate XII, Line 5).

Theresa Formation: 6230—6281 feet

Quartz (silt) comes into the section at 6230 feet,

and this point is, accordingly, used as the top of the Theresa. The following percentage estimates are indicative:

(feet)	Dolomite	CaCO ₃	Quartz
6225—6230	90	10	—
6230—6245	75	10	15
6245—6250	70	10	20
6250—6255	65	10	25
6255—6260	45	10	45
6260—6265	70	10	20
6265—6270	15	10	75
6270—6275	15	10	75
6275—6280	5	5	90

The dolomite/quartz ratios are fair estimates as they were determined with the petrographic microscope. The limestone percentage is arbitrary, all samples reacting about the same in cold hydrochloric acid.

K. Morse

Elevation: 1572 feet DF

Total Depth: 7100 feet

	Interval (feet)	Thickness (feet)	Sub-sea (feet)
Trenton-Black			
River	6145—6888	743	—4573
Tribes Hill	6888—6949	61	—5316
Little Falls	6949—7032	83	—5377
Theresa	7032—7100	—	—5460

Trenton-Black River Groups:

Trenton undifferentiated 6145—6850 feet

The Utica-Trenton contact occurs at 6145 feet, controlled by samples at 6139—6145 feet and 6145—6150 feet. Samples between 6150 and 6780 feet were not examined. Between 6780 and 6850 feet, the section consists of very dark brown to black, aphanitic limestone; gray and brown, fossiliferous limestone; dolomitic limestone; black shale; and at the base some light gray, finely crystalline, calcareous dolomite. The dark-colored limestones and dolomitic limestones are calcilitites. Insoluble residues show a little quartz. The base is in contact with tan, lithographic Lowville-type limestone.

Black River-Lowville 6850—6888 feet

Tan to light tan, lithographic Lowville-type limestone with some tan dolomite make up the bulk of

this 38 foot interval. A little black and brown shale is present in some of the samples, and a bed of dark gray, non-calcareous argillite occurs within the interval 6881—6886 feet. The base is in contact with dolomite. The Pamela appears to be missing.

Tribes Hill Formation: 6888—6949 feet

Gray medium, dark gray fine, and brown medium to coarsely crystalline dolomites interbedded with black and brown shale occur in this 61 foot interval. Brown, aphanitic limestone is present between 6900 and 6914 feet. Shale is particularly abundant in the lower half of the unit, reaching 50 percent of the sample material below 6934 feet. Traces of chert, pyrite, and a little rounded and frosted quartz are present in some samples; some of the dolomites are arenaceous, and a little dolomitic sandstone is present. This lithology fits the description of the Tribes Hill, and the interval 6870—6949 feet has previously been correlated with this formation. The previous top was evidently placed at 6870 feet, rather than 6888 feet, to include the argillites and some of the dolomite present between 6870 and

6888 feet in the Tribes Hill. However, some lithographic limestone occurs below 6870 feet, and the light tan dolomites are believed to be dolomitized Lowville. Moreover, the most significant change in lithology occurs at 6888 feet; hence, the deeper figure is used in this report.

Little Falls Formation: 6949—7032 feet

Basically, this unit consists of light-colored, medium crystalline dolomite lithologically compatible with the Little Falls. Some darker-colored dolomite, shale, silty shale, and some white chert make up the minor constituents. Some of the samples are ground to a fine powder, rendering color and texture determinations unreliable. Many of the samples also contain small amounts of brown, aphanitic limestone believed to be contamination. The upper and lower contacts are reasonably well defined.

Theresa Formation: 7032—7100 feet

Typical Theresa lithologies prevail below 7032 feet to total depth of 7100 feet.

APPENDIX I

Sample examination procedures:

General: Sample examination was limited to well cuttings, as few cores were available. Accordingly, gross textures, structures, porosity factors, and similar physical features could not be determined. Also, it was not always possible to know whether the quartz component, when present, occurred in the form of loose sand or sandstone lenses, or was disaggregated from the host rock by bit action. Similarly, some of the quartz reported as being angular could have been derived by crushing of larger rounded and frosted grains in the drilling process. Additionally, it should be mentioned that the sample descriptions as presented in the report are not necessarily complete for each individual sample listed and described. In a sequence of similar lithologies, a few samples were worked and described in detail, while the remainder were not. In view of the large number of samples involved, this was the only practical approach. However, the descriptions are adequate for construction of lithic logs and for correlation, which was the main purpose of the work. The rock component percentages listed are estimates and only approximate, although routine grain counts were made. Nevertheless, the limestone/dolomite/shale/sandstone ratios can be used with some confidence, subject to the usual sample quartering errors.

Insoluble residues were prepared on a very large number of samples, principally to determine whether the samples were arenaceous or cherty and to observe other insoluble rock and mineral components. In most instances, the residues were examined under the petrographic microscope, and results recorded along with the sample descriptions.

Heavy mineral separations were made with bromoform on some samples, particularly in relation to determining the sedimentary-basement contact.

Thin and polished sections of several samples were prepared to determine texture and composition. For the most part, these were examined in index oils, results incorporated in the sample de-

scriptions and then discarded. A few were mounted in Canada Balsam and are in the slide collection on file at the Geological Survey office in Albany.

Powdered samples, common from air or gas drilled sections, were routinely examined in index oils under the petrographic microscope to determine the quartz content and then examined in dilute hydrochloric acid under the binoculars to get an idea of the Ca/Mg ratio. Textures and colors of such samples are largely obliterated, and it is not always possible to know whether one is dealing with mixed limestone-dolomite lithologies or with dolomitic limestone or calcareous dolomite. Accordingly, the sample descriptions are in part incomplete and, no doubt, to some extent inaccurate.

Iron staining is met with commonly in the samples, particularly in the sandstones, but is believed to be largely due to oxidation of iron bit fragments usually found in such samples. In some cases, the staining has been noted in the sample descriptions but should not be considered as an indigenous feature of the formation.

Sample contamination due to downfall and recirculation of cuttings was an ever present problem. The presence of small amounts of limestone in some sections, consisting otherwise predominantly of dolomite, of interbedded dolomite and orthoquartzite, gave the most trouble and could not always be explained logically. It should be noted in this regard that all lithic logs accompanying the report are for the most part straight "sample logs" and not "interpretive logs."

Hydrocarbons

During the course of the sample study, quite a few samples were found to be oil stained or oil saturated or to have an unmistakable odor of gas or oil. In some instances, such as at Shepard and Grund, the oil was almost certainly introduced by the gas which was used as a drilling fluid in these tests. Likewise, the spotty staining noted in one

sample from the Olin test is no doubt rig oil or oil otherwise spilled on the sample.

Carbon tetrachloride was used as the solvent in making the "cuts" and to remove the oil from the samples prior to examination. As a matter of record, the occurrences noted are listed below:

Danisevich

4729—4889 feet oil stain, dark brown cut; very strong cut at 4744—67

Ellis

6243—feet sample tar stained

Grund

8380—8470 feet oil odor

Miller

3713—3738 feet oil stain and cut

3751—3752 feet slight oil cut

Olin

13,030—13,035 feet spotty oil staining

Shepard

8590—8630 feet samples oil stained, some sticky; good brown cut

8675—8835 feet as above, some with faint cut

8900—9400 feet as above, some with faint cut

Skramko

3305—3322 feet oil stained to tar saturated

APPENDIX II

SLIDE COLLECTION¹

1. Olin	10,545—50	Trenton	
2. "	10,805—10	Tribes Hill	
3. "	12,010—15	Theresa	orthoquartzite
4. "	12,100—105	Theresa	dolomite/sandstone contact
5. "	12,170—75	Theresa	oolitic dolomite
6. "	12,370—75	Theresa	oolite, arenaceous sandstone/oolitic sandstone contact
7. "	12,380—85	Theresa	orthoquartzite w/shale (?) lam.
8. "	12,410—15	Theresa	arenaceous oolite, orthoquartzite, oolitic orthoquartzite
9. "	12,450—55	Theresa	limestone, aphanitic sub-lithographic
10. "	12,485—88	Theresa	oolitic dolomite
11. "	12,485—88	Theresa	thin section
12. "	12,463—68	Theresa	siltstone with shale parting—dolomite with pyrite, dolomite with gypsum (?)
13. "	12,585—90	Theresa	oolitic dolomite
14. "	12,880—85	Theresa	oolitic orthoquartzite
15. "	12,910—15	Theresa	arenaceous dolomite
16. "	12,980—85	Theresa	oolitic orthoquartzite banded dolomite
17. "	13,070—75	Theresa	oolitic, pyrite, orthoquartzite
18. "	13,200—202	Potsdam	oolitic orthoquartzite
19. "	13,230—32	Potsdam	pyritized oolites in orthoquartzite
20. "	13,330—32	Potsdam	varicolored orthoquartzite
21. Grund	8,080—90	Black River	insoluble residue siltstone
22. "	8,130—40	Tribes Hill	insoluble residue siltstone, etc.
23. Fee No. 1	1,352—62	Precambrian	heavy minerals
24. Mahaney	6,151—56	Little Falls	RFQ in dolomite
25. Schaffer #2	5,380—90	Precambrian	insoluble residue
26. "	5,520—30	Precambrian	heavy minerals
27. "	5,520—30	Precambrian	miscellaneous lithologies
28. Shepard	9,380—85	Theresa	insoluble residue
29. Beckwith	2,329—35	Precambrian	heavy minerals
30. "	2,253—65	Pamelia	oolitic limestone
31. Kesselring	11,141—44	Theresa	heavy minerals
32. Fee #2	2,928—33	Black River	oolitic and crinoidal (?) limestone
33. "	2,933—42	Black River	as above, polished section
34. Slayton #2	3,230—	Trenton	quartzite sandstone with biotite
35. MacDonald	4,760—67	Theresa	oolitic dolomite
36. "	5,013—18	Theresa	oolitic dolomite
37. Skramko	3,095—3100	Tribes Hill	insoluble residue siltstone

¹ On file—New York State Geological Survey, Albany, New York.

38. Wilson	6,086—92	Black River	fossiliferous limestone
39. "	6,121—28	Black River	oolitic limestone
40. Ellis	5,641—	Theresa	rounded pebbles, agate(?)
41. Danisevich	4,562—68	Little Falls	oolitic chert
42. Cook #2	6,946—55	Pamelia	fossiliferous oolitic limestone
43. Niehaus #2	4,476—	Little Falls	oolitic chert

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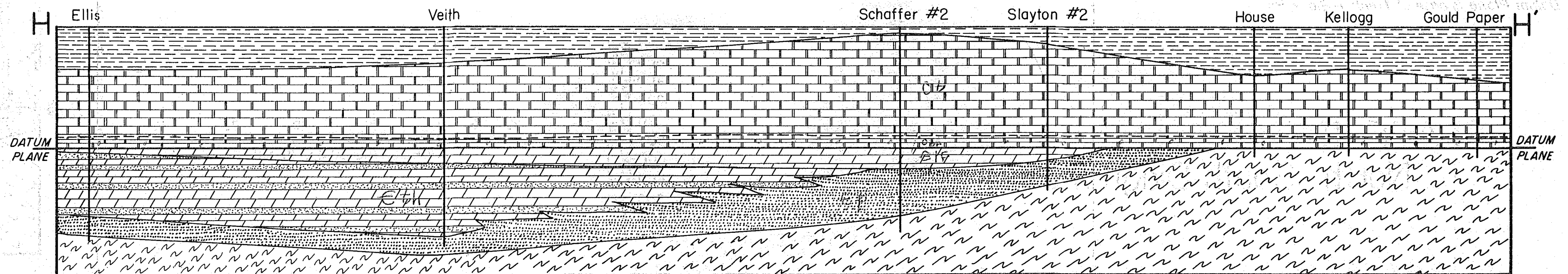
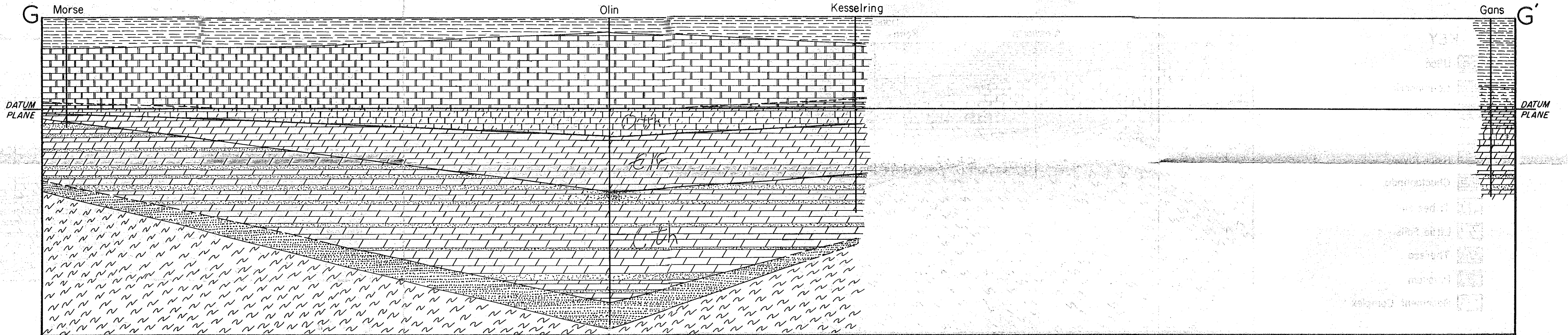
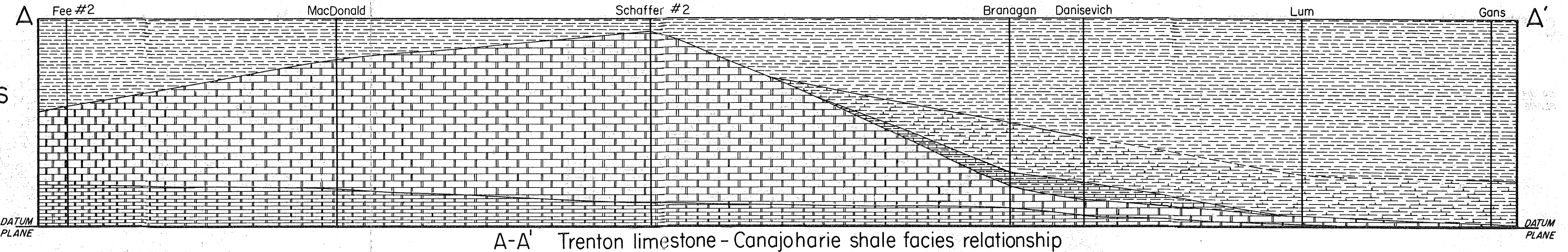
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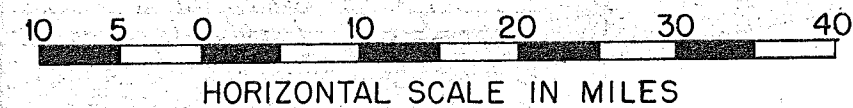
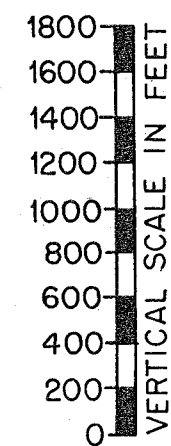
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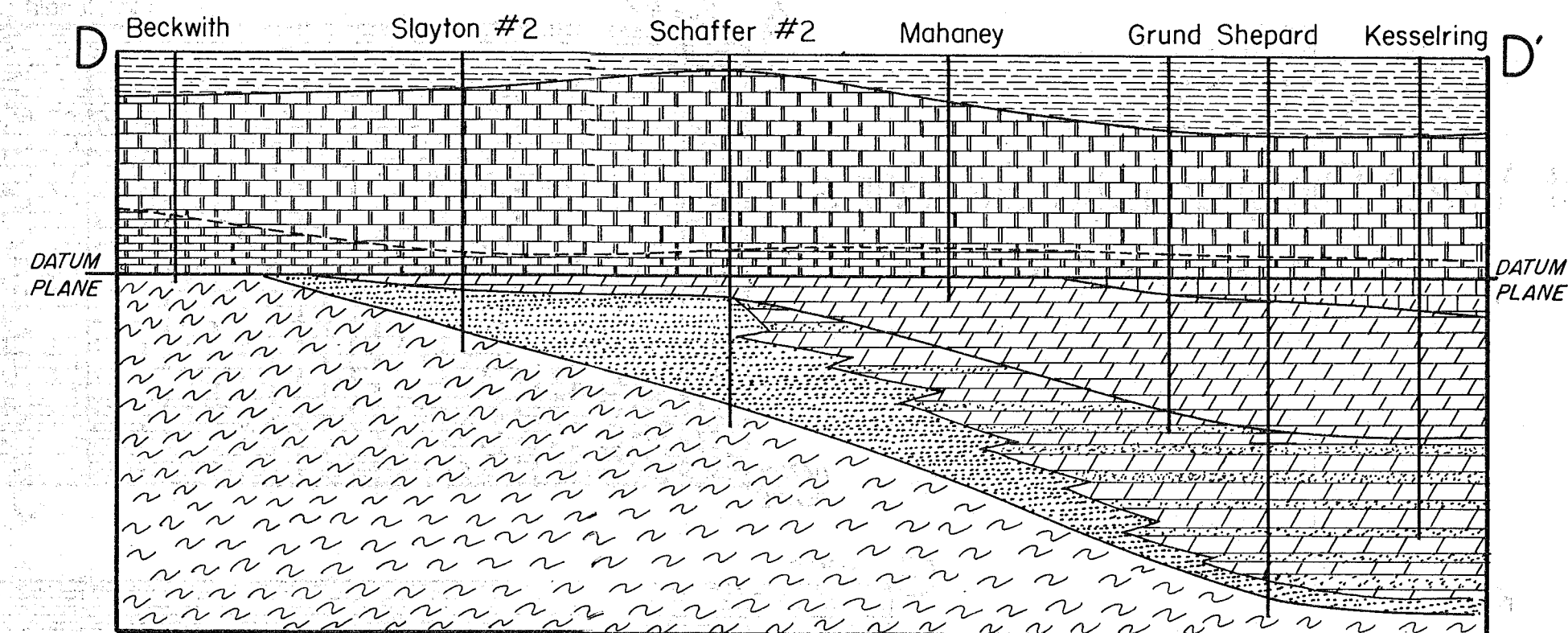
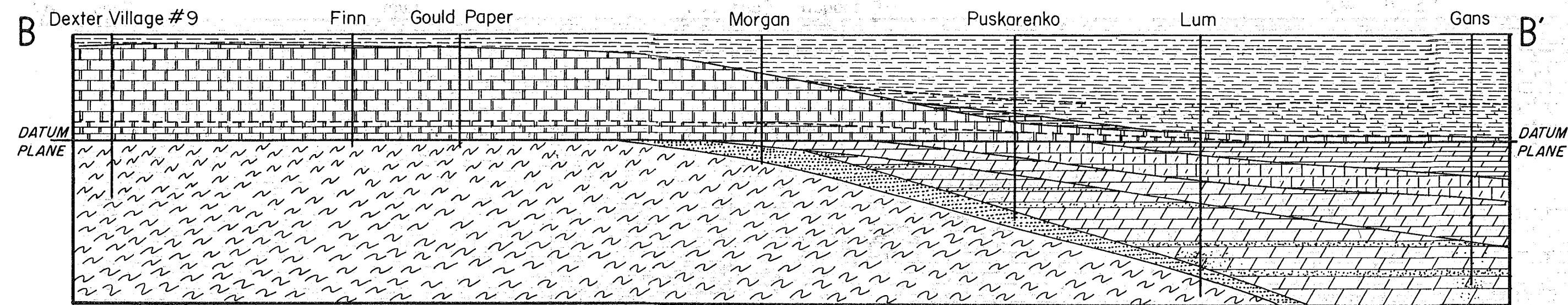
PLATE I East-West Diagrammatic Sections



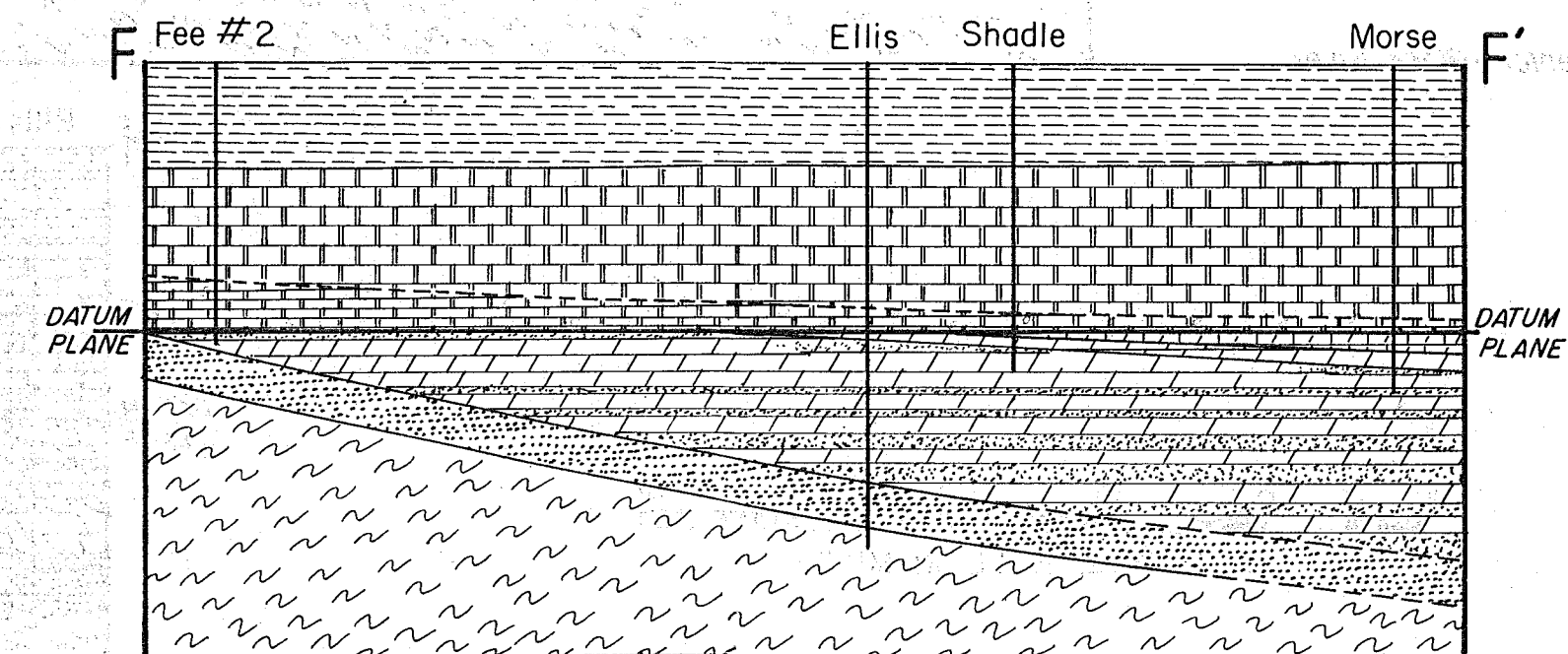
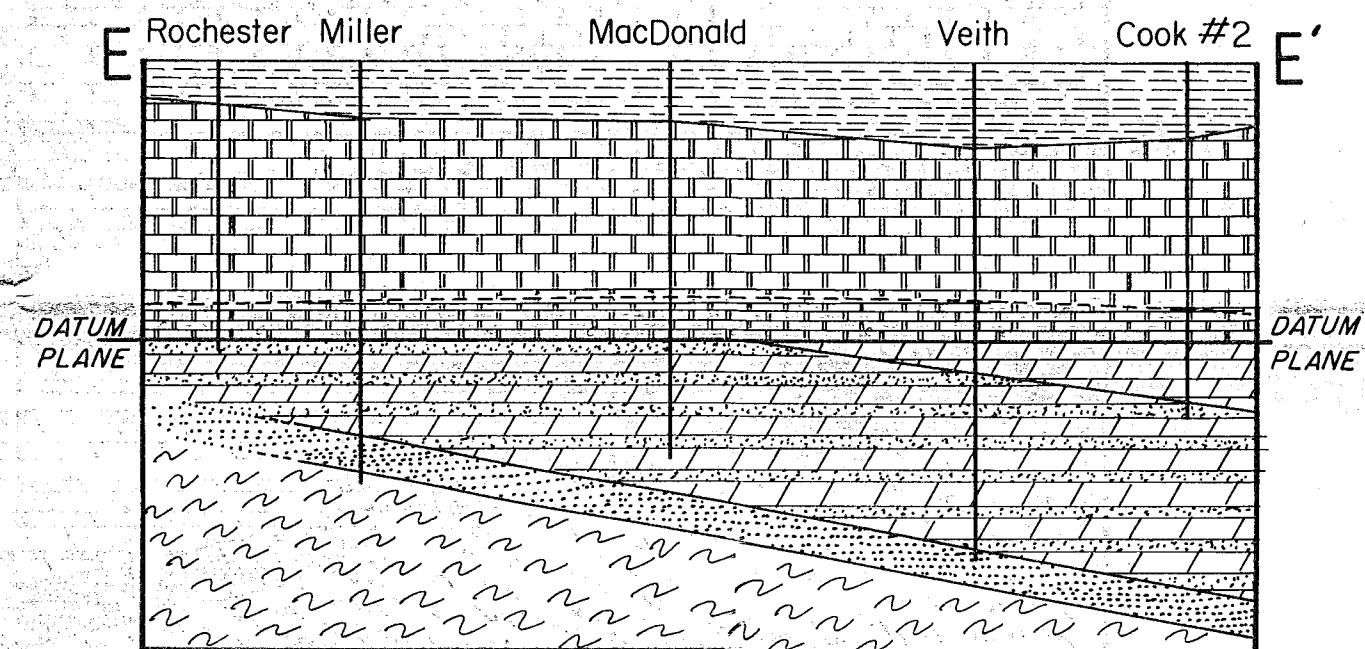
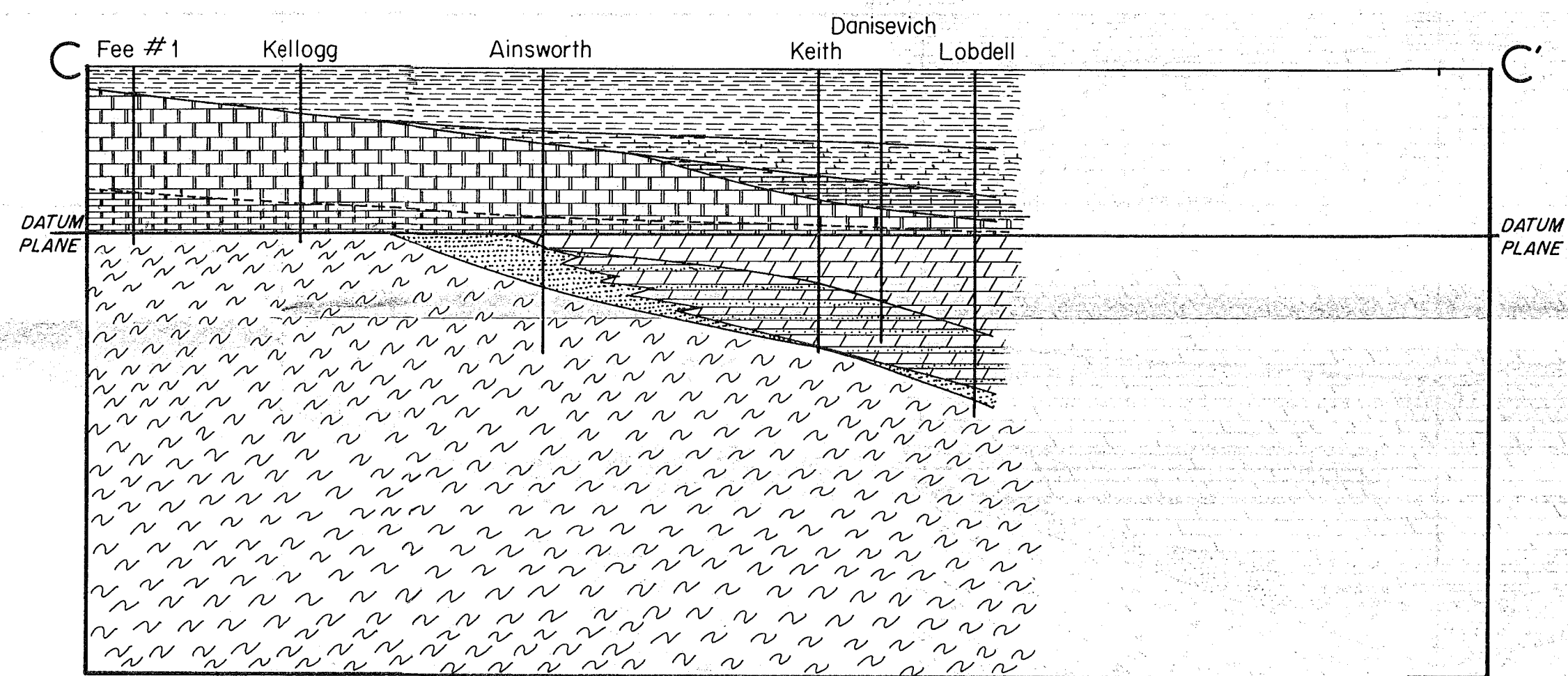
- KEY
- Utica
 - Canajoharie
 - Dolgeville
 - Trenton Undifferentiated
 - Black River
 - Chuctanunda
 - Tribes Hill
 - Little Falls
 - Theresa
 - Potsdam
 - Basement Complex

Note:
Datum Plane is base of Trenton-Black River





- KEY**
- Utica
 - Canajoharie
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 - Theresa
 - Potsdam
 - Basement Complex



Note:
Datum Plane is base of Trenton-Black River

PLATE II

North-South Diagrammatic Sections

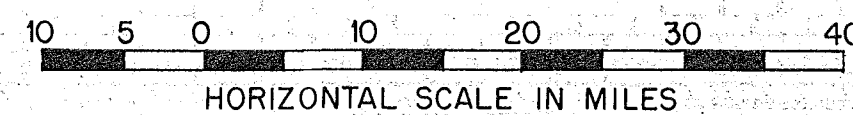
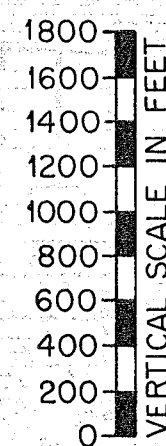
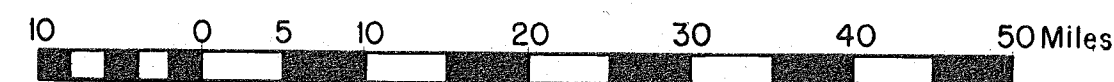


PLATE III — Contour Map

SUBSURFACE CONTOURS ON TOP OF TRENTON - DOLGEVILLE



CONTOUR INTERVAL 500 FEET

CONTACT BETWEEN:

○ Utica - Trenton

● Canajoharie - Dolgeville

● Canajoharie - Trenton

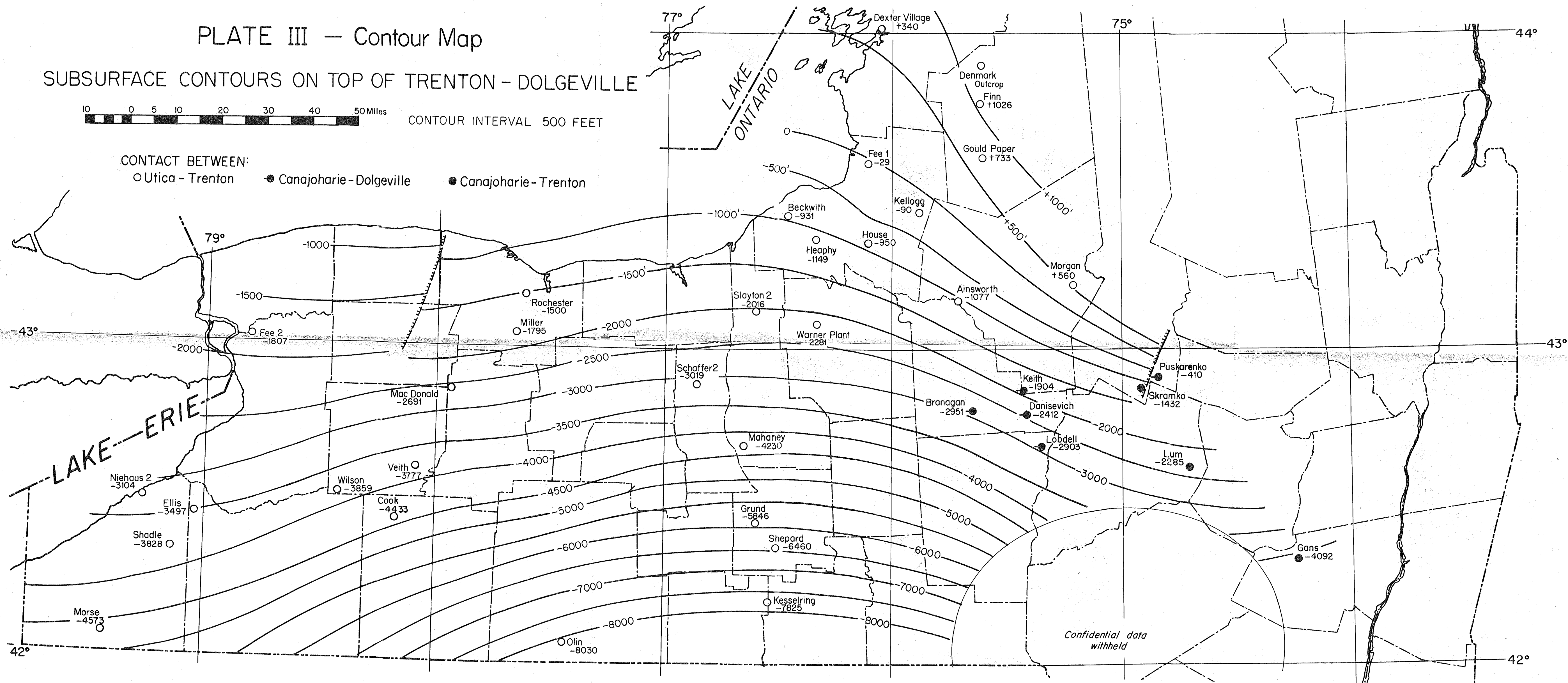
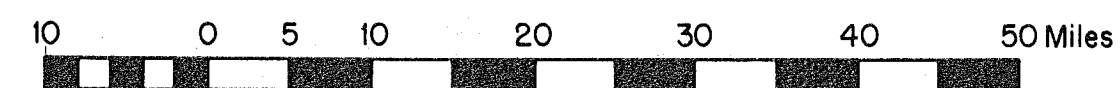


PLATE IV — Isopach Map
THICKNESS OF TRENTON — BLACK RIVER



CONTOUR INTERVAL 100 FEET

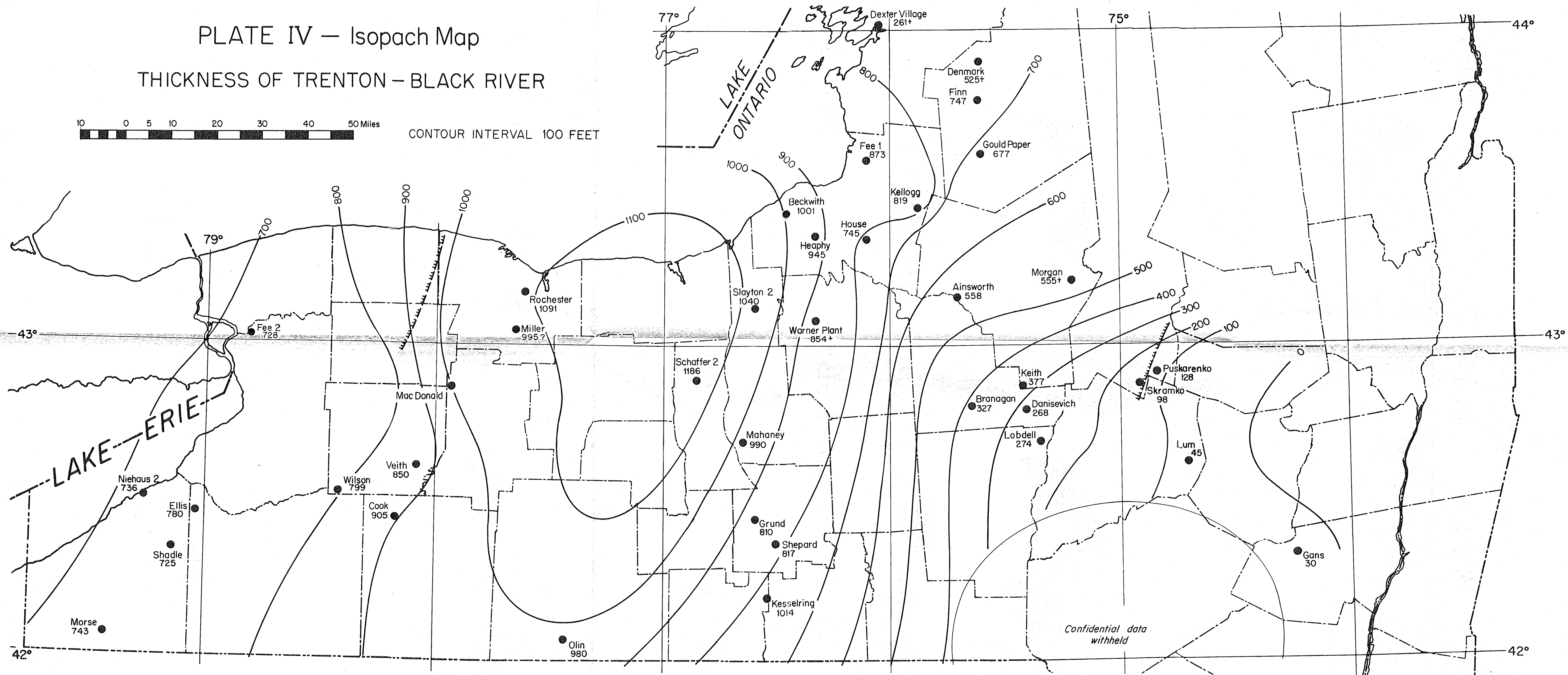
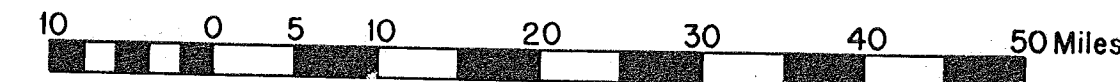


PLATE V — Contour Map

SUBSURFACE CONTOURS ON BASE OF TRENTON — BLACK RIVER



CONTOUR INTERVAL 500 FEET

IN CONTACT WITH:

- ⊕ Chuctanunda
- Tribes Hill
- Little Falls
- Theresa
- Precambrian

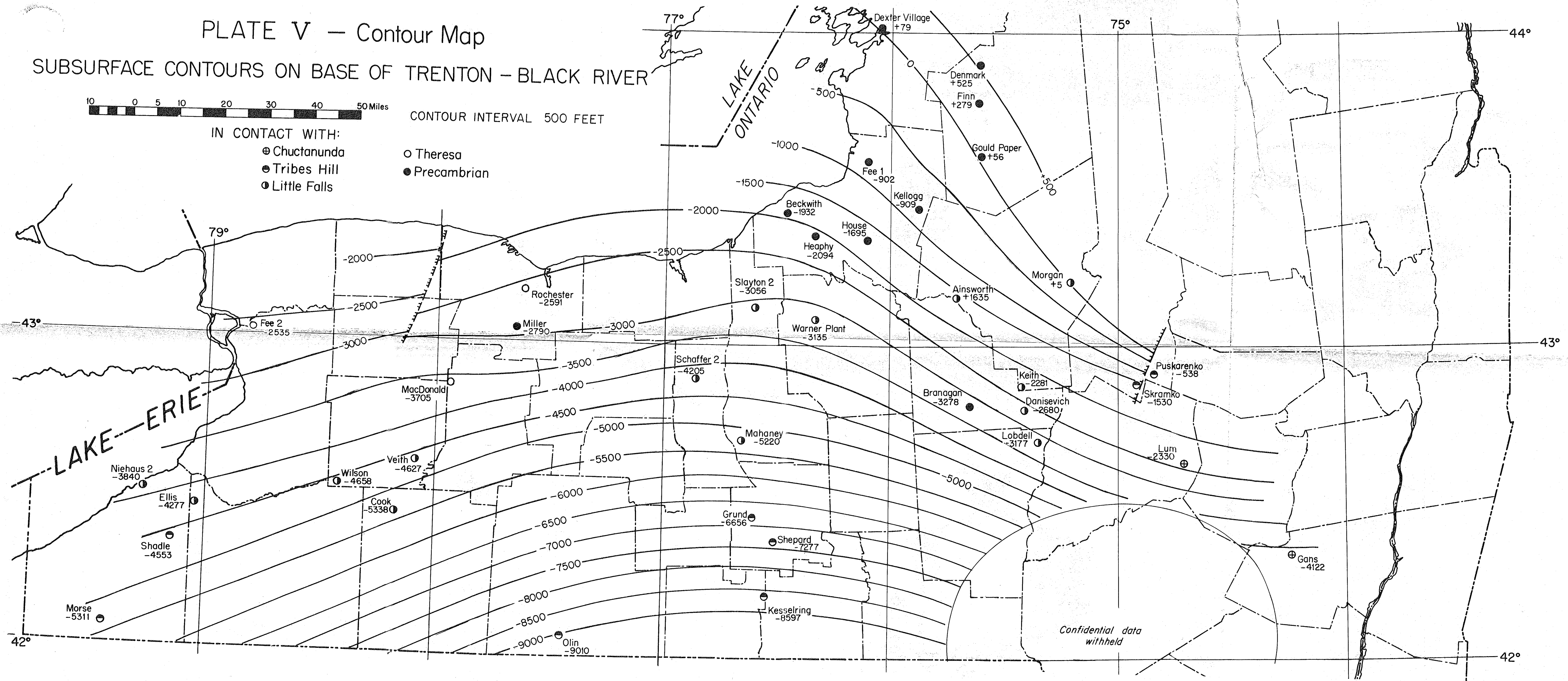
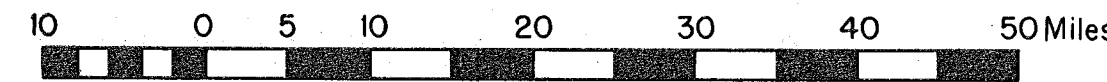


PLATE VI — Isopach Map

THICKNESS OF ROCK SECTION BETWEEN
BASE OF TRENTON - BLACK RIVER & TOP OF BASEMENT (PC)



CONTOUR INTERVAL 200 FEET

TEST TERMINATES IN:

● Little Falls

- o Theresa

● Potsdam

- Precambrian

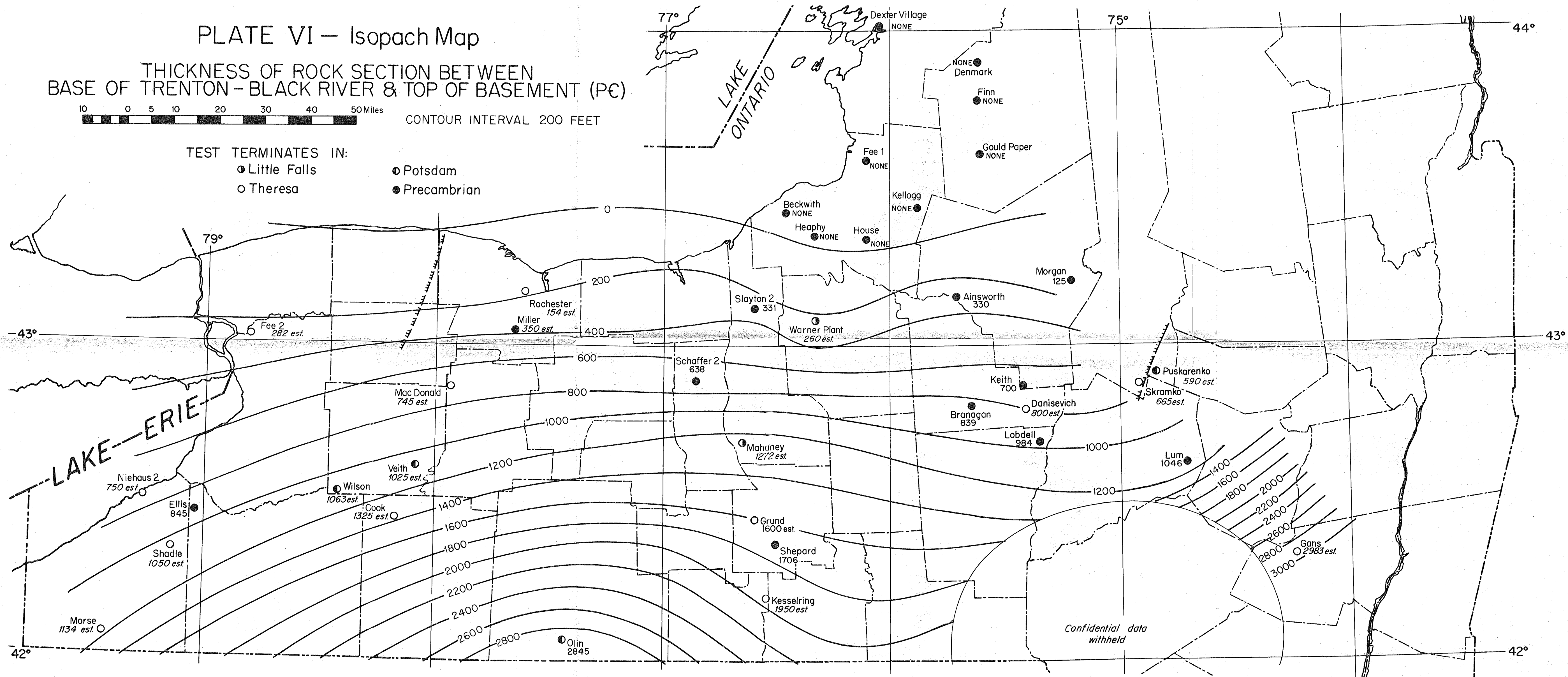


PLATE VIII Line 3

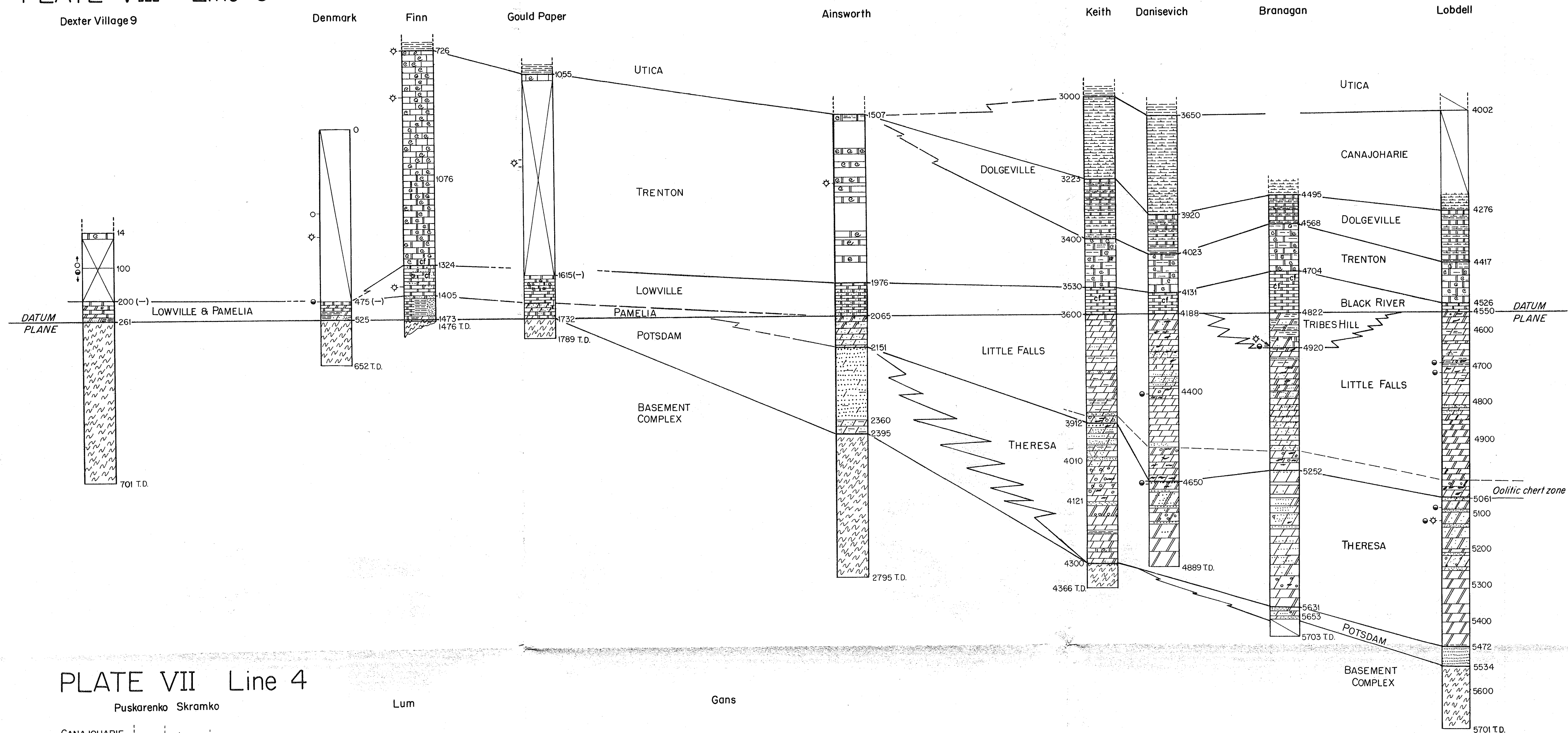
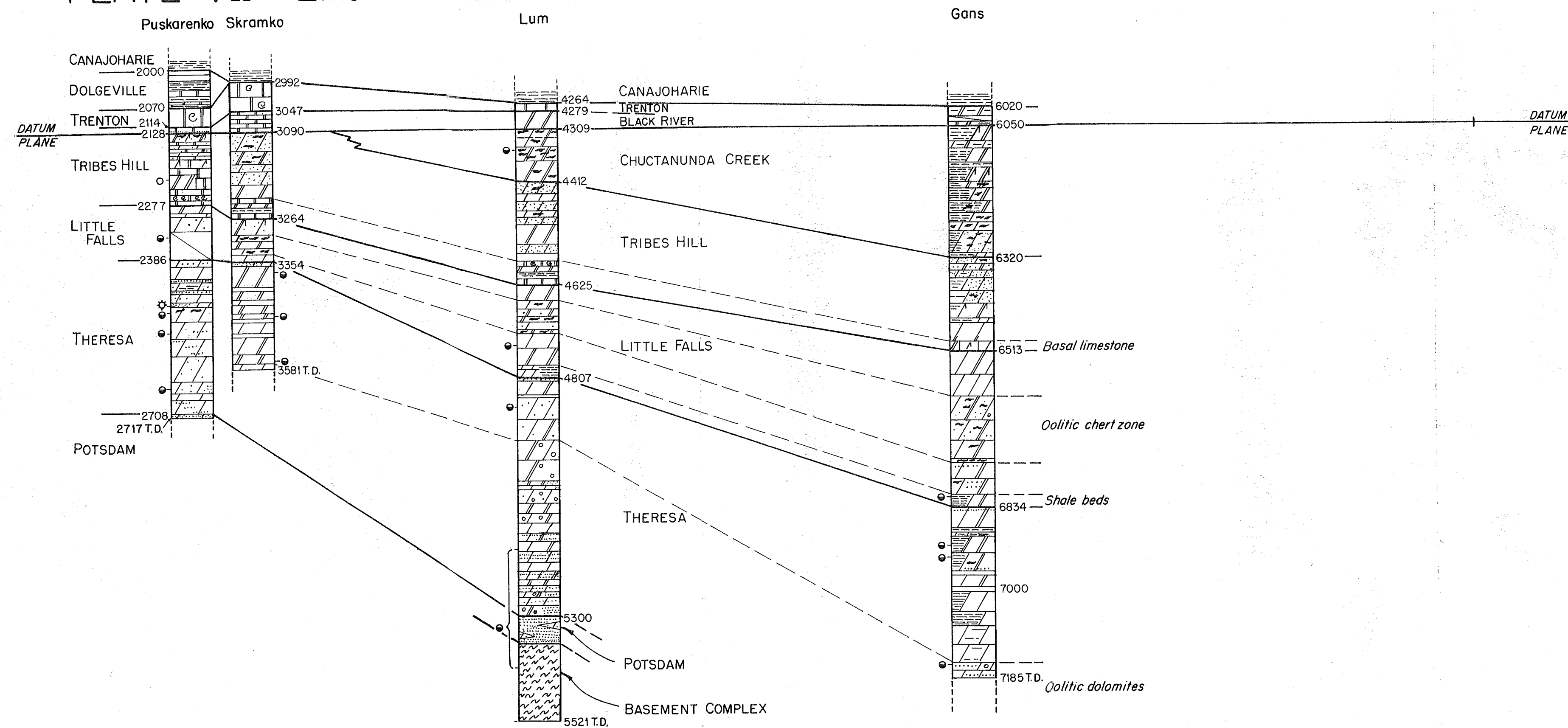
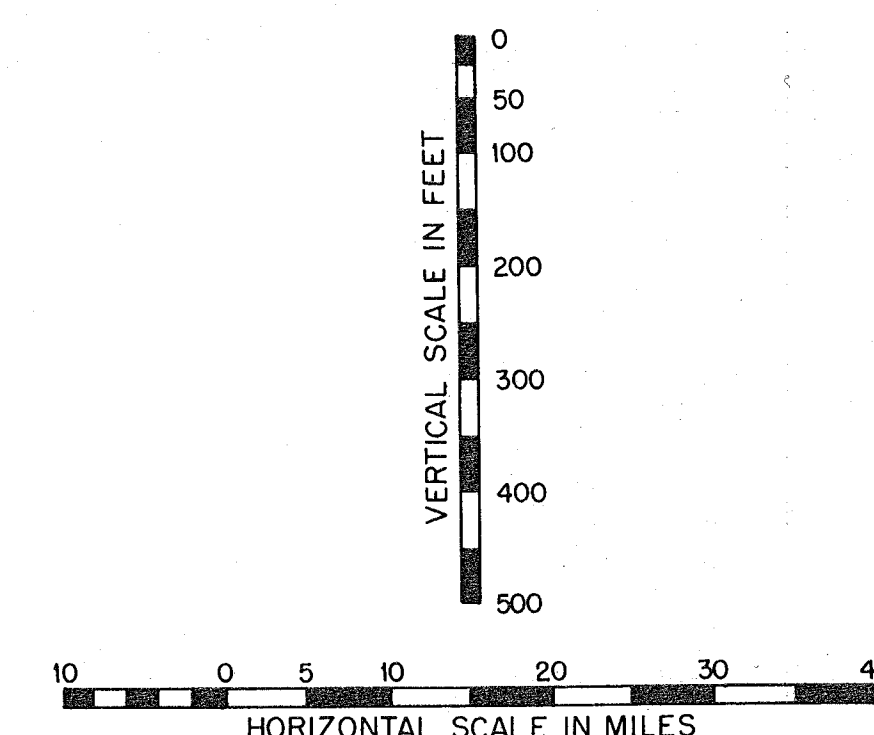


PLATE VII Line 4



Note: For key to symbols, see Frontispiece



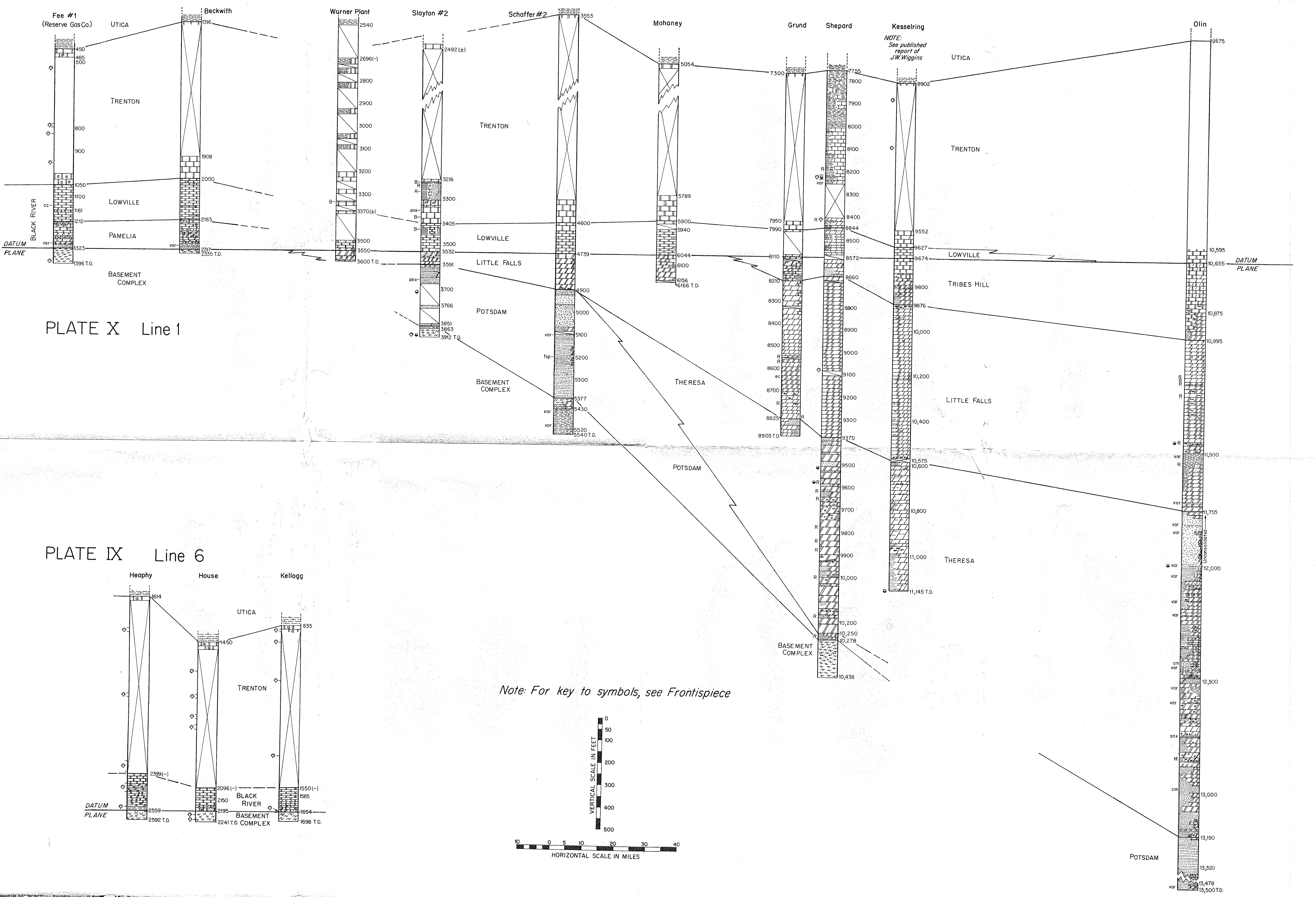


PLATE XI Line 2

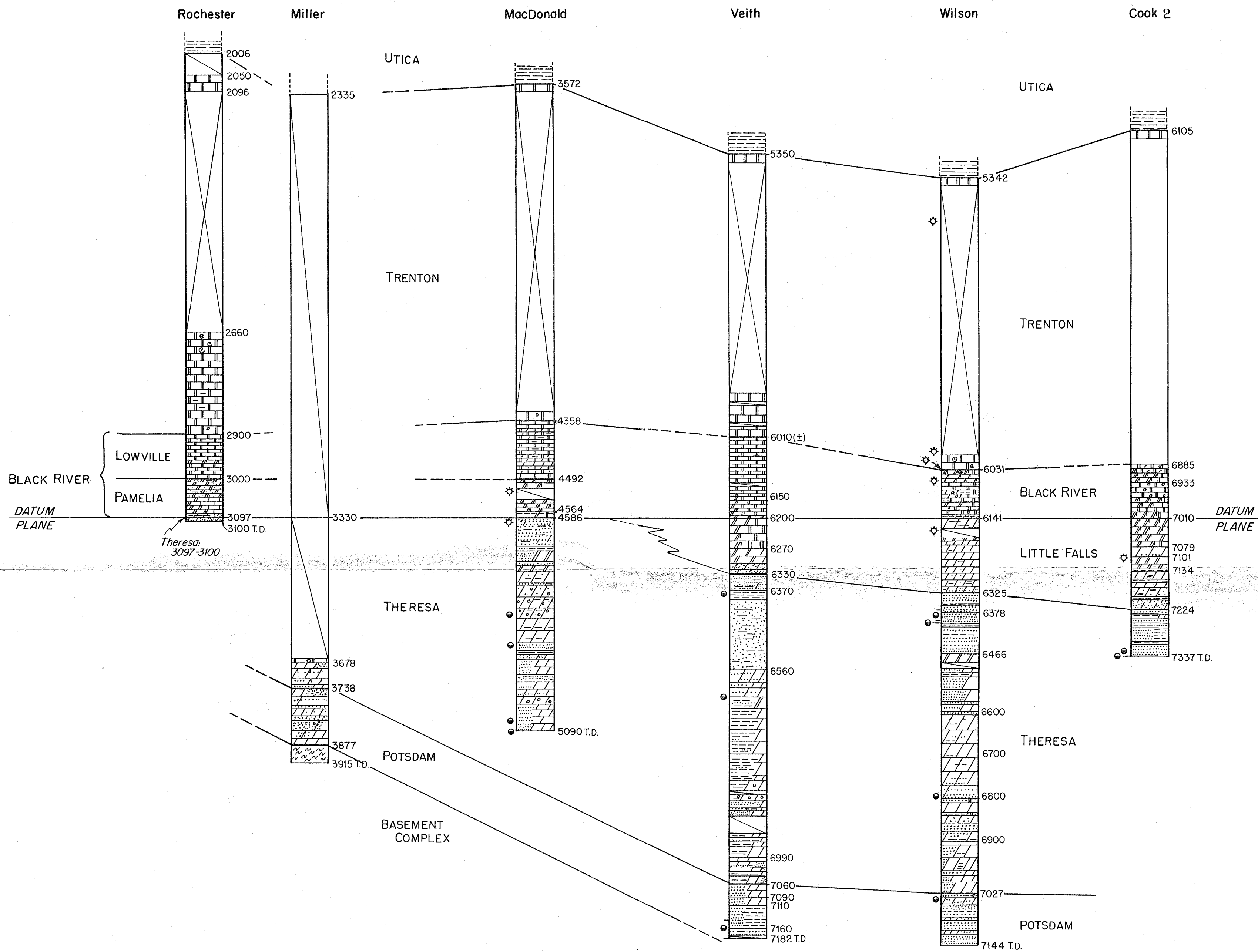
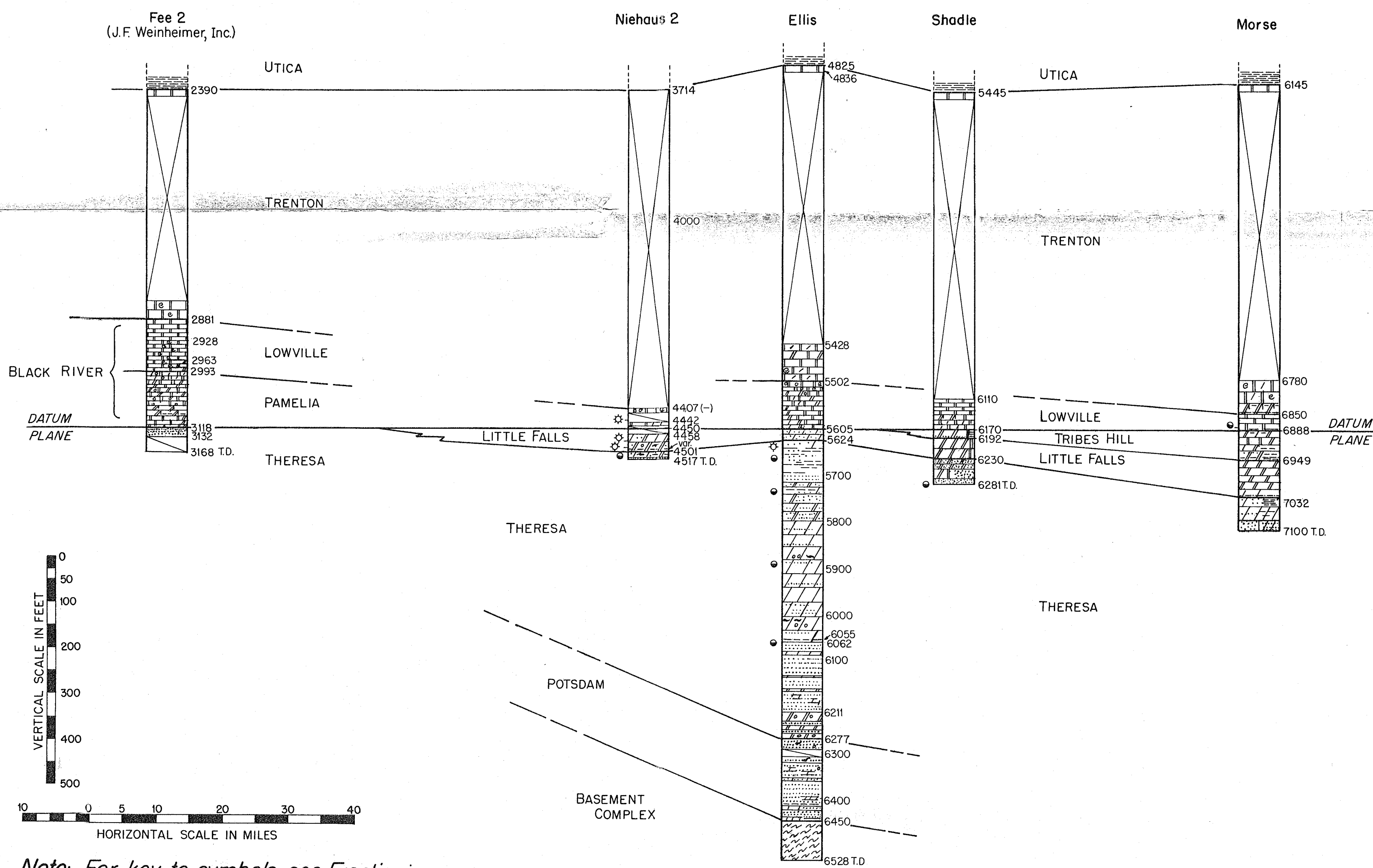


PLATE XII Line 5



Note: For key to symbols, see Frontispiece