

**U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY**

**Thermal maturity patterns (CAI and %R_o) in the Ordovician and Devonian
rocks of the Appalachian basin in New York State**

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature. Any use of trade names is for descriptive purposes only and does not imply endorsement by the USGS.

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INTRODUCTION

The classic study by Epstein and others (1977), using conodont alteration index (CAI) isograds, is the established standard for evaluating thermal maturity patterns of lower and middle Paleozoic rocks and associated oil and gas accumulation in the Appalachian basin. Maps from the Epstein and others (1977) and Harris and others (1978) studies show basin wide thermal maturity patterns for the Ordovician, Silurian through Middle Devonian, and Upper Devonian through Mississippian. Despite the value of these maps, they have a strong bias toward outcrop samples and, in many parts of the basin, CAI isograds have been extrapolated several hundreds of miles without being constrained by subsurface control points. Wandrey and others (1997) converted the CAI isograds of Harris and others (1978) to vitrinite reflectance equivalents (VTE) for the Ordovician of the central Appalachian basin; however, few new data points were added. Also, several vitrinite reflectance (%R_o) maps are available for evaluating thermal maturity patterns in the Appalachian basin but they are limited to smaller areas than the CAI-based maps. Among the best examples of these vitrinite reflectance maps are those of Upper Devonian black shale units by Streib (1981) and Boswell (1996) and of Pennsylvanian coal beds by Chyi and others (1987) and Zhang and Davis (1993).

The objective of this study is to enhance existing thermal maturity maps in New York State by establishing: 1) new subsurface CAI data points for the Ordovician and Devonian and 2) new %R_o and Rock Eval subsurface data points for Middle and Upper Devonian black shale units. The thermal maturity of the Ordovician and Devonian rocks is of major interest because they contain the source for most of the unconventional natural gas resources in the basin. Thermal maturity patterns of the Middle Ordovician Trenton

Group are evaluated here because they closely approximate those of the overlying Ordovician Utica Shale that is believed to be the source rock for the regional oil and gas accumulation in Lower Silurian sandstones (Jenden and others, 1993; Ryder and others, 1998). Improved CAI-based thermal maturity maps of the Ordovician are important to identify areas of optimum gas generation from the Utica Shale and to provide constraints for interpreting the origin of oil and gas in the Lower Silurian regional accumulation, in particular, its basin-centered part (Ryder, 1998). Thermal maturity maps of the Devonian will better constrain burial history-petroleum generation models of the Utica Shale, as well as place limitations on the origin of regional oil and gas accumulation in Upper Devonian sandstone and Middle to Upper Devonian black shale.

New York State is the first area in the Appalachian basin where collecting, processing, and analysis of subsurface drill-hole cuttings and core samples have been completed on a large-scale to recover conodont elements and assign CAI values to them. This investigation was a cooperative effort between the U.S. Geological Survey (USGS) and the New York State Geological Survey. Additional cooperative investigations in Pennsylvania (USGS–Pennsylvania Topographic and Geologic Survey), West Virginia (USGS–West Virginia Geological Survey) and Ohio (USGS–Ohio Division of Geological Survey), are at various stages of completion.

METHODOLOGY

Drill-hole cuttings (n=106) and selected cores (n=3) were collected by one of us (R.N.) at the New York State Geological Survey's sample storage facility in Albany. Sixty drill holes in 24 counties were sampled. Locations of the wells sampled are shown on figure 1. Where possible, Ordovician and Devonian intervals were collected from the

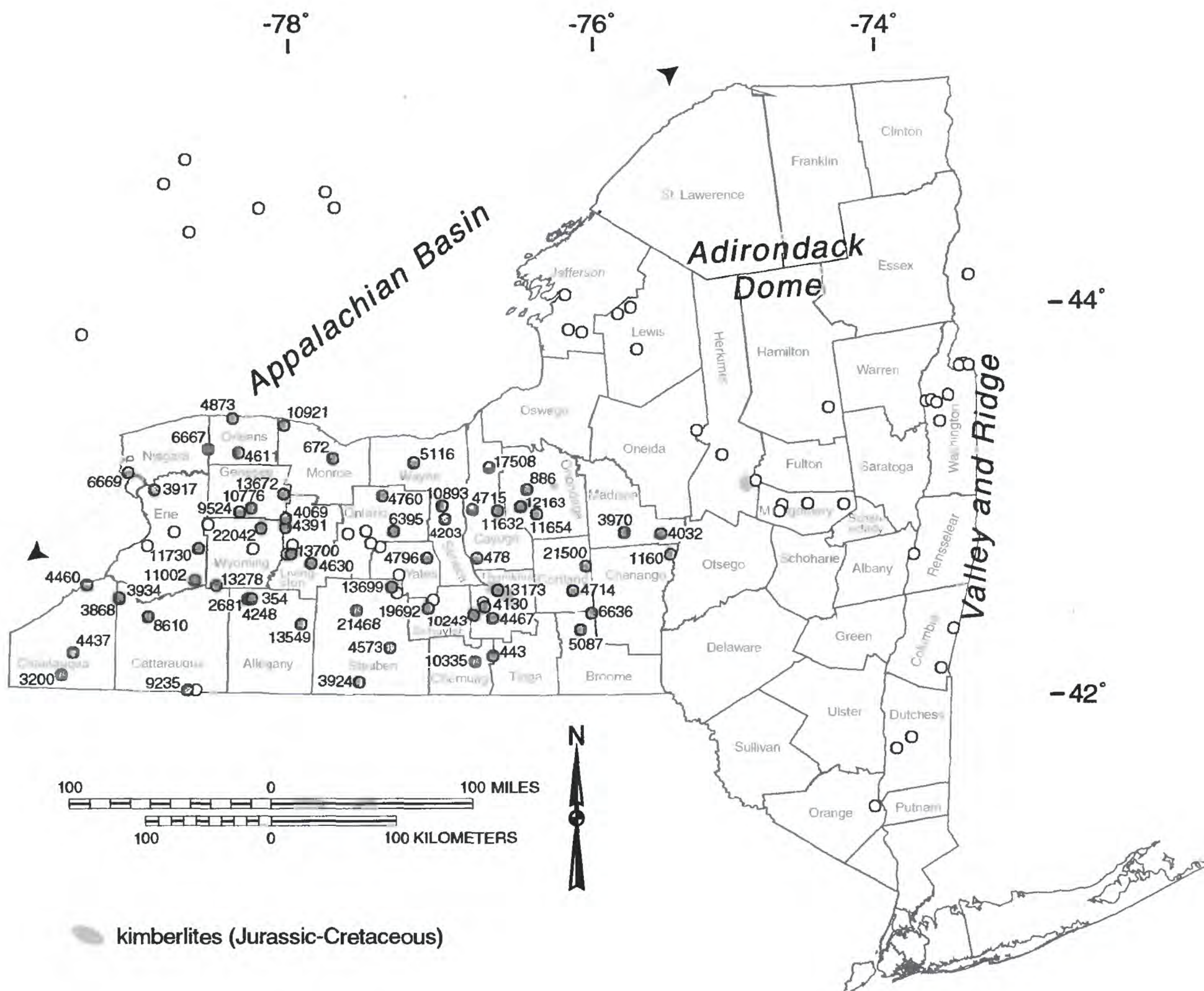


Figure 1. Map of New York showing location of wells (●) and surface localities sampled (○) in this study. Wells labeled with American Petroleum Institute (API) suffix numbers. Surface sample data from Harris and others (1978). Location of kimberlites shown because they are discussed later.

same drill hole (well). The total collection (n=109) consists of: 1) carbonate (limestone) samples from the Middle Ordovician Trenton Group (n=43), 2) carbonate (chiefly limestone and calcareous shale) samples from selected Devonian units (n=44), and 3) black shale samples primarily from the Middle Devonian Marcellus Shale (n=22). Each sample weighed about 100 g and consisted of rock fragments >20 mesh. Most samples were composites from 50 to 200 ft of stratigraphic section. The carbonate samples were sent to the USGS in Reston, Virginia, where they were processed and analyzed for conodonts. Devonian black shale samples were sent to Humble Geochemical Services¹, Humble, Texas where they were processed and analyzed for total organic carbon (TOC), Rock Eval parameters, and vitrinite reflectance.

Conodonts recovered were visually compared with a set of conodont color standards provided by A.G. Harris of the U.S. Geological Survey and assigned a CAI value. Samples exhibiting a range of CAI values were assigned a minimum and maximum value. Since variations in CAI within a sample can be caused by very local hydrothermal alteration, the CAI minimum value was assumed to most accurately reflect regional thermal effects, as per Epstein and others (1977) and Rejebian and others (1987), and was the value used for the succeeding maps (figs. 4-7). The conodont samples are repositied in the collections of the U.S. Geological Survey and filed under Cambrian-Ordovician (CO) or Silurian-Devonian (SD) collection numbers (see tables 1 and 2).

The maps, figs. 1 and 4-8, were constructed by plotting points in ARC/INFO over a digital base map, using latitude/longitude coordinates from the New York State

¹ Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

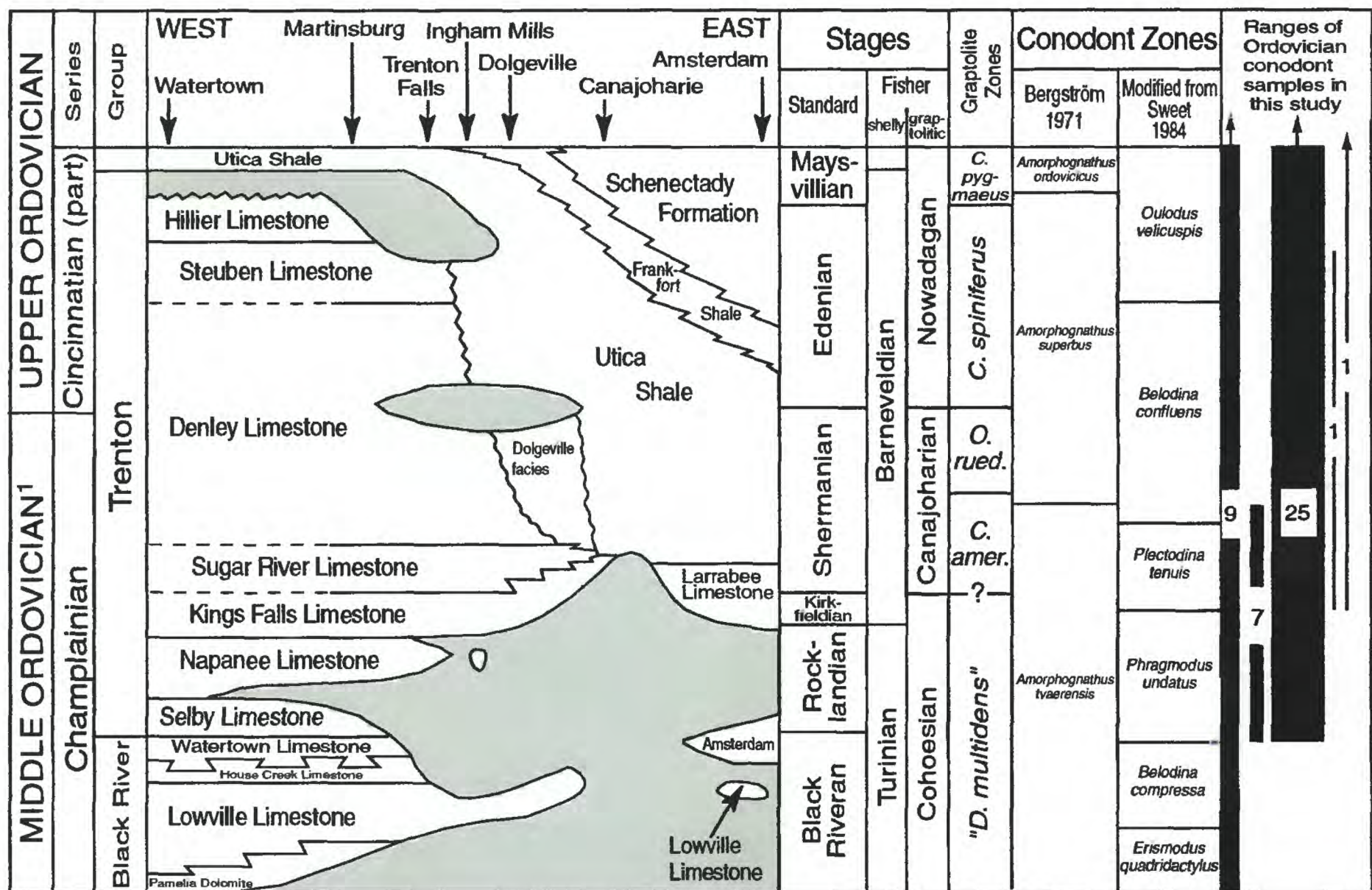
Geological Survey well database. The points were then attributed with American Petroleum Institute (API) numbers and minimum and maximum CAI values. Data points and CAI isograd contours from Harris and others (1978) were captured by scanning and georegistering the maps, then tracing and attributing the points and lines in ARC/INFO. The coverages were then projected to State Plane Projection and exported to ARCVIEW version 3.1 for ease of manipulation and graphic display.

RESULTS

STRATIGRAPHY OF SAMPLED INTERVALS

All Ordovician samples used in this study were identified on well logs by the New York Geological Survey as Trenton Group, with no subdivision. No attempt was made to identify any of the samples to formational level. All 43 carbonate samples from the Trenton Group yielded conodonts, in absolute abundances ranging from 1 element fragment up to 136 elements. Ranges of conodont species recovered indicate that all of the samples are consistent with the age of the Trenton Group, with 36 samples not necessarily restricted to the Trenton, and 7 samples restricted to that range (fig. 2). Table 1 contains detailed species composition, abundance, biostratigraphic position, and other data from the conodont collections recovered.

Devonian samples were selected from various carbonate units, predominantly in the Upper Devonian. Where Upper Devonian samples were not available or were ambiguous, samples were taken in Middle or Lower Devonian carbonates. Twenty-five of the 44 carbonate samples from the Devonian yielded conodonts, in absolute abundances ranging from 1 element fragment up to 262 elements. Recovered conodont species indicate ages ranging from Late Silurian/Early Devonian to late Devonian. A single sample



is possibly Late Silurian in age (Table 2, USGS sample number 12703-SD) but was retained in the Devonian sample set, as the CAI value from it is consistent with those from neighboring samples. Figure 3 illustrates the numbers, successful conodont yield, and approximate position within the regional stratigraphy of samples in the Devonian set. Table 2 contains detailed species composition, abundance, biostratigraphic position, and other data from the conodont collections recovered.

THERMAL MATURITY RESULTS

Ordovician Data Set

The new CAI data for the Ordovician samples are plotted in figure 4 and contoured as isograds. For comparison, the CAI isograds from Harris and others (1978) are also shown. The earlier data were chiefly from surface collections along the Adirondack Dome to the north and east, the Valley and Ridge rocks in the eastern part of the state, and central Pennsylvania to the south (figure 1), giving little control over the Appalachian basin in central and western New York. CAI isograds in Harris and others (1978) range from 2 in the west to 5 in the east and trend smoothly in a southwest to northeast direction. Although isograds defined from this study approximate those of Harris and others (1978) in eastern and western New York, they differ in central New York, where they are shifted markedly further west by more than 100 km and are more tightly grouped, particularly in the CAI 3 to 4.5 range. This close grouping of isograds reflects a steeper thermal gradient than previously noted by Harris and others (1978). A similarly abrupt east-to-west increase in thermal maturity across New York was noted by Johnsson (1986) in the Middle Devonian Tioga metabentonite using clay-mineral diagenesis and apatite fission-track age data. Moreover, our data show an adjoining relatively low thermal

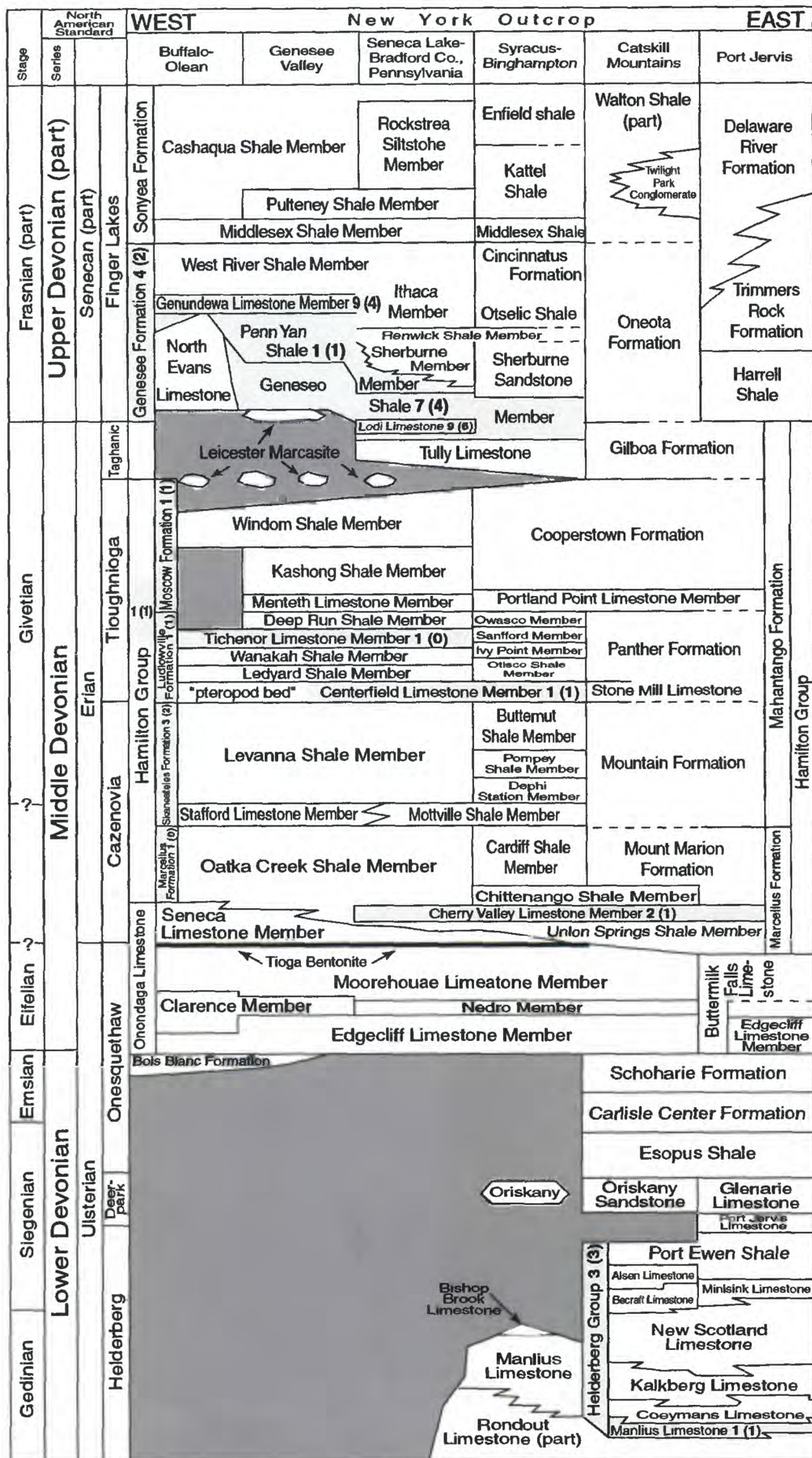


Figure 3. Stratigraphic relationships of Lower into Upper Devonian rocks in New York with conodont sample recoveries from this study. Stratigraphic units sampled in light gray. Hiatuses in dark gray. Number of conodont samples processed from each unit in plain numerals, samples yielding conodonts in parentheses. Total Devonian samples = 44. Stratigraphy from Oliver and others (1967, fig. 4)

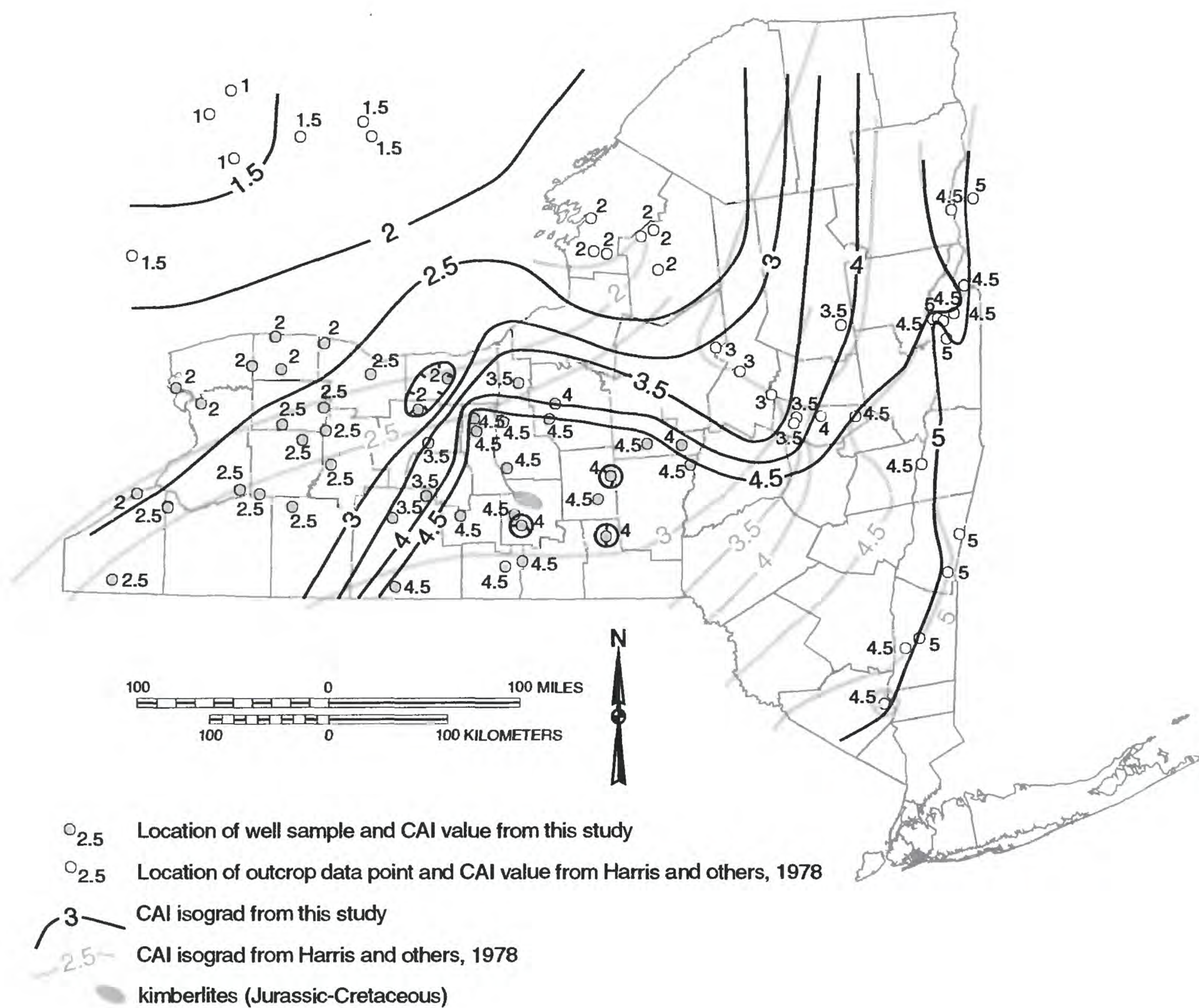


Figure 4. Middle and Upper Ordovician Conodont Alteration Index (CAI) isograds from data used in this study. The CAI isograds are based on data from this study and that of Harris and others (1978)

maturity embayment that protrudes southeastward from Herkimer County.

At first glance this shape in the isograds appears to mimic the isopach contours for Upper and Middle Ordovician clastic rocks, and Silurian carbonate and evaporite rocks in New York (Miller, 1975; de Witt and others, 1975). However, the CAI 3 to 4.5 isograds cut across the isopach at a high angle in west-central New York and CAI 4.5 to 5 isograds are centered over the thinnest isopachs. A better match between isograd and isopach patterns is achieved with the Middle Ordovician through Permian isopachs (Harris and others, 1978) but even in this situation CAI 3 to 4.5 isograds cut sharply across the isopachs in west-central New York. These comparisons between isograd and isopach patterns in New York are complicated by Paleozoic and post-Paleozoic uplift of the Appalachians and the erosion of parts of the Upper Ordovician and Silurian as well as all pre-existing Carboniferous and Permian strata.

The CAI isograds for the Ordovician samples are plotted on figure 5, along with the locations of Middle and Upper Ordovician and Lower Silurian gas fields. The gas fields are located largely between the 2.5 and 4.5 CAI isograds (%Ro ~1.5 and 4) which is broadly consistent with the range of thermal maturity indices commonly cited for the “window” of dry natural gas generation and preservation (Dow, 1977; Harris and others, 1978; Tissot and Welte, 1984).

Devonian data set

The CAI data and interpreted isograds for the Devonian samples are plotted in figure 6 along with the CAI isograds from Harris and others (1978) for comparison. The distribution and shape of the isograds in this study change significantly from those of the Harris and others (1978) plot because of additional sample localities, especially in north-

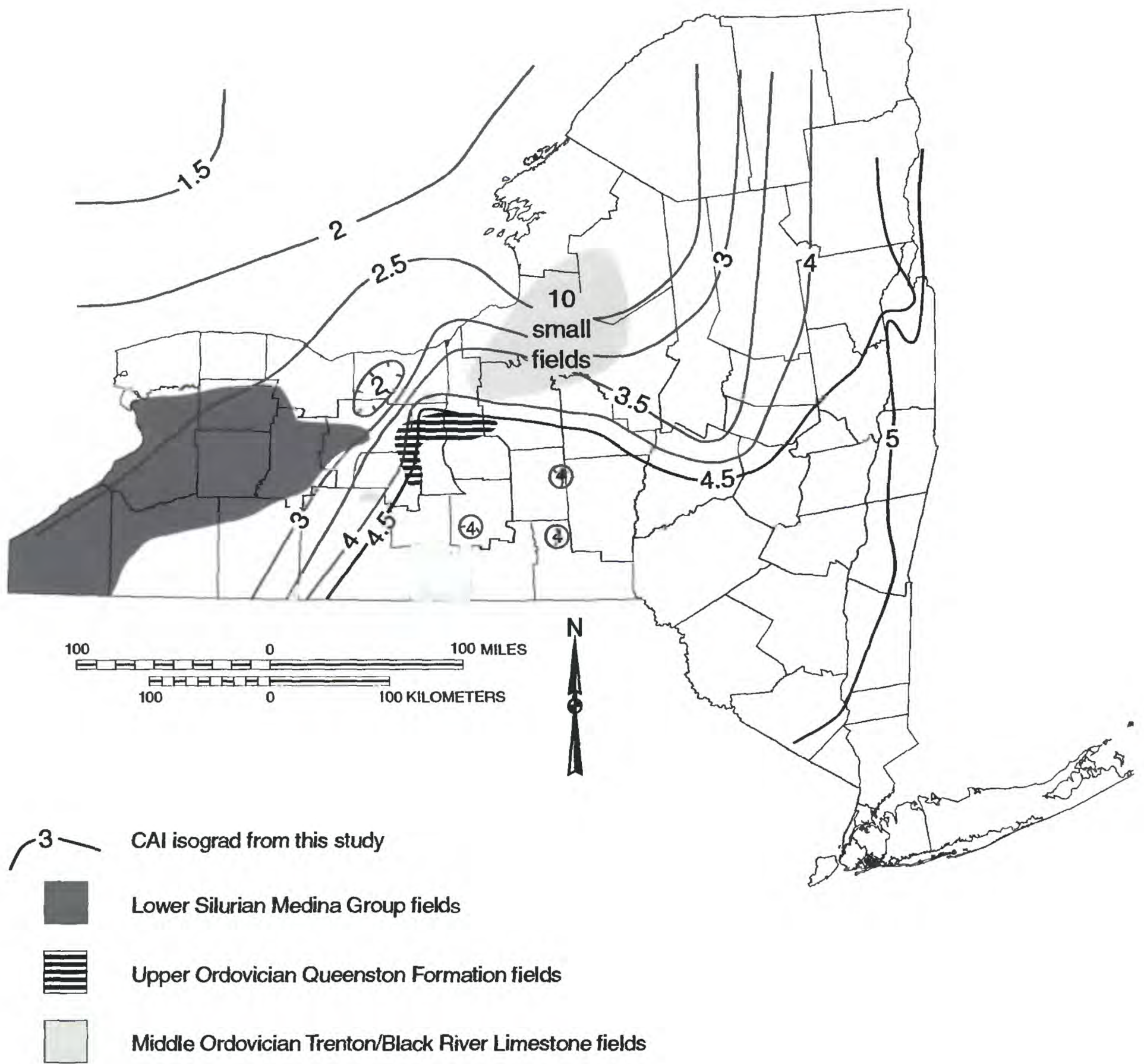


Figure 5. Comparison of locations of Middle/Upper Ordovician and Lower Silurian gas fields in New York with Ordovician Conodont Alteration Index (CAI) isograds from this study. Gas field data from New York State Department of Environmental Conservation (1986).

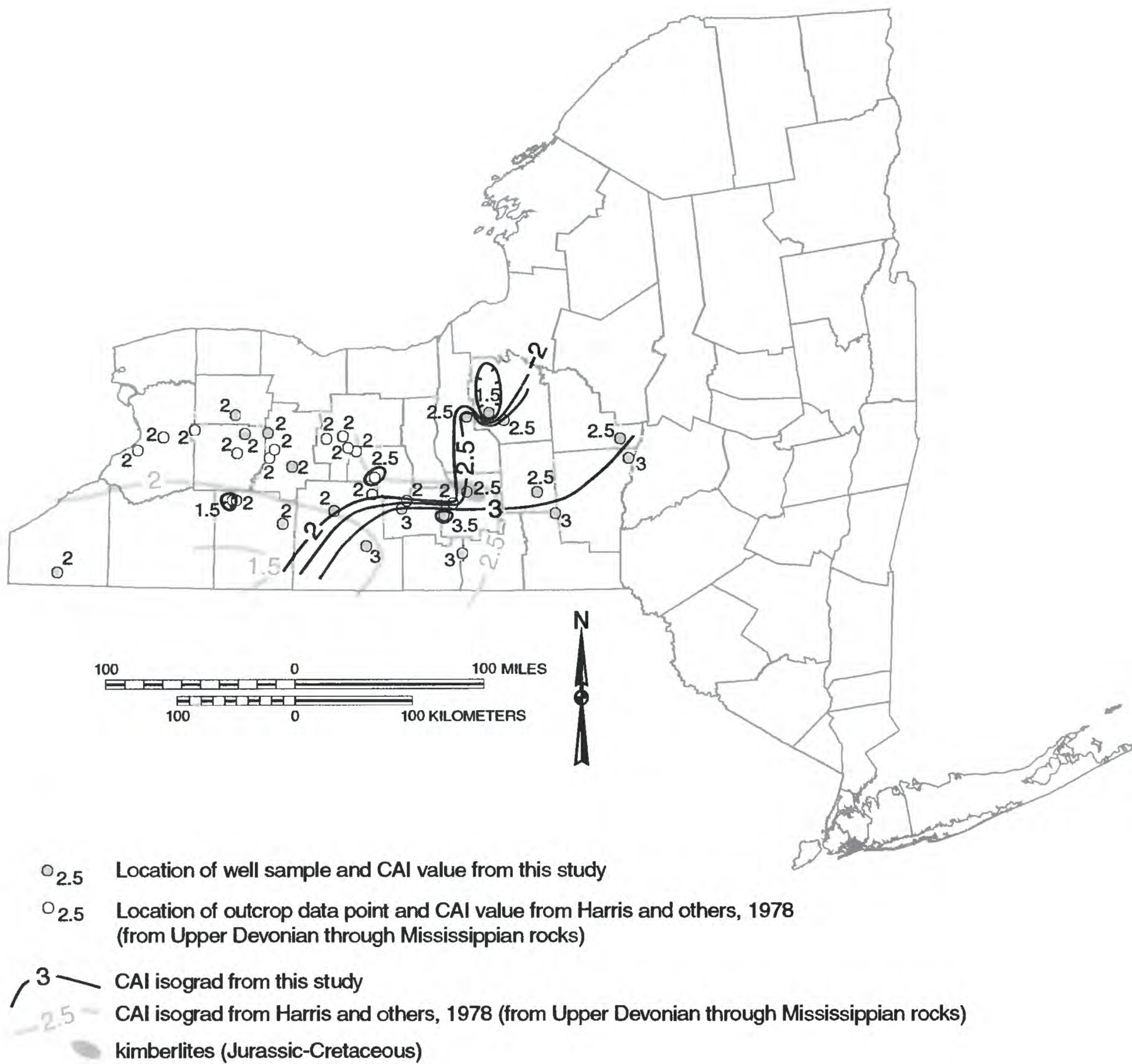


Figure 6. Devonian Conodont Alteration Index (CAI) isograds from data used in this study. The CAI isograds are based on data from this study and that of Harris and others (1978)

central and south-central New York. As noted for the Ordovician data, the CAI 2 to 3 isograds are shifted farther westward about 50 to 75 kilometers than shown in Harris and others (1978) and furthermore, there is a hint that they are more tightly grouped in the same approximate locations as the Ordovician isograds in the 3 to 4.5 range. Again the isograds reflect higher paleotemperatures and a steeper paleotemperature gradient in central New York than was recognizable given the data used by Harris and others (1978). Although the shapes of the Devonian isograds and overburden isopachs (Devonian through Permian; Harris and others, 1978) are more similar than in the Ordovician example, the isograds still cut sharply across the isopachs in central New York.

The CAI isograds for the Devonian samples are plotted on figure 7 along with locations of Upper Silurian and Devonian oil and gas fields. Oil fields are located in the western part of the area where CAI values are 2 or less ($\%Ro \sim 1$ or less). The eastern limit of oil fields in the western part of Steuben County has a CAI value of 2.5 ($\%Ro \sim 1.5$). Gas fields are found mainly in south-central and west-central New York where CAI values range from 2 to 3.5 ($\%Ro \sim 1$ to 2.7). These CAI isograds are broadly consistent with the range of thermal maturity indices commonly cited for the “window” of oil and natural gas generation and preservation (Dow, 1977; Harris and others, 1978; Tissot and Welte, 1984).

Vitrinite reflectance values of black shale samples from the Devonian (mainly Middle Devonian Marcellus Shale) are shown on figure 8. Percent Ro values range from 0.45 in the west (Genesee County) to over 2.12 in the east (Broome County), with a gradual west to east increase. The $\%Ro$ contour patterns are roughly compatible with the CAI isograds including the grouping of the contours in central New York. In most

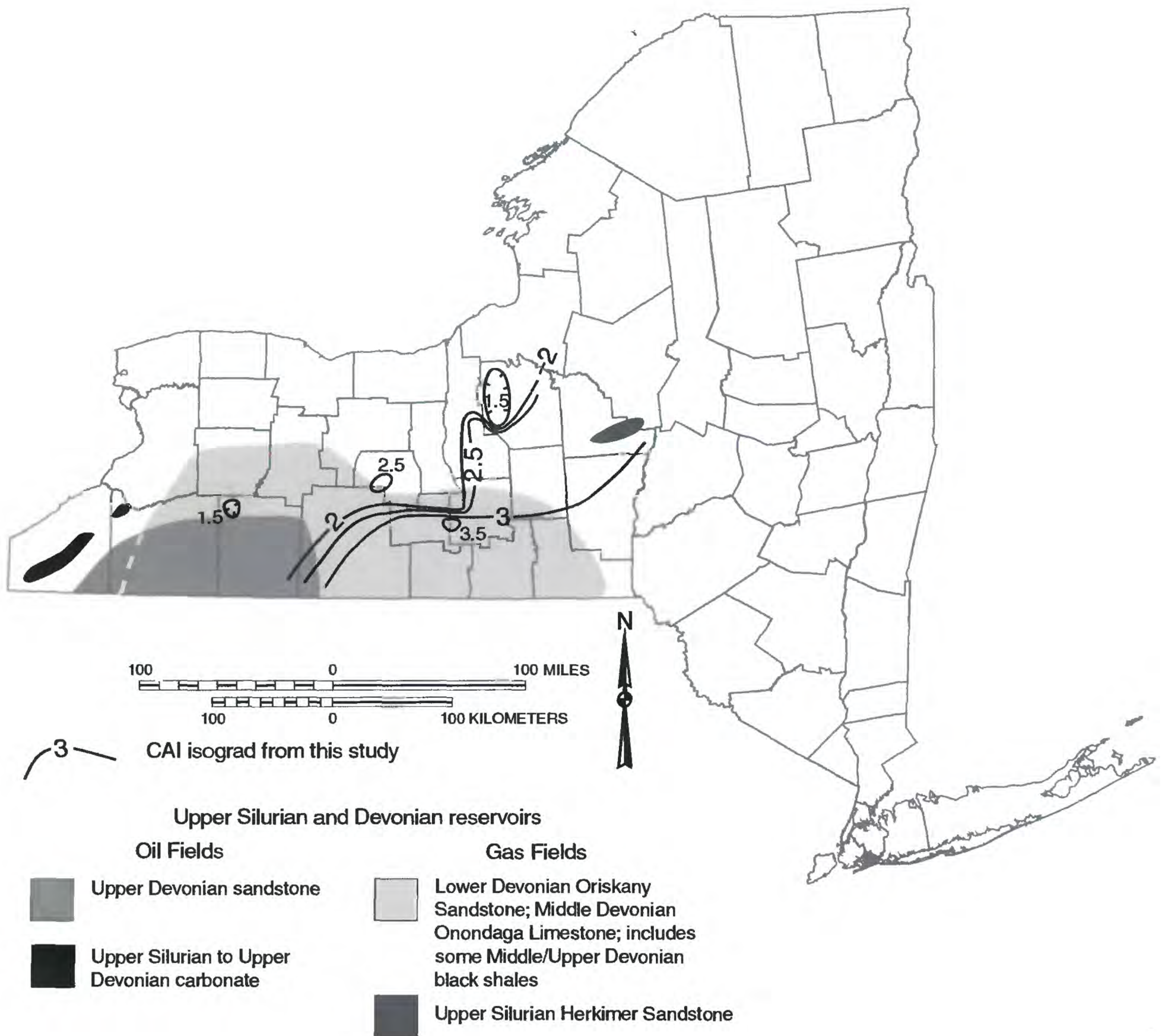


Figure 7. Comparison of locations of Upper Silurian/Devonian oil and gas fields in New York with Devonian Conodont Alteration Index (CAI) isograds from this study. Oil and gas field data from New York State Department of Environmental Conservation (1986).

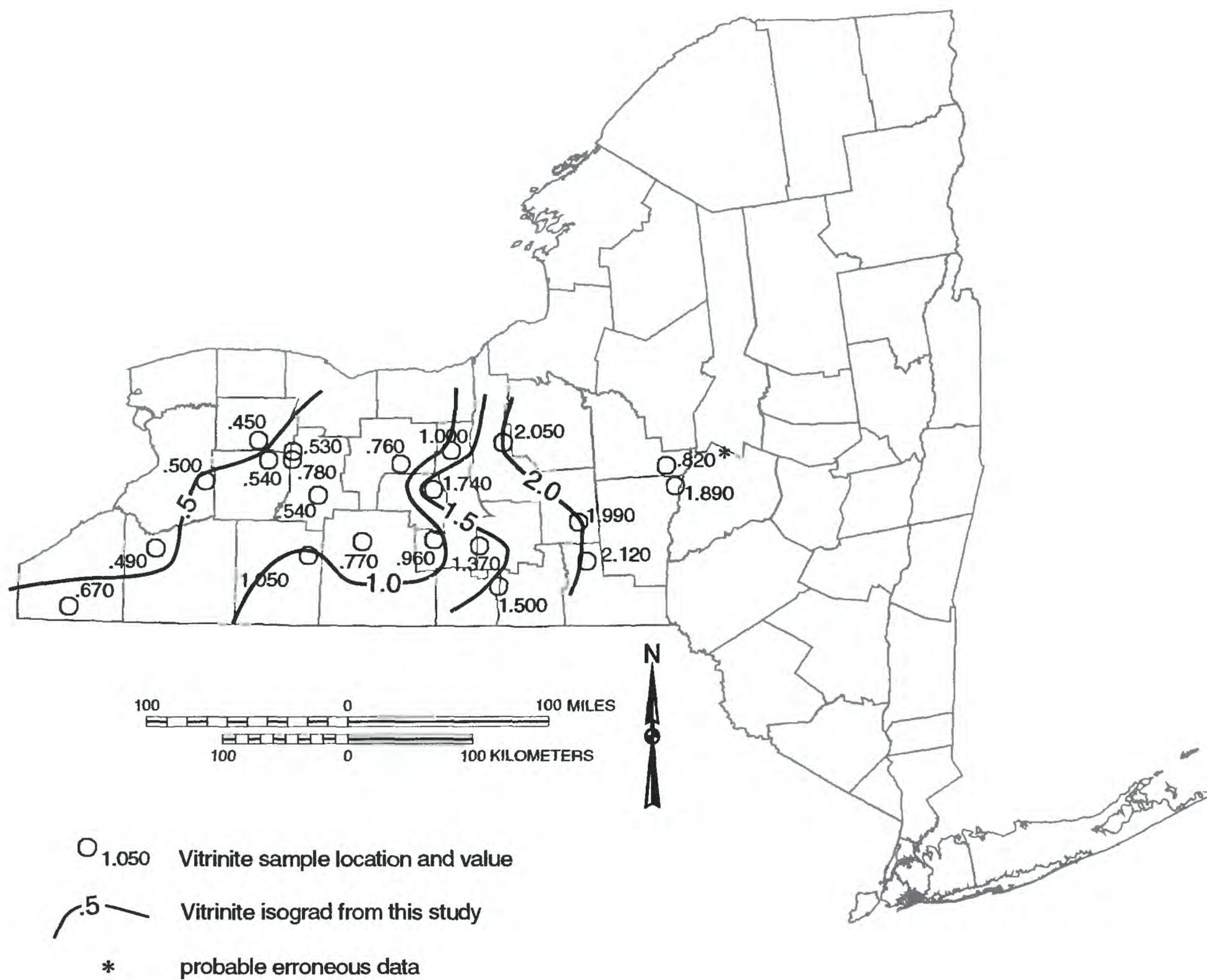


Figure 8. Devonian vitrinite reflectance value (%Ro) contours based on data collected in this study.

localities where both %Ro and CAI measurements are available, the %Ro values indicate a slightly higher level of thermal maturity than the CAI values. Overall, the %Ro contours agree with the oil and gas field locations about as well as the CAI isograds.

CONCLUSIONS

Assuming a geothermal gradient in the 20° to 30° C/km range that is typical of foreland basin settings, Ordovician CAI isograds in New York (figure 4) imply much higher paleotemperatures than can be explained by the 10,000 to 12,000 ft (3 to 3.7 km) of existing overburden. Moreover, the gradual thickness changes in overburden cannot account for the steep thermal maturity gradient in central New York as indicated by the tight grouping of CAI isograds. Thus, burial by the Taconic clastic wedge could not have been a controlling factor in the distribution of observed CAI isograds. The same is true for the Devonian CAI isograds and %Ro contours (figures 6, 8) which indicate much higher paleotemperatures than expected from the 6000 to 8,000 ft (1.8 to 2.4 km) of existing overburden. Thermal maturity indices measured and interpreted by Friedman and Sanders (1982), Lakatos and Miller (1983), and Johnsson (1986) lead to similar conclusions.

Several explanations for the high thermal maturity are possible: 1) burial beneath thick Carboniferous and Permian overburden that has since been eroded, 2) igneous activity, and 3) regional fluid flow. Johnsson (1986) favors burial heating by 4 km of Carboniferous overburden as the cause of the higher-than-expected paleotemperatures. Although discounted by Johnsson (1986), we suggest that an elevated geothermal flux associated with emplacement of Cretaceous-age ultramafic intrusions in central and eastern New York (Kay and others, 1983) (figures 1,4,6) may be a contributing factor.

The intrusions are small, but they could broaden with depth into pluton-sized bodies. Also, the expected high temperatures of emplacement (~900° to 1000° C at 80 to 90 km; Kay and others, 1983) may be sufficient to elevate the regional geothermal gradient. Regional fluid flow is probably not the cause of the high thermal maturity because estimated rates of flow of basin-derived fluids appear to be too high to leave a thermal imprint on CAI values (Dorobek, 1989).

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TABLE 1. Conodont data from Ordovician samples from the subsurface of New York.

COUNTY API number ¹ USGS Collection Number	WELL NAME; FOOTAGE (Latitude North/ Longitude West)	STRATIGRAPHIC UNIT (Based on picks provided by the New York State Geological Survey)	CORE? OR CUTTINGS	CONODONT FAUNA	AGE RANGE OF CONODONTS	CAI	REMARKS
Allegany Co. 003-04248 11681-CO	Wolfer No. 1 5930'-6040' 42.47043 -78.16017	Trenton Group	cuttings	1 <i>Drepanoistodus suberectus</i> (Branson & Mehl) element 1 <i>Phragmodius</i> sp. indet. 1 Sb, 3 Sc elements UNASSIGNED ELEMENTS: 1 M (oistodont) 2 indet. bar, blade, and platform fragments 1 <i>Phragmodius</i> sp. indet. 1 Sa, 2 Sb, 1 Sc elements 4 indet. bar, blade, and platform fragments	<i>C. friendsvillensis</i> - end of Ordovician (=late Whiterockian- latest Gamachian; = late middle -Late Ordovician)	2.5	151 g of rock processed (44 g +20 and 5 g 20-200 mesh insoluble residue).
Broome Co. 007-05087 11682-CO	Richards No. 1 7815'-7850' 42.32346 -75.94786	Trenton Group	cuttings	1 <i>Drepanoistodus suberectus</i> (Branson & Mehl) element 1 unassigned drepanodontiform <i>Phragmodius undatus</i> Branson & Mehl 2 Sb, 3 Sc & two S fragments	Middle or Late Ordovician	4	167 g of rock processed (48 g +20 and 11 g 20-200 mesh insoluble residue).
Cattaraugus Co. 009-03868 11683-CO	Ellis No. 1 4996'-5061' 42.45509 -79.03989	Trenton Group	cuttings	1 <i>Drepanoistodus suberectus</i> (Branson & Mehl) element 1 unassigned drepanodontiform <i>Phragmodius undatus</i> Branson & Mehl 2 Sb, 3 Sc & two S fragments	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late Middle -Late Ordovician)	2.5	119 g of rock processed (36 g +20 and 13 g 20-200 mesh insoluble residue).
Cattaraugus Co. 009-03934 11684-CO	Conger No. 1 4837'-4932' 42.45998 -79.04021	Trenton Group	cuttings	<i>Amorphognathus</i> sp. indet. 1 Pa, 1 Pb, 1 Sb, 1 Sc & 1 bar fragment element (all elements incomplete) 1 <i>Belodina compressa</i> (Branson & Mehl) element 1 Sb element <i>Iridodella</i> sp. indet. 5 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodius undatus</i> Branson & Mehl 5 P, 5 M, 3 Sb, 5 Sc & 5 S fragment elements 1 <i>Pseudoneotodus miratus</i> (Moskalenko) element 1 incomplete P element <i>Rhodesognathus</i> <i>elegans</i> (Rhodes)? 5 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-lowest B; <i>confluens</i> Zone (=latest Blackriveran-middle Shermanian; =late, but not latest, Middle Ordovician)	2.5	114 g of rock processed (21 g +20 and 12 g 20-200 mesh insoluble residue).
Cayuga Co. 011-00478 11685-CO	Mahaney No. 1 5344'-5603' 42.68477 -76.64431	Trenton Group	cuttings	1 <i>Panderodus gracilis</i> (Branson & Mehl) element <i>Phragmodius undatus</i> Branson & Mehl 5 P, 2 M, 1 Sa, 2 Sb, 8 Sc & 5 S element fragments 1 <i>Plectodina</i> sp. indet. Sb element	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	4.5	107 g of rock processed (19 g +20 and 8 g 20-200 mesh insoluble residue).

¹Since all samples are from New York, the state API prefix: 31 was omitted for brevity.

COUNTY API number ¹ USGS Collection Number	WELL NAME; FOOTAGE (Latitude North/ Longitude West)	STRATIGRAPHIC UNIT (Based on picks provided by the New York State Geological Survey)	CORE? OR CUTTINGS	CONODONT FAUNA	AGE RANGE OF CONODONTS	CAI	REMARKS
Cayuga Co. 011-04715 11686-CO	Alnutt No. 1 3749'-3877' 42.92171 -75.94786	Trenton Group	cuttings	1 <i>Belodina compressa</i> (Branson & Mehl) element 1 <i>Drepanoistodus suberectus</i> (Branson & Mehl) element 5 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodus undatus</i> Branson & Mehl 4 P, 4 M, 1 Sa, 10 Sb, 5 Sc & 6 S fragment elements 10 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-lowest B. confluens Zone (=latest Blackriveran-middle Shermanian; =late, but not latest, Middle Ordovician)	4.5	149 g of rock processed (30 g +20 and 3 g 20-200 mesh insoluble residue).
Cayuga Co. 011-17508 11687-CO	Hunter No. 1 2850'-2860' 43.12899 -76.56174	Trenton Group	cuttings	<i>Amorphognathus</i> sp. indet. 1 Pb element, 1 Sb element 2 <i>Belodina</i> sp. indet. elements 1 <i>Curtoognathus</i> sp. indet. M element 1 <i>Dapsilodid</i> sp. indet. element 1 <i>Drepanoistodus suberectus</i> (Branson & Mehl) element 12 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodus undatus</i> Branson & Mehl 5 P, 3 M, 22 undifferentiated S elements & 23 S element fragments 7 Pa elements <i>Polyplocognathus ramosus</i> Stauffer 6 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-lowest B. confluens Zone (=latest Blackriveran-middle Shermanian; =late, but not latest, Middle Ordovician)	3.5	126 g of rock processed (5 g +20 and 7 g 20-200 mesh insoluble residue).
Chautauqua Co. 013-3200 11688-CO	Morse No. 1 6501'-6433' 42.06821 -79.41556	Trenton Group	cuttings	<i>Phragmodus undatus</i> Branson & Mehl 2 P, 1 M, 2 Sc elements	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	2.5	146 g of rock processed (31 g +20 and 4 g 20-200 mesh insoluble residue).
Chautauqua Co. 013-04460 11689-CO	Sommers- Tuttle No. 1 3760'-3800' 42.52111 -79.26226	Trenton Group	cuttings	1 <i>Amorphognathus</i> sp. indet. Sc element 3 <i>Drepanoistodus suberectus</i> (Branson & Mehl) elements 6 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodus undatus</i> Branson & Mehl 3 P, 1 M, 2 Sb, 6 Sc, 2 undifferentiated S element fragments 2 <i>Staufferella falcata</i> (Stauffer) elements 3 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-within O. <i>robustus</i> Zone (=latest Blackriveran-middle Maysvillian; = late middle -Late Ordovician)	2	170 g of rock processed (51 g +20 and 20 g 20-200 mesh insoluble residue).
Chemung Co. 015-00443 11690-CO	Kesseling No. 1 9091'-9230' 42.19857 -76.53807	Trenton Group	cuttings	1 <i>Panderodus gracilis</i> (Branson & Mehl) element <i>Phragmodus undatus</i> Branson & Mehl 3 M, 1 Sb, 1 Sc, 2 S element fragments 3 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	4.5	133 g of rock processed (96 g +20 and 4 g 20-200 mesh insoluble residue).

COUNTY API number ¹ USGS Collection Number	WELL NAME; FOOTAGE (Latitude North/ Longitude West)	STRATIGRAPHIC UNIT (Based on picks provided by the New York State Geological Survey)	CORE? OR CUTTINGS	CONODONT FAUNA	AGE RANGE OF CONODONTS	CAI	REMARKS
Chemung Co. 015-10335 11691-CO	Matejka No. 1 9595'-9650' 42.16901 -76.65898	Trenton Group	cuttings	1 belodindid rastrate element 4 <i>Panderodus gracilis</i> (Branson & Mehl) elements 1 <i>Perodonta</i> sp. indet. M element <i>Phragmodius undatus</i> Branson & Mehl 6 P, 3 M, 2 Sb, 3 Sc & 23 S element fragments 13 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	4.5- 5	116 g of rock processed (31 g +20 and 18 g 20-200 mesh insoluble residue).
Chenango Co. 017-01160 11692-CO	Lobdell No. 1 4417'-4511' 42.69328 -75.34506	Trenton Group	cuttings	1 belodindid sp. indet. rastrate element <i>Phragmodius undatus</i> Branson & Mehl 1 P, 1 M, 2 Sb, 1 Sc & 4 S element fragments	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	4.5	107 g of rock processed (14 g +20 and 7 g 20-200 mesh insoluble residue).
Cortland Co. 023-04714 11693-CO	Clough No. 1 6920'-6958' 42.51847 -76.00093	Trenton Group	cuttings	1 indet. coniform element 4 pyritized, phosphatic ostracode steinkerns, 1 phosphatic gastropod steinkern.	Post Cambrian Paleozoic	4.5	217 g of rock processed (73 g +20 and 11 g 20-200 mesh insoluble residue).
Cortland Co. 023-21500 11694-CO	NYSRT No. 6#1 6290'-6450' 42.63903 -75.91361	Trenton Group	cuttings	2 unassigned M elements 1 indet. bar, blade, or platform fragment	Post Cambrian Paleozoic	4- 4.5	26 g of rock processed (5 g +20 and 4 g 20-200 mesh insoluble residue).
Erie Co. 029-03917 11695-CO	Fee No. 2 2492'-2572' 43.00044 -78.82458	Trenton Group	cuttings	3 <i>Drepanoliodus suberectus</i> (Branson & Mehl) elements 6 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodius undatus</i> Branson & Mehl 1 P, 4 M, 1 Sb, 3 Sc & 5 S element fragments <i>Plectodina tenuis</i> (Branson & Mehl) 1 Pa, 1 Pb, 1 M & 1 Sc elements 1 <i>Pseudoneotodus mitratus</i> (Moskalenko) element UNASSIGNED ELEMENTS: 1 M & 1 Sb 5 indet. bar, blade, and platform fragments	<i>Pl. tenuis</i> Zone-A. <i>shaleri</i> Zone (Kirkfieldian-Gamachian; =very late Middle-Late Ordovician)	2	204 g of rock processed (66 g +20 and 13 g 20-200 mesh insoluble residue).
Erie Co. 029-11002 11696-CO	Brown No. 1 5340'-5450' 42.55748 -78.53568	Trenton Group	cuttings	<i>Amorphognathus</i> sp. indet. 1 Sa, 1 Sc element 1 <i>Drepanoliodus suberectus</i> (Branson & Mehl) elements 3 <i>Panderodus gracilis</i> (Branson & Mehl) elements 1 <i>Perodonta</i> sp. indet. M element <i>Phragmodius undatus</i> Branson & Mehl 4 P, 1 M, 2 Sb, 4 Sc & 4 S element fragments 2 <i>Plectodina</i> sp. indet. Pa elements 1 <i>Yaoxianognathus abruptus</i> (Branson & Mehl) P element 7 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	2.5	115 g of rock processed (10 g +20 and 49 g 20-200 mesh insoluble residue).

COUNTY	WELL NAME; FOOTAGE (Latitude North/ Longitude West)	STRATIGRAPHIC UNIT (Based on picks provided by the New York State Geological Survey)	CORE? OR CUTTINGS	CONODONT FAUNA	AGE RANGE OF CONODONTS	CAI	REMARKS
Genesee Co. API number ¹ USGS Collection Number	Buckenmeyer No. 1 3385'-3500' 42.90003 -78.24422	Trenton Group	cuttings	<i>Amorphognathus</i> sp. indet. 1 Pa, 1 Pa fragment, 1 Sc element 1 <i>Drepanoistodus subrectus</i> (Branson & Mehl) elements UNASSIGNED ELEMENTS: 1 M 4 indet. bar, blade, and platform fragments	<i>C. friendsvillensis</i> -end of Ordovician (=late White-rockian- latest Gamachian; = late middle -Late Ordovician)	2.5	31 g of rock processed (3 g +20 and 3 g 20-200 mesh insoluble residue).
Genesee Co. 037-13672 11698-CO	Fee No. 1 3230'-3300' 42.99354 -77.95185	Trenton Group	cuttings	5 <i>Drepanoistodus subrectus</i> (Branson & Mehl) elements 7 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodus undatus</i> Branson & Mehl 13 P, 3 M, 6 Sb, 4 Sc & 6 S fragment elements 3 Pa elements 1 <i>Rhodesognathus elegans</i> (Rhodes) element 3 <i>Staufferia falcata</i> (Stauffier) elements UNASSIGNED ELEMENTS: 1 M	<i>Ph. undatus</i> Zone-within O. robustus Zone (=latest Blackriveran-middle Maysvillian; = late middle -Late Ordovician)	2.5	138 g of rock processed (31 g +20 and 35 g 20-200 mesh insoluble residue).
Livingston Co. 051-04069 11699-CO	MacDonald No. 1 4031'-4117' 42.87157 -77.93213	Trenton Group	cuttings	3 <i>Belodina compressa</i> (Branson & Mehl) elements 2 <i>panderodid</i> element fragments <i>Phragmodus undatus</i> Branson & Mehl 8 P, 1 M, 3 Sb, 9 Sc & 7 S fragment elements 3 Pa elements <i>Polyplacognathus ramosus</i> Stauffer 4 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-lowest B. <i>confiluentis</i> Zone (=latest Blackriveran-middle Shermanian; =late, but not latest, Middle Ordovician)	2.5	140 g of rock processed (40 g +20 and 38 g 20-200 mesh insoluble residue).
Livingston Co. 051-13700 11700-CO	Hill's No. 1 4710'-4970' 42.69719 -77.89195	Trenton Group	cuttings	2 <i>Drepanoistodus subrectus</i> (Branson & Mehl) elements 3 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodus undatus</i> Branson & Mehl 6 P, 4 M, 2 Sa, 5 Sb, 10 Sc & 15 S fragment elements 11 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	2.5	156 g of rock processed (15 g +20 and 15 g 20-200 mesh insoluble residue).
Madison Co. 053-03970 11701-CO	Branagan No. 1 4568'-4695' 42.80480 -75.65048	Trenton Group	cuttings	<i>Phragmodus undatus</i> Branson & Mehl 1 P, 2 Sb, 1 S fragment elements 1 indet. fragment	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	4.5	105 g of rock processed (59 g +20 and 8 g 20-200 mesh insoluble residue).
Madison Co. 053-04032 11702-CO	Danisevich No. 1 4042'-4100' 42.79630 -75.40464	Trenton Group	cuttings	<i>belodindid</i> sp. indet. 1 P, 1 M element 1 M element <i>Pericodon</i> sp. indet. <i>Phragmodus undatus</i> Branson & Mehl 4 P, 4 M, 5 Sb, 5 Sc & 4 S fragment elements 1 Pa element <i>Polyplacognathus ramosus</i> Stauffer 1 indet. fragment	<i>Ph. undatus</i> Zone-lowest B. <i>confiluentis</i> Zone (=latest Blackriveran-middle Shermanian; = late middle - Late Ordovician)	4	120 g of rock processed (24 g +20 and 11 g 20-200 mesh insoluble residue).

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Monroe Co. 055-00672 11703-CO	Rochester Deep Well 2200'-2610' 43.17023 -77.61864	Trenton Group	cuttings	1 <i>Belodina compressa</i> (Branson & Mehl) element 1 <i>Dapsilodus</i> sp. indet. element 5 <i>Drepanoliodus suberectus</i> (Branson & Mehl) elements 6 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodus undatus</i> Branson & Mehl 7 P, 4 M, 6 Sa, 4 Sb, 5 Sc & 7 S fragment elements 1 Pa element <i>Polyplacognathus ramosus</i> Stauffer 2 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-lowest <i>B. confluens</i> Zone (=latest Blackriveran-middle Shermanian; =late, but not latest, Middle Ordovician)	2.5	121 g of rock processed (21 g +20 and 3 g 20-200 mesh insoluble residue).
Monroe Co. 055-10921 11704-CO	Kerberle No. 1 1240' - 1300' 43.33336 -77.95290	Trenton Group	cuttings	<i>Amorphognathus</i> sp. indet. 3 Pa, 4 Pb, 1 Sa, 1 Sb, 1 Sc elements. 1 <i>Coelocerodontus trigonius</i> Ethington element 4 <i>Drepanoliodus suberectus</i> (Branson & Mehl) elements 13 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodus undatus</i> Branson & Mehl 1 P, 1 Sc elements <i>Plectodina tenuis</i> (Branson & Mehl) 2 Pa, 2 Pb, 2 M, 1 Sa, 1 Sc elements 1 <i>Protopanderodus</i> sp. indet. juvenile element 6 indet. bar, blade, and platform fragments	<i>P. tenuis</i> Zone - lower O. <i>vellicuspis</i> Zone (=Kirkfieldian-early Maysvillian; =late, but not latest, Middle Ordovician-early Late Ordovician)	2	196 g of rock processed (29 g +20 and 10 g 20-200 mesh insoluble residue).
Niagara Co. 063-06667 11705-CO	FMC Fee No. 1 2020'-2230' 42.20756 -78.46499	Trenton Group	cuttings	1 <i>belodiniid</i> sp. indet. <i>rastrate</i> element 5 <i>Drepanoliodus suberectus</i> (Branson & Mehl) elements 3 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodus undatus</i> Branson & Mehl 3 P, 3 M, 3 Sb, 7 Sc & 6 S fragment elements 1 <i>Plectodina</i> sp. indet. Pa element 1 <i>Rhodesagnathus?</i> sp. indet. element 4 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	2	121 g of rock processed (25 g +20 and 3 g 20-200 mesh insoluble residue).
Niagara Co. 063-06669 11706-CO	Hooker Fee No. 1 2400'-2470' 43.07993 -79.00674	Trenton Group	cuttings	9 <i>Drepanoliodus suberectus</i> (Branson & Mehl) elements 4 <i>Panderodus gracilis</i> (Branson & Mehl) elements 1 <i>Peribon</i> sp. indet. M element <i>Phragmodus undatus</i> Branson & Mehl 32 P, 16 M, 5 Sa, 11 Sb, 24 Sc & 23 S fragment elements 11 indet. bar, blade, and platform fragments 1 phosphaized scolecodont	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	2	129 g of rock processed (13 g +20 and 12 g 20-200 mesh insoluble residue).

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Onondaga Co. 067-00886 11707-CO	Munroe No. 1 3376'-3451' 43.01886 -76.30389	Trenton Group	cuttings	1 <i>Phragmodius</i> sp. indet. P element UNASSIGNED ELEMENTS: 1 Pb 3 indet. bar, blade, and platform fragments	Middle or Late Ordovician	4	100 g of rock processed (24 g +20 and 14 g 20-200 mesh insoluble residue).
Onondaga Co. 067-12163 11708-CO	Harrison No. 1 4120'-4180' 42.93688 -76.34586	Trenton Group	cuttings	<i>Phragmodius undatus</i> Branson & Mehl 2 P, 2 Sc & 1 S fragment elements	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	4.5	151 g of rock processed (15 g +20 and 13 g 20-200 mesh insoluble residue).
Ontario Co. 069-04760 11709-CO	Wyman No. 1 2970'-3640' 42.98944 -77.27984	Trenton Group	cuttings	<i>Phragmodius undatus</i> Branson & Mehl 1 P, 3 Sc, 2 indet S fragment elements 3 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	2	44 g of rock processed (10 g +20 and 17 g 20-200 mesh insoluble residue).
Ontario Co. 069-06395 11710-CO	Frankish No. 1 4350'-5010' 42.81262 -77.20285	Trenton Group	cuttings	1 <i>Drepanolobus suberectus</i> (Branson & Mehl) elements 2 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodius undatus</i> Branson & Mehl 3 P, 1 Sa, 1 Sb 1 Sc, 1 indet S fragment elements 4 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	3.5	77 g of rock processed (11 g +20 and 8 g 20-200 mesh insoluble residue).
Orleans Co. 073-04611 11711-CO	Kelley No. 1 2321'-2406' 43.19091 -78.25826	Trenton Group	cuttings	2 <i>Drepanolobus suberectus</i> (Branson & Mehl) elements 4 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodius undatus</i> Branson & Mehl 6 P, 3 M, 1 Sa, 3 Sb, 6 Sc & 10 S fragment elements <i>Plectodina</i> sp. indet. 1 Pa, 1 Pb elements 1 <i>Pseudoneolobus mitratus</i> (Moskalenko) element 4 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	2	174 g of rock processed (25 g +20 and 21 g 20-200 mesh insoluble residue).
Orleans Co. 073-04873 11712-CO	Green No. 1 1420'-1570' 43.36272 -78.30504	Trenton Group	cuttings	1 Pb element <i>Amorphognathus</i> sp. indet. 5 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodius undatus</i> Branson & Mehl 9 P, 3 M, 1 Sb, 7 Sc & 5 S fragment elements 1 Pa elements <i>Polyplocognathus ramosus</i> Stauffer 5 indet. bar, blade, and platform fragments 1 phosphatic brachiopod valve	<i>Ph. undatus</i> Zone-lowest B. <i>confluens</i> Zone (=latest Blackriveran-middle Shermanian; =late, but not latest, Middle Ordovician)	2	164 g of rock processed (28 g +20 and 21 g 20-200 mesh insoluble residue).

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Schuyler Co. 097-19692 11713-CO	Perigo No. 21578 7150'-7440' 42.43251 -76.97039	Trenton Group	cuttings	3 <i>Panderodus gracilis</i> (Branson & Mehl) elements 1 <i>Perodion</i> sp. indet. M element <i>Phragmodius undatus</i> Branson & Mehl 5 P, 1 M, 3 Sb, 4 Sc & 12 S fragment elements UNASSIGNED ELEMENTS: 1 M, 1 Sa 7 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	4	92 g of rock processed (20 g +20 and 4 g 20-200 mesh insoluble residue).
Seneca Co. 099-04203 11714-CO	Schaefer No. 2 4000'-4440' 42.87620 -76.85854	Trenton Group	cuttings	4 <i>Drepanoliodus suberectus</i> (Branson & Mehl) elements 2 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodius undatus</i> Branson & Mehl 6 P, 3 M, 3 Sb, 4 Sc & 8 S fragment elements UNASSIGNED ELEMENTS: 1 Sa, 3 M 7 indet. bar, blade, and platform fragments 1 Sb element <i>Phragmodius</i> sp. indet. 3 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	4.5	76 g of rock processed (15 g +20 and 11 g 20-200 mesh insoluble residue).
Seneca Co. 099-10893 11715-CO	Kinney No. 1 3200'-3700' 42.94114 -76.87669	Trenton Group	cuttings	1 <i>Panderodus</i> sp. indet. 3 indet. bar, blade, and platform fragments	Middle or Late Ordovician	4.5	96 g of rock processed (42 g +20 and 12 g 20-200 mesh insoluble residue).
Steuben Co. 101-03924 11716-CO	Olin No. 1 9785'-10300' 43.06303 -77.43067	Trenton Group	cuttings	1 <i>Panderodus</i> sp. indet. 2 indet. bar, blade, and platform fragments	Middle or Late Ordovician	4.5	59 g of rock processed (11 g +20 and 6 g 20-200 mesh insoluble residue).
Steuben Co. 101-13699 USGS 9732-CO	Columbia NYS Reforestation No. 6 7990'-8100' 42.5372 -77.2157	Black River Group	cuttings	1 drepanodontiform element 1 <i>Panderodus</i> sp. element UNASSIGNED ELEMENTS: 1 trichonodelliform element 6 indet. bar, blade, and platform fragments	Middle or Late Ordovician	3.5- 4	680 g of rock processed (91.2 g +20 and 7 g 20-200 mesh insoluble residue) Sample processed and analysed by Anita G. Harris, USGS, Paleontology and Stratigraphy Branch shipment number: 0-80- 77.
Steuben Co. 101-21468 11717-CO	Avoca No. 1 7570'-7620' 42.41958 -77.45354	Trenton Group	cuttings	1 <i>Amorphognathus</i> sp. indet. Pa element fragment 1 belodind sp. indet. rastrate element 1 <i>Drepanoliodus suberectus</i> (Branson & Mehl) elements 10 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodius undatus</i> Branson & Mehl 25 P, 10 M, 5 Sa, 8 Sb, 16 Sc elements, 25 S element fragments 1 <i>Polyplacognathus</i> sp. indet. Pa element fragment 23 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	3.5	143 g of rock processed (27 g +20 and 28 g 20-200 mesh insoluble residue).

COUNTY API number ¹ USGS Collection Number	WELL NAME; FOOTAGE (Latitude North/ Longitude West)	STRATIGRAPHIC UNIT (Based on picks provided by the New York State Geological Survey)	CORE? OR CUTTINGS	CONODONT FAUNA	AGE RANGE OF CONODONTS	CAI	REMARKS
Tompkins Co. 109-04130 11718-CO	Grund No. 1 7400'-7700' 42.44211 -76.59280	Trenton Group	cuttings	2 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodus undatus</i> Branson & Mehl 4 P, 1 M, 1 Sa, 4 Sb, 4 Sc elements 2 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	4.5	64 g of rock processed (13 g +20 and 21 g 20-200 mesh insoluble residue).
Tompkins Co. 109-04467 11719-CO	Richardson Fee No. 1 7620'-7770' 42.38417 -76.54083	Trenton Group	cuttings	2 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodus undatus</i> (Branson & Mehl) 2 S element fragments	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	4	24 g of rock processed (4 g +20 and 1 g 20-200 mesh insoluble residue).
Wayne Co. 117-05116 11720-CO	Hammond No. 1 2590'-2630' 43.15198 -77.06980	Trenton Group	cuttings	2 <i>Drepanolostodus suberectus</i> (Branson & Mehl) elements 5 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodus undatus</i> Branson & Mehl 1 P, 2 M, 1 Sb, 1 Sc elements UNASSIGNED ELEMENTS: 1 Sa 10 phosphatic steinkerns of gastropods and miscellanea.	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	2	141 g of rock processed (44 g +20 and 8 g 20-200 mesh insoluble residue).
Wyoming Co. 121-13278 11721-CO	George No. 1 5870'-5970' 42.53465 -78.39469	Trenton Group	cuttings	1 <i>Amorphognathus</i> sp. indet Sc element 2 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodus undatus</i> Branson & Mehl 3 P, 3 M, 1 Sb, 4 Sc elements & 1 S element fragment 4 indet. bar, blade, and platform fragments	<i>Ph. undatus</i> Zone-end of Ordovician (=latest Blackriveran-latest Gamachian; = late middle -Late Ordovician)	2.5	166 g of rock processed (16 g +20 and 8 g 20-200 mesh insoluble residue).
Wyoming Co. 121-22042 11722-CO	Titus Brothers. No. 1 4170'-4210' 42.82192 -78.09957	Trenton Group	cuttings	3 <i>Drepanolostodus suberectus</i> (Branson & Mehl) elements 1 Sa element <i>Icriodella</i> sp. indet. 8 <i>Panderodus gracilis</i> (Branson & Mehl) elements <i>Phragmodus undatus</i> Branson & Mehl 8 P, 3 M, 2 Sb, 3 Sc & 8 S fragment elements <i>Plectodina</i> sp. indet. 2 Pa, 1 Pb, 1 Sa, 1 Sb, 1 Sc elements. 2 <i>Rhodesognathus elegans</i> (Rhodes) elements 4 indet. bar, blade, and platform fragments	A. <i>Maerensis</i> Zone-A. ordovician Zone (=latest Blackriveran-Maysvillian; = late middle -Late Ordovician)	2.5	142 g of rock processed (44 g +20 and 2 g 20-200 mesh insoluble residue).

TABLE 2. Conodont data from Devonian samples from the subsurface of New York.

COUNTY	WELL NAME FOOTAGE (Latitude North/ Longitude West)	STRATIGRAPHIC UNIT (Based on picks provided by the NY State Geological Survey)	CORE? OR CUTTINGS	CONODONT FAUNA	AGE RANGE OF CONODONTS	CAI	REMARKS
Allegany Co. USGS collection number 003-00354 12691-SD	M. Connor No. 1 1882'-1900' 42.46947 -78.15479	Genundewa Limestone	cuttings	1 <i>Delotaxis</i> (?) sp. indet. Sb element <u>UNASSIGNED ELEMENTS:</u> 2 Sc elements 3 indet. bar, blade, or platform fragments	Post Lower Ordovician Paleozoic	2	18 g of rock processed (14 g +20 and 1 g 20-200 mesh insoluble residue).
Allegany Co. 003-02681 12692-SD	Thomas No. 1 1889'-1936' 42.46920 -78.18133	Penn Yan Shale	cuttings	13 indet. bar, blade, and platform fragments	No older than Devonian (by superposition)	1.5	122 g of rock processed (110 g +20 and 2 g 20-200 mesh insoluble residue).
Allegany Co. 003-02681 12693-SD	Thomas No. 1 1936'-1945' 42.46920 -78.18133	Lodi Limestone	cuttings	1 <i>Polygnathus</i> sp. indet. extremely juvenile Pa element	Devonian or Lower Carboniferous	2	28 g of rock processed (11 g +20 and 1 g 20-200 mesh insoluble residue).
Allegany Co. 003-02681 12694-SD	Thomas No. 1 1945'-1958' 42.46920 -78.18133	Genesee Formation	cuttings	1 indet bar or blade fragment.	Post Lower Ordovician Paleozoic	2	39 g of rock processed (34 g +20 and 1 g 20-200 mesh insoluble residue).
Cattaraugus Co. 003-09235	E.T.S. No. 1 4160'-4200' 42.00866 -78.56875	Genundewa Limestone	cuttings	BARREN	indet.		38 g of rock processed (22 g +20 and 1 g 20-200 mesh insoluble residue).

¹ Since all samples are from New York, the state API prefix: 31 was omitted for brevity.

COUNTY API Number ¹ USGS collection number	WELL NAME FOOTAGE (Latitude North/ Longitude West)	STRATIGRAPHIC UNIT (Based on picks provided by the NY State Geological Survey)	CORE? OR CUTTINGS	CONODONT FAUNA	AGE RANGE OF CONODONTS	CAI	REMARKS
Allegany Co. 003-13549 12695-SD	National Fuel & NYS Natural Gas No. 3 2730.7'-2731.5' 42.34889 -77.8200	Genundewa Limestone	core	6 <i>Ancyrodella rotundiloba</i> (Bryant) Pa elements 8 <i>Ancyrodella</i> spp. indet Pa fragments and juveniles <i>Delotaxis</i> spp. indet; 3 Pa (2 morphotypes), 1 Pb1, 2 Pb2, 5 M, 2 Sa, 2 Sb, 3 Sc elements <i>Icriodus difficilis</i> Ziegler and Klapper 31 P, 1 coniform elements 13 <i>Polygnathus dengleri</i> (Bischoff & Ziegler) elements 28 <i>Polygnathus dubius</i> Hinde Pa elements 8 <i>Polygnathus pennatus</i> Hinde Pa elements <u>UNASSIGNED ELEMENTS:</u> 15 Pb (4 morphotypes), 13 M (3 morphotypes), 2 Sa (2 morphotypes), 12 Sb (2 morphotypes), 25 Sc (4 morphotypes) 114 indet. bar, blade, and platform fragments OTHER: 8 pyritized steinkerns of cephalopods, bivalves ¹	Lower falsiovalis Zone to within <i>transitans</i> Zone (= early Frasnian; Late Devonian)	2- 2.5	280 g of rock processed (67 g +20 and 80 g 20-200 mesh insoluble residue).
Allegany Co. 003-13549 12696-SD	National Fuel & NYS Natural Gas No. 3 2732'-2732.3' 42.34889 -77.8200	Genundewa Limestone	core	2 <i>Ancyrodella alata</i> Glenister and Klapper Pa elements 1 <i>Ancyrodella rotundiloba</i> (Bryant) Pa elements 5 <i>Ancyrodella</i> spp. indet Pa fragments and juveniles <i>Delotaxis</i> sp. indet; 1 Pb1, 1 Pb2 elements <i>Icriodus difficilis</i> Ziegler and Klapper 8 P, 1 coniform elements 5 <i>Polygnathus dengleri</i> (Bischoff & Ziegler) elements 7 <i>Polygnathus dubius</i> Hinde Pa elements 5 <i>Polygnathus pennatus</i> Hinde Pa elements <u>UNASSIGNED ELEMENTS:</u> 5 Pb (4 morphotypes), 5 M (3 morphotypes), 1 Sa, 6 Sb (3 morphotypes), 6 Sc (3 morphotypes) 57 indet. bar, blade, and platform fragments OTHER: 6 pyritized steinkerns of cephalopods, bivalves, and gastropods	Lower falsiovalis Zone to within <i>transitans</i> Zone (= early Frasnian; Late Devonian)	2- 2.5	210 g of rock processed (62 g +20 and 34 g 20-200 mesh insoluble residue).
Allegany Co. 003-13549 12697-SD	National Fuel & NYS Natural Gas No. 3 2867.8'-2868.8' 42.34889 -77.82000	Lodi Limestone	core	21 <i>Polygnathus ovinodorus</i> Zeigler, Klapper, and Johnson Pa and Pa element fragments <u>UNASSIGNED ELEMENTS:</u> 2 Pb, 2 M, 1 Sc 23 indet. bar, blade, and platform fragments	Lower varcus Zone through <i>transitans</i> Zone (= Givetian to early Frasnian; Middle to Late Devonian)	2- 2.5	2700 g of rock processed (404 g +20 and 193 g 20-200 mesh insoluble residue).

COUNTY API Number ¹ USGS collection number	WELL NAME FOOTAGE (Latitude North/ Longitude West)	STRATIGRAPHIC UNIT (Based on picks provided by the NY State Geological Survey)	CORE? OR CUTTINGS	CONODONT FAUNA	AGE RANGE OF CONODONTS	CAI	REMARKS
Broome Co. 007-06636 12698-SD	C. Smith No. 1 3235'-3460' 42.40618 -75.87740	Helderberg Group	cuttings	1 M element, sp. indet.	post Lower Ordovician Paleozoic	3	71 g of rock processed (13 g +20 and 9 g 20-200 mesh insoluble residue).
Cayuga Co. 011-11632 12699-SD	Steinle No. 9 420'-450' 42.91694 -76.50542	Helderberg Group	cuttings	6 indet. bar, blade, and platform fragments	post Lower Ordovician Paleozoic	2.5- 3.0	68 g of rock processed (1 g +20 and 2 g 20-200 mesh insoluble residue).
Chautauqua Co. 013-03200 12700-SD	Morse No. 1 2600'-2637' 42.06821 -79.41556	Moscow-Ludlowville	cuttings	4 indet. bar, blade, and platform fragments	post Lower Ordovician Paleozoic	2	146 g of rock processed (31 g +20 and 4 g 20-200 mesh insoluble residue).
Chautauqua Co. 013-04437	Harrington No. 1 2340'-2410' 42.18421 -79.33785	Genesee Group	cuttings	BARREN	Indet.		
Chemung Co. 015-00443	Kesseling No. 1 659'-706" 42.19857 -76.53807	Genesee Group	cuttings	BARREN	indet.		103 g of rock processed (68 g +20 and 1 g 20-200 mesh insoluble residue).
Chemung Co. 015-00443 12701-SD	Kesseling No. 1 836'-869" 42.19857 -76.53807	Genesee Group	cuttings	1 <i>Polygnathus alatus</i> Huddle Pa element 4 indet. bar, blade, and platform fragments	Middle varcus subzone into transitans Zone (= Givetian to Frasnian; Middle to Late Devonian)	3	133 g of rock processed (96 g +20 and 4 g 20-200 mesh insoluble residue).
Chenango Co. 017-01160 12702-SD	Lobdell No. 1 338'-353' 42.69328 -75.34506	Skaneateles Formation	cuttings	<i>Icriodus</i> sp. indet.; 4 incomplete P elements of at least two species, 5 lateral process fragments. 1 <i>Polygnathus timorensis</i> ? Klapper, Phillip and Jackson partial Pa element 2 indet. bar, blade, and platform fragments	Probably Givetian (= Middle Devonian)	3	One of the <i>Icriodus</i> species is probably either <i>I. arkionensis</i> Stauffer, or <i>I. n. sp. E</i> of Weddige (1977). The other platforms are possibly <i>I. obliquimarginatus</i> Bischoff and Ziegler or <i>I. expansus</i> Branson and Mehl. The morphotypes of the lateral process fragments are similar to those seen on <i>I. latericrescens</i> <i>latericrescens</i> Branson and Mehl. These are all Givetian forms. 109 g of rock processed (73 g +20 and 6 g 20-200 mesh insoluble residue).

COUNTY	WELL NAME FOOTAGE (Latitude North/ Longitude West)	STRATIGRAPHIC UNIT (Based on picks provided by the NY State Geological Survey)	CORE? OR CUTTINGS	CONODONT FAUNA	AGE RANGE OF CONODONTS	CAI	REMARKS
Cortland Co. API Number ¹ USGS collection number	Clough No. 1 2880'-2910' 42.51847 -76.00093	Heiderberg Group	cuttings	<i>Ozarkodina remscheidensis</i> (Ziegler) 3 Pa, 1 Sb elements 2 indet. bar, blade, or platform fragments	Lower <i>O. remscheidensis</i> Subzone-uppermost L. woschmidt Zone (=Pridolian- Lochkovian; Upper Silurian- Lowermost Devonian)	2.5- 3	107 g of rock processed (6 g +20 and 7 g 20-200 mesh insoluble residue).
Genesee Co. 037-10776 12704-SD	Danby Belt No. 1 70'-100' 42.92045 -78.16734	Ludlowville Formation	cuttings	1 indet. bar, blade, or platform fragment	post Lower Ordovician Paleozoic	2	101 g of rock processed (67 g +20 and 21 g 20-200 mesh insoluble residue).
Genesee Co. 037-10776 12705-SD	Danby Belt No. 1 140'-170' 42.92045 -78.16734	Centerfield Limestone Member, Ludlowville Formation	cuttings	1 indet. bar fragment	post Lower Ordovician Paleozoic	1	104 g of rock processed (67 g +20 and 9 g 20-200 mesh insoluble residue). This may be downhole contamination. CAI should not be lower than overlying sample.
Livingston Co. 051-04391 12706-SD	J. Parnell 156'-175' 42.82758 -77.93560	Genesee Group	cuttings	1 <i>Ancyrodella</i> sp. indet. Pa element fragment 1 <i>Icriodus</i> sp. indet. very juvenile P element 1 <i>Polygnathus dubius</i> Hinde Pa element fragment 1 <i>Polygnathus pennatus</i> Hinde Pa element 1 <i>Polygnathus</i> sp. indet. Pa fragment UNASSIGNED ELEMENTS: 1 Pb, 2 Sb (2 morphotypes), 3 Sc (2 morphotypes).	Lower <i>falsiovals</i> Zone through <i>transitans</i> Zone (= Frasnian; Upper Devonian)	2	Although the <i>Ancyrodella</i> specimen is not identifiable to species, it is clearly of Upper Devonian morphotype, probably <i>An. rotundiloba</i> (Bryant) or <i>An.</i> <i>alata</i> (Glenister and Klapper). 113 g of rock processed (76 g +20 and 6 g 20-200 mesh insoluble residue).
Livingston Co. 051-04630 12707-SD	Kennedy No. 1 260'-280' 42.65023 -77.75596	Genundewa Limestone	cuttings	14 indet. bar, blade, or platform fragments 4 indet. bar, blade, and platform fragments.	post Lower Ordovician Paleozoic	2	35 g of rock processed (26 g +20 and 1 g 20-200 mesh insoluble residue).
Livingston Co. 051-04630	Kennedy No. 1 280'-300' 42.65023 -77.75596	Lodi Limestone	cuttings	BARREN	indet.		53 g of rock processed (38 g +20 and 1 g 20-200 mesh insoluble residue).
Livingston Co. 051-04630 12708-SD	Kennedy No. 1 330'-370' 42.65023 -77.75596	Genesee Shale	cuttings	1 <i>Polygnathus</i> sp. indet. juvenile Pa element, of Middle Devonian morphotype 11 indet. bar, blade, and platform fragments.	Middle Devonian	2	71 g of rock processed (59 g +20 and 1 g 20-200 mesh insoluble residue).
Madison Co. 053-04032 12709-SD	Danisevich No. 1 140'-157' 42.79630 -75.40464	Skaneateles Group	cuttings	1 <i>Icriodus</i> sp. indet. P element fragment	Devonian	2.5	137 g of rock processed (121 g +20 and 1 g 20-200 mesh insoluble residue).

COUNTY API Number ¹ USGS collection number	WELL NAME FOOTAGE (Latitude North/ Longitude West)	STRATIGRAPHIC UNIT (Based on picks provided by the NY State Geological Survey)	CORE? OR CUTTINGS	CONODONT FAUNA	AGE RANGE OF CONODONTS	CAI	REMARKS
Onondaga Co. 067-11654 12710-SD	Sears No. 1 110'-160' 42.89831 -76.23852	Moscow Shale	cuttings	2 indet. bar, blade, and platform fragments.	Post Lower Ordovician Paleozoic	2.5- 3	134 g of rock processed (112 g +20 and 8 g 20-200 mesh insoluble residue).
Onondaga Co. 067-11654	Sears No. 1 260'-270' 42.89831 -76.23852	Skaneateles Group	cuttings	BARREN	indet.		124 g of rock processed (101 g +20 and 6 g 20-200 mesh insoluble residue).
Onondaga Co. 067-12163 12711-SD	Harrison No. 1 430'-460' 42.93688 -76.34586	Cherry Valley Limestone	cuttings	3 indet. bar, blade, and platform fragments.	Post Lower Ordovician Paleozoic	1.5	81 g of rock processed 70 g +20 and 1 g 20-200 mesh insoluble residue).
Ontario Co. 069-06395	Frankish No. 1 310'-370' 42.81262 -77.20285	Tichenor Limestone	cuttings	BARREN	indet.		103 g of rock processed (61 g +20 and 2 g 20-200 mesh insoluble residue).
Schuyler Co. 097-19692 12712-SD	L. Perigo No. 1 1240'-1270' 42.43251 -76.97039	Lodi Limestone	cuttings	1 Sa element fragment, sp. indet. 1 indet. bar fragment	Post Lower Ordovician Paleozoic	3	160 g of rock processed (127 g +20 and 1 g 20-200 mesh insoluble residue).
Schuyler Co. 097-19692 12713-SD	L. Perigo No. 1 1290'-1320' 42.43251 -76.97039	Genesee Shale	cuttings	2 indet. bar, blade, and platform fragments	Post Lower Ordovician Paleozoic	3.5	101 g of rock processed (93 g +20 and 1 g 20-200 mesh insoluble residue).
Steuben Co. 101-03924	Olin No. 1 3170'-3190' 43.06303 -77.43067	Genundewa Limestone	cuttings	BARREN	indet.		6 g of rock processed (1g +20 and 1g 20-200 mesh insoluble residue).
Steuben Co. 101-03924	Olin No. 1 3190'-3220' 43.06303 -77.43067	Genesee Shale	cuttings	BARREN	indet.		21 g of rock processed (17 g +20 and 1 g 20-200 mesh insoluble residue).
Steuben Co. 101-04573	Scudder No. 1 2082'-2101' 42.23546 -77.22256	Genundewa Limestone	cuttings	BARREN	indet.		66 g of rock processed (58 g +20 and 1 g 20-200 mesh insoluble residue).
Steuben Co. 101-04573 12714-SD	Scudder No. 1 2319'-2344' 42.23546 -77.22256	Lodi Limestone	cuttings	1 indet. bar fragment.	Post Lower Ordovician Paleozoic	3.0	66 g of rock processed (31 g +20 and 8 g 20-200 mesh insoluble residue).

COUNTY API Number ¹ USGS collection number	WELL NAME FOOTAGE (Latitude North/ Longitude West)	STRATIGRAPHIC UNIT (Based on picks provided by the NY State Geological Survey)	CORE? OR CUTTINGS	CONODONT FAUNA	AGE RANGE OF CONODONTS	CAI	REMARKS
Sleuben Co. 101-04573	Scudder No. 1 2344'-2389' 42.23546 -77.22256	Genesee Shale	cuttings	BARREN	indet.		104 g of rock processed (97 g +20 and 1 g 20-200 mesh insoluble residue).
Sleuben Co. 101-21468	Avoca No. 1 2380'-2410' 42.41958 -77.45354	Lodi Limestone	cuttings	BARREN	indet.		122 g of rock processed (104 g +20 and 1 g 20-200 mesh insoluble residue).
Sleuben Co. 101-21468 12715-SD	Avoca No. 1 2410'-2430' 42.41958 -77.45354	Genesee Shale	cuttings	1 indet. denticulate bar, blade, or platform fragment	Post Lower Ordovician Paleozoic	2-3?	106 g of rock processed (88 g +20 and 1 g 20-200 mesh insoluble residue).
Tompkins Co. 109-10243	R. Place No. 1 2980'-3020' 42.40099 -76.66854	Cherry Valley Limestone	cuttings	BARREN	indet.		57g of rock processed (34 g +20 and 4 g 20-200 mesh insoluble residue).
Tompkins Co. 109-10243 12716-SD	R. Place No. 1 3240'-3290' 42.40099 -76.66854	Manlius Limestone	cuttings	1 indet. denticle fragment 1 scolecodont? fragment	Paleozoic	3.5- 4	74 g of rock processed (2 g +20 and 11 g 20-200 mesh insoluble residue).
Tompkins Co. 109-13173 12717-SD	Cargill Cove Test No. 17 33'-34' 42.52296 -76.5052	Lodi Limestone	core	1 indet. denticulate bar, blade, or platform fragment	Post Lower Ordovician Paleozoic	2.5- 3.0	1007g of rock processed (710 g +20 and 42 g 20-200 mesh insoluble residue).
Wyoming Co. 121-22042	Titus Bros. No. 1 430'-460' 42.82192 -78.09957	Genundewa Limestone	cuttings	BARREN	indet.		106 g of rock processed (67 g +20 and 20 g 20-200 mesh insoluble residue).
Wyoming Co. 121-22042 12718-SD	Titus Bros. No. 1 560'-600' 42.82192 -78.09957	Lodi Limestone	cuttings	1 <i>lcrdous</i> sp. indet. P element fragment	Devonian	2	92 g of rock processed (49 g +20 and 18 g 20-200 mesh insoluble residue).
Wyoming Co. 121-22042	Titus Bros. No. 1 810'-840' 42.82192 -78.09957	Marcellus Shale	cuttings	BARREN	indet.		g of rock processed (g +20 and g 20-200 mesh insoluble residue).

COUNTY API Number ¹ USGS collection number	WELL NAME FOOTAGE (Latitude North/ Longitude West)	STRATIGRAPHIC UNIT (Based on picks provided by the NY State Geological Survey)	CORE? OR CUTTINGS	CONODONT FAUNA	AGE RANGE OF CONODONTS	CAI	REMARKS
Yates Co. 123-04796	Borglum No. 1 137°-175' 42.68333 -76.9779	Genundewa Limestone	cuttings	BARREN	indel.		73 g of rock processed (65 g +20 and 1 g 20-200 mesh insoluble residue).
Yates Co. 123-04796	Borglum No. 1 243°-264' 42.68333 -76.9779	Lodi Limestone	cuttings	BARREN	indel.		87 g of rock processed (77 g +20 and 1 g 20-200 mesh insoluble residue).
Yates Co. 123-04796	Borglum No. 1 271°-308' 42.68333 -76.9779	Genesee Shale	cuttings	BARREN	indel.		121 g of rock processed (113 g +20 and 1 g 20-200 mesh insoluble residue).

Table 3. Thermal maturity data from Ordovician samples from the subsurface of New York.

API NUMBER	STATE	COUNTY	TOWNSHIP (or 7 1/2 quad)	LATITUDE (N)	LONGITUDE (W)	LEASE NAME	STRATIGRAPHIC UNIT	AGE	SAMPLE TYPE	INTERVAL	SAMPLE MASS (g)	USGS PALEONTOLOGY COLLECTION #	CAI min	CAI max
31-003-04248	New York	Alegany	Hume	42.47043	-78.18017	Wolfer No. 1	Trenton Group	Late Ordovician	cuttings	5930'-6040'	151	11681-CO	2.5	2.5
31-007-05087	New York	Broome	Triangle	42.32346	-75.94786	Richards No. 1	Trenton Group	Middle or Late Ordovician	cuttings	7815'-7850'	167	11682-CO	4	4
31-009-03688	New York	Cattaraugus	Perryburg	42.45509	-79.03989	Ellis No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	4996'-5061'	119	11683-CO	2.5	2.5
31-009-03534	New York	Cattaraugus	Perryburg	42.45998	-79.04021	Conger No. 1	Trenton Group	Middle Ordovician	cuttings	4837'-4832'	114	11684-CO	2.5	2.5
31-011-00478	New York	Cayuga	LeOyard	42.68477	-76.64431	Mahoney No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	5344'-5803'	107	11685-CO	4.5	4.5
31-011-04715	New York	Cayuga	Aurelius	42.92171	-75.94786	Abund No. 1	Trenton Group	Middle Ordovician	cuttings	3749'-3877'	149	11686-CO	4.5	4.5
31-011-17508	New York	Cayuga	Cairo	43.12899	-76.56174	Hunter No. 1	Trenton Group	Middle Ordovician	cuttings	2850'-2860'	126	11687-CO	3.5	3.5
31-013-3200	New York	Chautauque	Harmony	42.06821	-79.41556	Morse No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	6501'-6433'	146	11688-CO	2.5	2.5
31-013-04460	New York	Chautauque	Sheridan	42.52111	-79.26226	Sommers-Tuttle No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	3760'-3800'	170	11689-CO	2	2
31-015-00443	New York	Chemung	Van Etten	42.19857	-76.53807	Kesseling No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	9051'-9230'	133	11690-CO	4.5	4.5
31-015-10335	New York	Chemung	Erin	42.16901	-76.65898	Malejka No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	9595'-9650'	116	11691-CO	4.5	5
31-017-01160	New York	Chemung	Columbus	42.69328	-75.34506	Lobdel No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	4417'-4511'	107	11692-CO	4.5	4.5
31-017-04714	New York	Cortland	Freetown	42.51847	-76.00093	Clough No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	6920'-6958'	217	11693-CO	4.5	4.5
31-023-21500	New York	Cortland	Taylor	42.63903	-75.91361	NYSRT No. 681	Trenton Group	late Middle-Late Ordovician	cuttings	6290'-6450'	26	11694-CO	4	4.5
31-029-03917	New York	Erie	Tonawanda	43.00044	-78.82458	Fee No. 2	Trenton Group	late Middle-Late Ordovician	cuttings	2492'-2572'	204	11695-CO	2	2
31-029-11002	New York	Erie	Sardina	42.55748	-78.53568	Brown No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	5340'-5450'	115	11696-CO	2.5	2.5
31-037-9524	New York	Genesee	Alexander	42.90003	-78.24422	Buckenmeyer No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	3385'-3500'	31	11697-CO	2.5	2.5
31-037-13672	New York	Genesee	Leroy	42.99354	-77.95185	Fee No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	3230'-3300'	138	11698-CO	2.5	2.5
31-051-04069	New York	Livingston	York	42.87157	-77.93213	MacDonald No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	4031'-4117'	140	11699-CO	2.5	2.5
31-051-13700	New York	Livingston	Mount Morris	42.89719	-77.89195	Hill's No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	4710'-4870'	156	11700-CO	2.5	2.5
31-053-03970	New York	Madison	Lebanon	42.8048	-75.65048	Branagan No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	4568'-4695'	105	11701-CO	4.5	4.5
31-053-04032	New York	Madison	Brookfield	42.7963	-75.40464	Danisevich No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	4042'-4100'	120	11702-CO	4	4
31-055-00672	New York	Monroe	Brighton	43.17023	-77.61864	Rochester Deep Well	Trenton Group	Middle Ordovician	cuttings	2200'-2610'	121	11703-CO	2.5	2.5
31-055-10921	New York	Monroe	Hamlin	43.33336	-77.9529	Karberle No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	1240' - 1300'	196	11704-CO	2	2
31-063-06667	New York	Niagara	Royalton	43.2075	-78.465	FMC Fee No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	2020'-2230'	121	11705-CO	2	2
31-063-06689	New York	Niagara	Niagara	43.07893	-79.00674	Hooker Fee No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	2400'-2470'	129	11706-CO	2	2
31-067-00886	New York	Onondaga	Camillus	43.01886	-76.30289	Munroe No. 1	Trenton Group	Middle or Late Ordovician	cuttings	3376'-3451'	100	11707-CO	4	4
31-067-12163	New York	Onondaga	Marcellus	42.93688	-76.34586	Harrison No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	4120'-4180'	151	11708-CO	4.5	4.5
31-069-04760	New York	Ontario	Farmington	42.98944	-77.27984	Wyman No.1	Trenton Group	late Middle-Late Ordovician	cuttings	2970'-3640'	44	11709-CO	2	2
31-069-06395	New York	Ontario	Gorham	42.81262	-77.20285	Frankish No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	4350'-5010'	77	11710-CO	3.5	3.5
31-073-04611	New York	Orleans	Barre	43.19091	-78.25826	Kelley No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	2321'-2406'	174	11711-CO	2	2
31-073-04873	New York	Orleans	Carlton	43.36272	-78.30504	Green No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	1420'-1570'	164	11712-CO	2	2
31-097-19692	New York	Schuyler	Reading	42.43251	-76.97039	Perigo No.21578	Trenton Group	late Middle-Late Ordovician	cuttings	7150'-7440'	92	11713-CO	4	4
31-099-04203	New York	Seneca	Fayette	42.8762	-76.65854	Scharf No. 2	Trenton Group	late Middle-Late Ordovician	cuttings	4000'-4440'	76	11714-CO	4.5	4.5
31-099-10893	New York	Seneca	Waterloo	42.94114	-76.87669	Kinney No. 1	Trenton Group	Middle or Late Ordovician	cuttings	3200'-3700'	96	11715-CO	4.5	4.5

Table 3. Thermal maturity data from Ordovician samples from the subsurface of New York.

API NUMBER	STATE	COUNTY	TOWNSHIP (or 7 1/2 quad)	LATITUDE (N)	LONGITUDE (W)	LEASE NAME	STRATIGRAPHIC UNIT	AGE	SAMPLE TYPE	INTERVAL	SAMPLE MASS (g)	USGS PALEONTOLOGY COLLECTION #	CAI min	CAI max
31-101-03924	New York	Stueben	Woodhull	42.0631	-77.4306	Olin No. 1	Trenton Group	Middle or Late Ordovician	cuttings	9785'-10300'	59	11716-CO	4.5	4.5
31-101-13699	New York	Stueben	Wheeler	42.5372	-77.2157	Columbia NY's Reforestation No. 6	Trenton Group	Middle or Late Ordovician	cuttings	7950'-8100'	680	11717-CO	3.5	4
31-101-21468	New York	Stueben	Avoca	42.41958	-77.45354	Avoca No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	7570'-7620'	143	11718-CO	3.5	3.5
31-109-04130	New York	Tompkins	Enfield	42.44211	-76.5928	Grund No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	7400'-7700'	64	11719-CO	4.5	4.5
31-109-04467	New York	Tompkins	Newfield	42.38417	-76.54083	Richardson Fee No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	7620'-7770'	24	11720-CO	4	4
31-117-05116	New York	Wayne	Arcadia	43.15198	-77.0698	Hammond No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	2590'-2630'	141	11721-CO	2	2
31-121-13278	New York	Wyoming	Arcade	42.53465	-78.39469	George No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	5870'-5970'	166	11722-CO	2.5	2.5
31-121-22042	New York	Wyoming	Middlebury	42.82192	-78.09957	Titus Brothers. No. 1	Trenton Group	late Middle-Late Ordovician	cuttings	4170'-4210'	142	11723-CO	2.5	2.5

Table 4. Thermal maturity data from Devonian samples from the subsurface of New York.

API NUMBER	STATE	COUNTY	TOWNSHIP (or 7 1/2' quad)	LATITUDE (N)	LONGITUDE (W)	LEASE NAME	STRATIGRAPHIC UNIT	CONODONT AGE	SAMPLE TYPE
31-003-00354	New York	Alegany	Hume	42.46947	-78.15479	M. Connor No. 1	Genudewa Limestone	Post Early Ordovician Paleozoic	cuttings
31-003-02681	New York	Alegany	Hume	42.4692	-78.18133	Thomas No. 1	Penn Yan Shale	No older than Devonian	cuttings
31-003-02681	New York	Alegany	Hume	42.4692	-78.18133	Thomas No. 1	Lodi Limestone	Devonian	cuttings
31-003-02681	New York	Alegany	Hume	42.4692	-78.18133	Thomas No. 1	Genesee Formation	Post Early Ordovician Paleozoic	cuttings
31-003-13549	New York	Alegany	Almond	42.34889	-77.82	National Fuel & NYS Natural Gas No. 3	Genudewa Limestone	Late Devonian	core
31-003-13549	New York	Alegany	Almond	42.34889	-77.82	National Fuel & NYS Natural Gas No. 3	Lodi Limestone	Late Devonian	core
31-003-13549	New York	Alegany	Almond	42.34889	-77.82	National Fuel & NYS Natural Gas No. 3	Genudewa Limestone	Late Devonian	core
31-003-13549	New York	Alegany	Almond	42.34889	-77.82	National Fuel & NYS Natural Gas No. 3	Lodi Limestone	Middle to Late Devonian	core
31-007-05087	New York	Broome	Triangle	42.32346	-75.94786	Richards No. 1	Marcellus Shale	Middle Devonian	cuttings
31-007-06836	New York	Broome	Triangle	42.40618	-75.8774	C. Smith No. 1	Helderberg Group	Post Early Ordovician Paleozoic	cuttings
31-009-09235	New York	Cattaraugus	Alegany	42.00866	-78.56875	E.T.S. No. 1	Genudewa Limestone	indet.	cuttings
31-009-08610	New York	Cattaraugus	Otto	42.37142	-78.84315	Manning No. 1	Marcellus Shale	Middle Devonian	cuttings
31-011-11632	New York	Cayuga	Owasco	42.91694	-76.50542	Steinie No. 9	Marcellus Shale	Middle Devonian	cuttings
31-011-11632	New York	Cayuga	Owasco	42.91694	-76.50542	Steinie No. 9	Helderberg Group	Post Early Ordovician Paleozoic	cuttings
31-013-03200	New York	Chautauqua	Harmony	42.06821	-79.41556	Morse No. 1	Pipe Creek Shale; Rhinestreet Shale	Late Devonian	cuttings
31-013-03200	New York	Chautauqua	Harmony	42.06821	-79.41556	Morse No. 1	Moscow-Ludlowville	Post Early Ordovician Paleozoic	cuttings
31-013-04437	New York	Chautauqua	Elery	42.18421	-79.33785	Herrington No. 1	Genesee Group	Indet.	cuttings
31-015-00443	New York	Chemung	Van Etten	42.19857	-76.53807	Kesseling No. 1	Genesee Group	Indet.	cuttings
31-015-00443	New York	Chemung	Van Etten	42.19857	-76.53807	Kesseling No. 1	Genesee Group	Middle to Late Devonian	cuttings
31-015-00443	New York	Chemung	Van Etten	42.19857	-76.53807	Kesseling No. 1	Marcellus Shale	Middle Devonian	cuttings
31-017-01160	New York	Chenango	Columbus	42.69328	-75.34506	Lobdell No. 1	Skaneateles Formation	Middle Devonian	cuttings
31-017-01160	New York	Chenango	Columbus	42.69328	-75.34506	Lobdell No. 1	Marcellus Shale	Middle Devonian	cuttings
31-023-04714	New York	Corland	Freetown	42.51847	-76.00093	Clough No. 1	Marcellus Shale	Middle Devonian	cuttings
31-023-04714	New York	Corland	Freetown	42.51847	-76.00093	Clough No. 1	Helderberg Group	Late Silurian-Early Devonian	cuttings
31-029-11730	New York	Erie	Wales	42.71383	-78.51733	Foss No. 1	Marcellus Shale	Middle Devonian	cuttings
31-037-10776	New York	Genesee	Alexander	42.92045	-78.16734	Danby Belt No. 1	Ludlowville Formation	Post Early Ordovician Paleozoic	cuttings
31-037-10776	New York	Genesee	Alexander	42.92045	-78.16734	Danby Belt No. 1	Centerfield Limestone Member, Ludlowville Formation	Post Early Ordovician Paleozoic	cuttings
31-037-10776	New York	Genesee	Alexander	42.92045	-78.16734	Danby Belt No. 1	Marcellus Shale	Middle Devonian	cuttings
31-051-04069	New York	Livingston	York	42.87157	-77.93213	McDonald No. 1	Marcellus Shale	Middle Devonian	cuttings
31-051-04391	New York	Livingston	York	42.82758	-77.9356	J. Parnell	Genesee Group	Late Devonian	cuttings
31-051-04391	New York	Livingston	York	42.82758	-77.9356	J. Parnell	Marcellus Shale	Middle Devonian	cuttings
31-051-04630	New York	Livingston	Sparta	42.65023	-77.75596	Kennedy No. 1	Genudewa Limestone	Post Early Ordovician Paleozoic	cuttings
31-051-04630	New York	Livingston	Sparta	42.65023	-77.75596	Kennedy No. 1	Lodi Limestone	indet.	cuttings
31-051-04630	New York	Livingston	Sparta	42.65023	-77.75596	Kennedy No. 1	Genesee Shale	Middle Devonian	cuttings
31-051-04630	New York	Livingston	Sparta	42.65023	-77.75596	Kennedy No. 1	Marcellus Shale	Middle Devonian	cuttings
31-053-04032	New York	Madison	Brookfield	42.7963	-75.40464	Danisevich No. 1	Skaneateles Group	Devonian	cuttings
31-053-04032	New York	Madison	Brookfield	42.7963	-75.40464	Danisevich No. 1	Marcellus Shale	Middle Devonian	cuttings
31-067-11654	New York	Onondaga	Otisco	42.89831	-76.23852	Sears No. 1	Moscow Shale	Post Early Ordovician Paleozoic	cuttings
31-067-11654	New York	Onondaga	Otisco	42.89831	-76.23852	Sears No. 1	Skaneateles Group	indet.	cuttings
31-067-12163	New York	Onondaga	Marcellus	42.93688	-76.34586	Harrison No. 1	Marcellus Shale	Middle Devonian	cuttings
31-067-12163	New York	Onondaga	Marcellus	42.93688	-76.34586	Harrison No. 1	Cherry Valley Limestone	Post Early Ordovician Paleozoic	cuttings
31-069-06395	New York	Ontario	Gorham	42.81262	-77.20285	Frankish No. 1	Tichenor Limestone	indet.	cuttings
31-069-06395	New York	Ontario	Gorham	42.81262	-77.20285	Frankish No. 1	Marcellus Shale	Middle Devonian	cuttings
31-097-19692	New York	Schuyler	Reading	42.43251	-76.97039	L. Perigo No. 1	Lodi Limestone	Post Early Ordovician Paleozoic	cuttings
31-097-19692	New York	Schuyler	Reading	42.43251	-76.97039	L. Perigo No. 1	Genesee Shale	Post Early Ordovician Paleozoic	cuttings
31-097-19692	New York	Schuyler	Reading	42.43251	-76.97039	L. Perigo No. 1	Marcellus Shale	Middle Devonian	cuttings
31-099-04203	New York	Seneca	Fayette	42.8762	-76.85854	Schaffer No. 2	Marcellus Shale	Middle Devonian	cuttings
31-101-03924	New York	Steuben	Woodhull	43.06303	-77.43067	Olin No. 1	Genudewa Limestone	indet.	cuttings
31-101-03924	New York	Steuben	Woodhull	43.06303	-77.43067	Olin No. 1	Genesee Shale	indet.	cuttings
31-101-04573	New York	Steuben	Campbell	42.23546	-77.22256	Scudder No. 1	Genudewa Limestone	indet.	cuttings
31-101-04573	New York	Steuben	Campbell	42.23546	-77.22256	Scudder No. 1	Lodi Limestone	Post Early Ordovician Paleozoic	cuttings
31-101-04573	New York	Steuben	Campbell	42.23546	-77.22256	Scudder No. 1	Genesee Shale	indet.	cuttings
31-101-21468	New York	Steuben	Avoca	42.41958	-77.45354	Avoca No. 1	Lodi Limestone	indet.	cuttings
31-101-21468	New York	Steuben	Avoca	42.41958	-77.45354	Avoca No. 1	Marcellus Shale	Middle Devonian	cuttings
31-101-21468	New York	Steuben	Avoca	42.41958	-77.45354	Avoca No. 1	Genesee Shale	Post Early Ordovician Paleozoic	cuttings
31-109-10243	New York	Tompkins	Enfield	42.40099	-76.66854	R. Place No. 1	Marcellus Shale	Middle Devonian	cuttings
31-109-10243	New York	Tompkins	Enfield	42.40099	-76.66854	R. Place No. 1	Cherry Valley Limestone	indet.	cuttings
31-109-10243	New York	Tompkins	Enfield	42.40099	-76.66854	R. Place No. 1	Manlius Limestone	Paleozoic	cuttings
31-109-13173	New York	Tompkins	Lansing	42.52296	-76.5052	Cargill Cove Test No. 17	Lodi Limestone	Post Early Ordovician Paleozoic	core
31-121-22042	New York	Wyoming	Middlebury	42.82192	-78.09957	Titus Bros. No. 1	Genudewa Limestone	indet.	cuttings
31-121-22042	New York	Wyoming	Middlebury	42.82192	-78.09957	Titus Bros. No. 1	Lodi Limestone	Devonian	cuttings
31-121-22042	New York	Wyoming	Middlebury	42.82192	-78.09957	Titus Bros. No. 1	Marcellus Shale	Middle Devonian	cuttings
31-123-04796	New York	Yates	Benton	42.68333	-76.9779	Borglum No. 1	Genudewa Limestone	indet.	cuttings
31-123-04796	New York	Yates	Benton	42.68333	-76.9779	Borglum No. 1	Lodi Limestone	indet.	cuttings
31-123-04796	New York	Yates	Benton	42.68333	-76.9779	Borglum No. 1	Genesee Shale	Indet.	cuttings
31-123-04796	New York	Yates	Benton	42.68333	-76.9779	Borglum No. 1	Marcellus Shale	Middle Devonian	cuttings

Table 4. Thermal maturity data from Devonian samples from the subsurface of New York.

API NUMBER	INTERVAL	SAMPLE MASS (g)	USGS PALEONTOLOGY COLLECTION #	CAI min	CAI max	VTE	TOC	S1	S2	S3	Tmax	HI	OI	PI	% Ro (mean)	Readings for Ro	TAI
31-003-00354	1882'-1900'	18	12691-SD	2	2												
31-003-02681	1889'-1936'	122	12692-SD	1.5	1.5												
31-003-02681	1936'-1945'	28	12693-SD	2	2												
31-003-02681	1945'-1958'	39	12694-SD	2	2												
31-003-13549	2730.7'- 2731.5'	280	12695-SD	2	2.5												
31-003-13549	2731.9'						2.95	1.46	2.78	0.18	451	94	6	0.34	1.05	23	
31-003-13549	2732'-2732.3'	210	12696-SD	2	2.5												
31-003-13549	2867.8'- 2868.8'	2700	12697-SD	2	2.5												
31-007-05087	2530'-2650'						0.26	0.09	0.06	0.72	387	23	277	0.6	2.12	19	
31-007-06636	3235'-3460'	71	12698-SD	3	3												
31-009-09235	4160'-4200'	38															
31-009-08610	2650'-2660'						5.77	4.02	12.8	0.29	432	222	5	0.24	0.49	48	
31-011-11632	300'-350'						3.54	0.6	0.61	0.34	361	17	10	0.5	2.05	11	
31-011-11632	420'-450'	68	12699-SD	2.5	3												
31-013-03200	1971'-1983'; 2431'-2465'						4.35	2.19	13.12	0.4	445	302	9	0.14	0.67	30	
31-013-03200	2600'-2637'	146	12700-SD	2	2												
31-013-04437	2340'-2410'																
31-015-00443	659'-706'	103															
31-015-00443	836'-869'	133	12701-SD	3	3												
31-015-00443	2928'-2984'						6.98	1.23	0.87	0.78	374	12	11	0.59	1.5	10	
31-017-01160	338'-353'	109	12702-SD	3	3												
31-017-01160	1342'-1414'						2.19	0.41	0.58	0.24	505	26	11	0.41	1.89	37	
31-023-04714	2470'-2510'						2.11	0.13	0.14	0.24	511	7	11	0.48	1.99	8	
31-023-04714	2880'-2910'	107	12703-SD	2.5	3												
31-029-11730	1300'-1310'						4.86	3.2	6.73	0.5	434	138	10	0.32	0.5	38	
31-037-10776	70'-100'	101	12704-SD	2	2												
31-037-10776	140'-170'	104	12705-SD	1	1												
31-037-10776	350'-380'						5.7	1.82	10.78	0.43	436	189	8	0.14	0.45	30	
31-051-04069	405'-420'						11.05	6.48	29.04	0.56	429	263	5	0.18	0.53	27	
31-051-04391	156'-175'	113	12706-SD	2	2												
31-051-04391	706'-735'						6.6	3.58	15.69	0.41	435	238	6	0.19	0.78	29	
31-051-04630	260'-280'	35	12707-SD	2	2												
31-051-04630	280'-300'	53															
31-051-04630	330'-370'	71	12708-SD	2	2												
31-051-04630	900'-940'						6.24	3.71	9.69	0.48	433	155	8	0.28	0.54	34	
31-053-04032	140'-157'	137	12709-SD	2.5	2.5												
31-053-04032	963'-993'						1.71	0.34	0.23	0.3	392	13	18	0.6	0.82	27	
31-067-11654	110'-160'	134	12710-SD	2.5	3												
31-067-11654	260'-270'	124															
31-067-12163	400'-430'						6.3	0.53	0.81	0.36	558	13	6	0.4			
31-067-12163	430'-460'	81	12711-SD	1.5	1.5												
31-069-06395	310'-370'	103															
31-069-06395	780'-820'						1.77	0.72	0.93	0.43	446	53	24	0.44	0.76	15	
31-097-19692	1240'-1270'	160	12712-SD	3	3												
31-097-19692	12909'-1320'	101	12713-SD	3.5	3.5												
31-097-19692	2290'-2310'						5.77	0.39	0.89	0.27	504	15	5	0.3	0.96	7	
31-099-04203	50'-80'						1.72	0.28	0.19	0.31	437	11	18	0.51	1	11	
31-101-03924	3170'-3190'	6															
31-101-03924	3190'-3220'	21															
31-101-04573	2082'-2101'	66															
31-101-04573	2319'-2344'	66	12714-SD	3	3												
31-101-04573	2344'-2389'	104															
31-101-21468	2380'-2410'	122															
31-101-21468	3110'-3140'						1.57	0.55	0.56	0.21	459	36	13	0.5	0.77	2	
31-101-21468	2410'-2430'	106	12715-SD	2	3												
31-109-10243	2850'-2930'						0.58	0.08	0.4	0.15	348	17	26	0.44	1.37	4	
31-109-10243	2980'-3020'	57															
31-109-10243	3240'-3290'	74	12716-SD	3.5	4												
31-109-13173	33'-34'	1007	12717-SD	2.5	3												
31-121-22042	430'-460'	106															
31-121-22042	560'-600'	92	12718-SD	2	2												
31-121-22042	810'-840'						7.07	2.84	14.97	0.39	437	212	6	0.16	0.54	25	
31-123-04796	137'-175'	73															
31-123-04796	243'-264'	87															
31-123-04796	271'-308'	121															
31-123-04796	1051'-1095'						6.22	0.31	0.69	0.25	535	11	4	0.31	1.74	33	