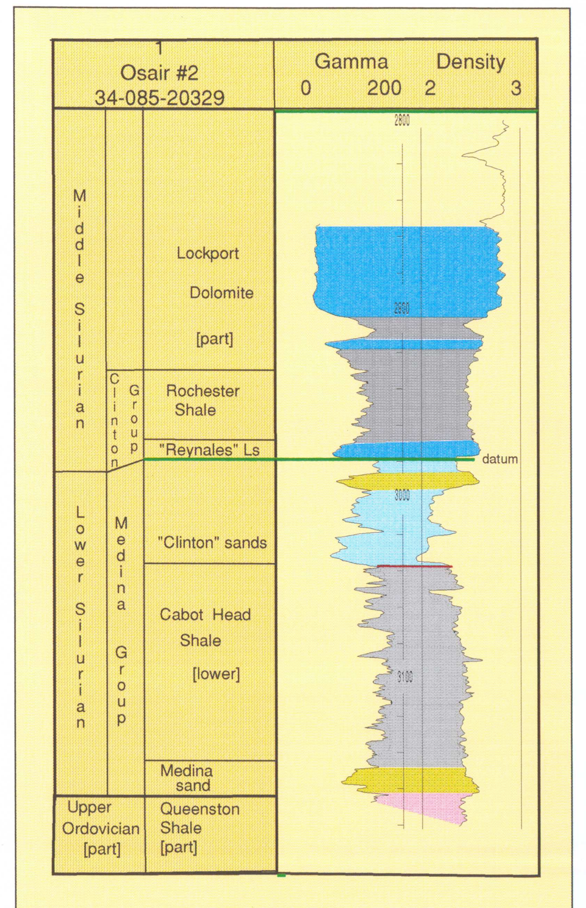
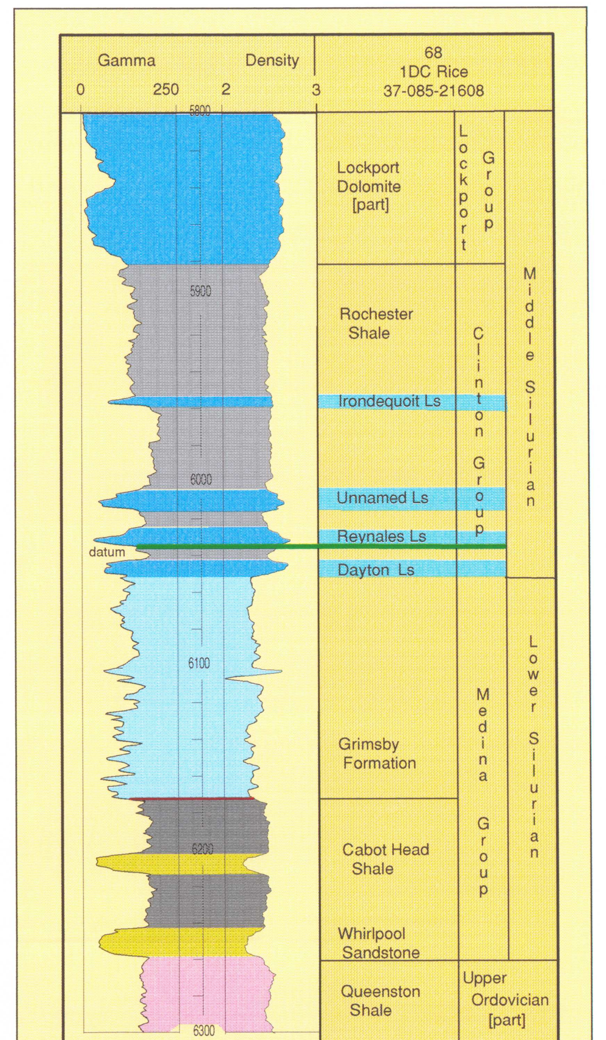
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT 98-500



Generalized stratigraphic section of strata in the Ohio portion of transect D-D'.

Preliminary cross-section of Middle and Lower Silurian strata along transect D-D'. Transect extends approximately 85 miles from Lake County, Ohio, to Butler County, Pennsylvania.



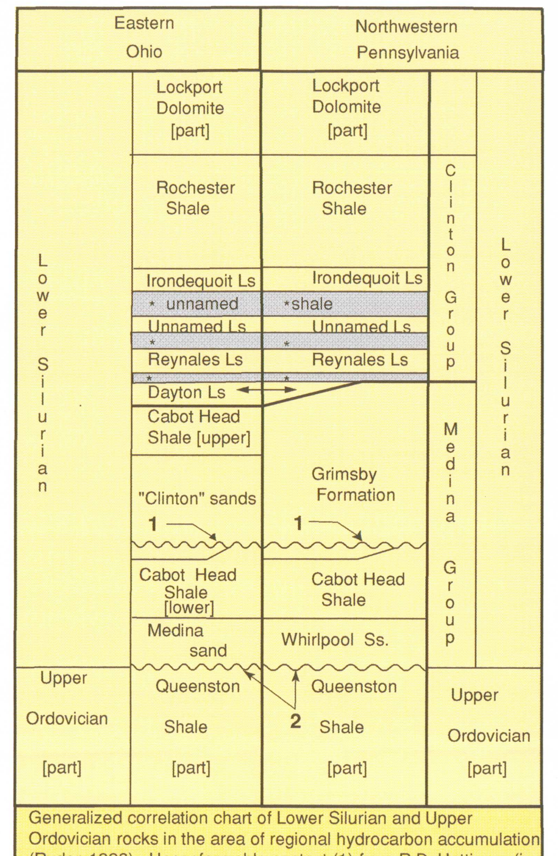
Introduction

The Appalachian basin contains significant quantities of recoverable natural gas in regionally extensive, continuous-type gas accumulations whose reservoirs consist of low-permeability sandstones of the Lower "Clinton" sands and Medina Group (Ryder, 1995). This report is part of a multi-year study to evaluate the nature, distribution, and origin of natural gas in the "Clinton" sand, Medina Group sandstones, and equivalent Tuscarora Sandstone. The transects help establish geologic controls of the regional "Clinton" and Medina gas-bearing strata, and refine the stratigraphic framework of these rocks across parts of New York, Pennsylvania, and Ohio. Transects B-B' through F-F' trend northwest-southeast, and are subparallel to the depositional strike of the Lower Silurian sandstone system. They cross, and are tied to, transect A-A' (in preparation, R. Ryder), a 425 mile-long, northeast-southwest trending transect which crosses New York, Pennsylvania, and Ohio, and is approximately subparallel to the depositional strike of the Lower Silurian sandstone system.

Subsurface cross-section D-D' was constructed through the Lower Silurian Niagaran Provincial Series, and a portion of the Upper Ordovician Queenston Shale (Cincinnatian) in Ohio and Pennsylvania to: a) illustrate the geometry of hydrocarbon-bearing sandstone reservoirs, and b) determine if stratigraphic controls affect hydrocarbon accumulation. The 85-mile long cross-section utilized geophysical logs from 71 wells, and was constructed along a northwest-southeast depositional dip-oriented transect.

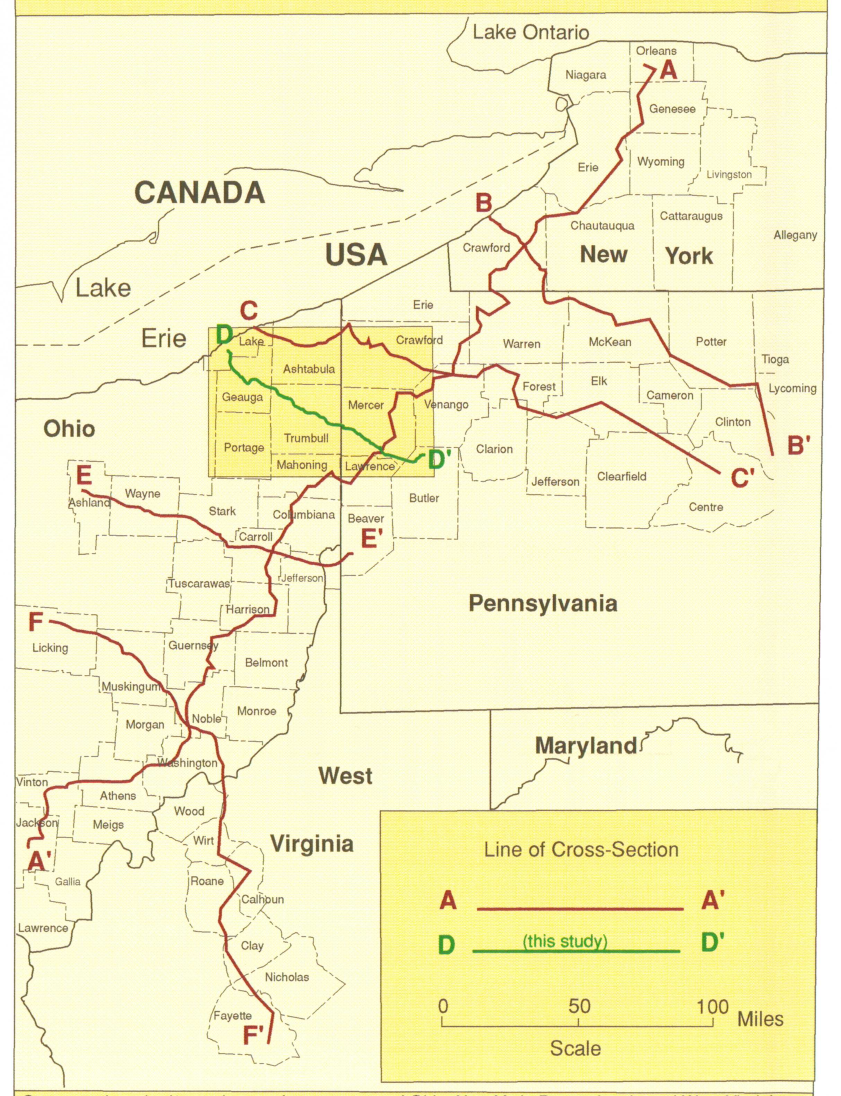
The study interval thins northwestward from about 380 feet in western Pennsylvania (Mercer and Butler Counties) to 235 feet in central Ohio (Lake County). The base of the interval unconformably overlies the Upper Ordovician Queenston Shale, and is defined by the 4- to 14-foot thick Whirlpool Sandstone/Medina sand which is interpreted as a shoreface and fluvial deposit. The overlying Cabot Head Shale is interpreted as a lower shoreface mudrock containing irregularly distributed upper shoreface sandstones. The Cabot Head is overlain conformably by shoreface sandstones of the lower part of the the Grimsby Formation (in Pennsylvania) and coeval deposits in the "Clinton" sands (in Ohio). Laterally discontinuous sandstone and mudrock in the upper part of the Grimsby and coeval "Clinton" are interpreted as deposits of fluvial and tidally influenced environments that rest unconformably on shoreface sandstone of the Grimsby/"Clinton" and mudrock of the Cabot Head. The top of the study interval contains several offshore carbonates, such as the Dayton and Reynales Limestones, separated by inner shelf mudrocks. The carbonate units coalesce to the northwest, and form a 15- to 20-foot thick unnamed limestone in Lake County, Ohio.

Facies dislocation along the transect may provide sequence stratigraphic interpretations for the "Clinton"/Medina interval in western Pennsylvania and northeastern Ohio. Perforated zones and initial production data are available from the wells (see table in this report).

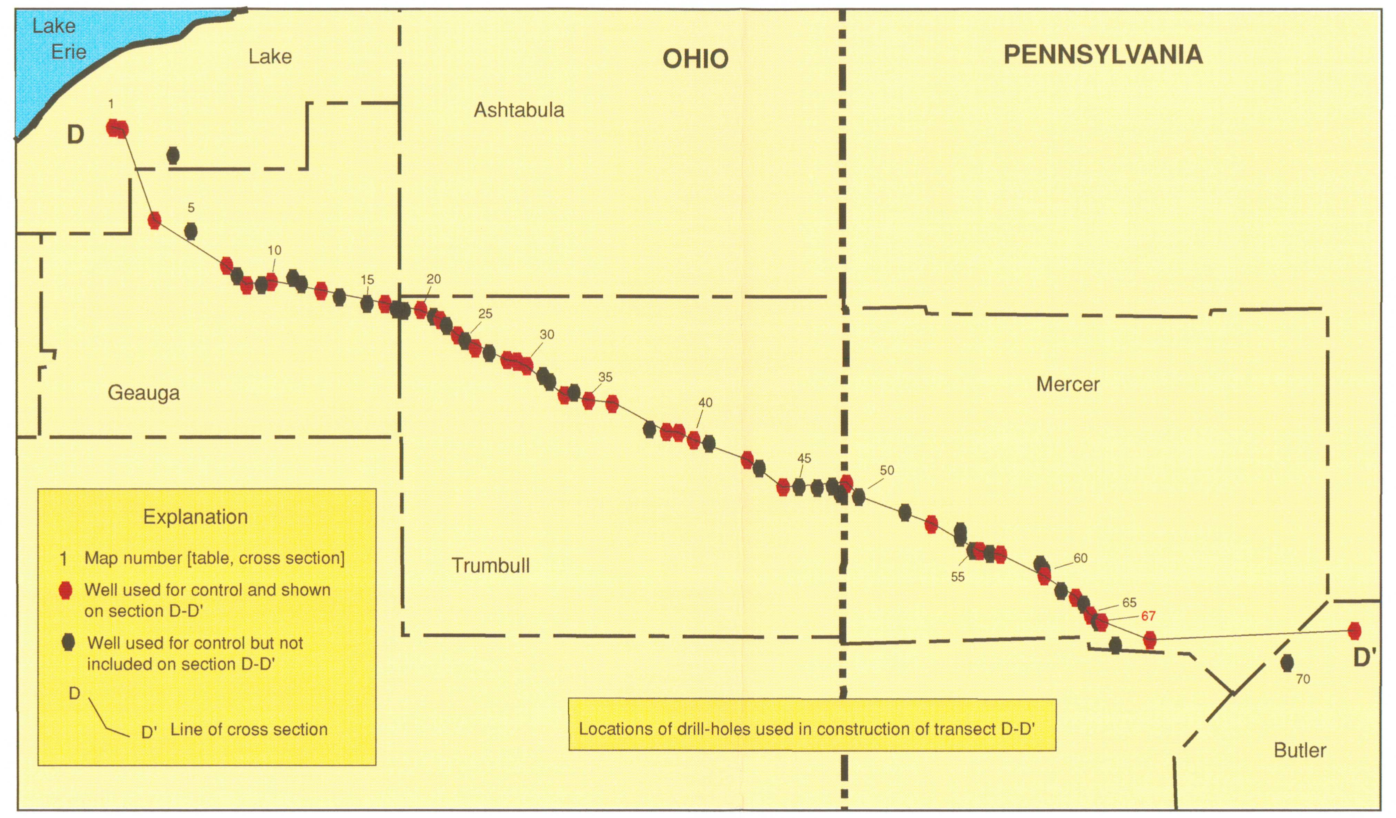


Generalized correlation chart of Lower Silurian and Upper Ordovician rocks in the area of regional hydrocarbon accumulation (Ryder, 1998). Unconformable contact (1) from R.D. Hettinger (in Ryder and others, 1996); (2) from Brett and others, 1995. Abbreviations: Ls = limestone; * = unnamed shale

Locations of Cross-Sections



Cross-sections (red/green) extend across parts of Ohio, New York, Pennsylvania and West Virginia. Cross-section A-A' extends 425 miles subparallel to depositional strike; the other sections extend 75-200 miles along depositioal dip. Investigations along cross-sections A-A', E-E', and F-F' are being conducted by R.T. Ryder (U.S. Geological Survey); B-B' and C-C' are in preparation by R.D. Hettinger (U.S. Geological Survey)



Locations of drill-holes used in construction of transect D-D'.

DEPOSITIONAL DIP-ORIENTED CROSS SECTION THROUGH THE LOWER SILURIAN "CLINTON" SANDS AND MEDINA GROUP IN NORTHEASTERN OHIO AND WESTERN PENNSYLVANIA

By

C. W. Keighin

1998

Map No.	Latitude	Longitude	API Number	Company	Lease	County/State	Township (7 1/2° Quad)	Log Date	Perf. Interval (ft)	Initial Prod. (IP)*	Reservoir(s)
1	41.68765	-81.31488	34-085-20329	Osair, Inc.	Osair #2	Lake/Ohio	Mentor	6/9/83	3014-3055	125	C
2	41.68597	-81.30516	34-085-20371	Osair, Inc	Shultz #2	Lake/Ohio	Mentor	6/16/83	3051-3099	150	C
3	41.65734	-81.24977	34-085-20245	Diamond Shamrock	Concord Fee #5	Lake/Ohio	Concord	5/3/78	3339-3412		C
4	41.58562	-81.27	34-055-21139	Bass Energy	#1 Tannerwood	Geauga/Ohio	Chardon	3/5/85	3826-3870	70	C
5	41.57507	-81.23142	34-055-21006	Park-Ohio Energy, Inc	#1 Soubusta-Sanborn	Geauga/Ohio	Chardon	11/12/84	3858-3915	155	C
6	41.5373	-81.1927	34-055-20881	Park-Ohio Energy, Inc.	Babcock-Hess RMII-2	Geauga/Ohio	Munson	11/7/84	3773-3826	125	C
7	41.52611	-81.17889	34-055-20468	Lomak Petroleum	#1 A. & G. Gollwitzer	Geauga/Ohio	Clairdon	10/8/83	3736-3782	160	C
8	41.51592	-81.16884	34-055-20528	Lomak Petroleum	A. First #2	Geauga/Ohio	Clairdon	10/3/83	3800-3844	157	C
9	41.5155	-81.15314	34-055-20408	Lomak Petroleum	First Unit #1	Geauga/Ohio	Clairdon	6/9/83	3863-3927	150	C
10	41.5206	-81.14347	34-055-21556	Langasco Energy	#1 Wilmot	Geauga/Ohio	Clairdon	12/4/88	3958-4033	21	C
11	41.52715	-81.12818	34-055-20525	Lomak Petroleum	Miller-Willson Unit #1	Geauga/Ohio	Clairdon	11/17/83	3918-3966	100	C
12	41.52369	-81.11883	34-055-20907	Carter Resources	Elder #1	Geauga/Ohio	Clairdon	8/28/84	3855-3962	100	C
13	41.51686	-81.10966	34-055-20351	Collins-McGregor	Peterson #2	Geauga/Ohio	Clairdon	6/7-82	3872-3932	150	C
14	41.51002	-81.08862	34-055-21016	Mutual Oil & Gas	#1 Haueter-Smallwood	Geauga/Ohio	Huntsburg	12/31/85	3834-3925	40 Nat; 120 AF	C
15	41.50359	-81.06777	34-055-20205	Energy Development	Eli J. Mast #2	Geauga/Ohio	Huntsburg	7/30/83	3840-3870	20	C
16	41.49554	-81.03856	34-055-20190	Energy Development	Miller #8	Geauga/Ohio	Middlefield	10/21/82	3828-3866	20	C
17	41.49611	-81.01974	34-055-20194	Resource Exploration	Alta Weaver #1	Geauga/Ohio	Middlefiedl	2/25/77	4155-4198[?]	30	C
18	41.49075	-81.00782	34-055-20238	Resource Exploration	S. & E. Erb #1	Geauga/Ohio	Middlefield	12/21/76	3884-3930	20	C
19	41.48815	-80.99784	34-155-22490	Gasearch	Freeman-Miller #2	Trumbull/Ohio	Mesopotamia	5/7/84	3880-3919	500	C
20	41.48984	-80.97973	34-155-22484	Gasearch	Snyder #4	Trumbull/Ohio	Mesopotamia	8/18/85	3799-3832	500	C
21	41.48187	-80.96641	34-155-22257	General Electric Energy	Detweiler #3	Trumbull/Ohio	Mesopotamia	11/25/82	3726-3828	500	C
22	41.47811	-80.96042	34-155-22180	General Electric/Gasearch	Easton-Detweiler #1	Trumbull/Ohio	Mesopotamia	8/20/82	3734-3752	300	C
23	41.47206	-80.9531	34-155-22174	Gasearch	D. & B. Miller Jr. #1	Trumbull/Ohio	Mesopotamia	9/11/82	3679-3713	500	C
24	41.46119	-80.94157	34-155-22885	Partners Petroleum	Kaufman #2	Trumbull/Ohio	Mesopotamia	4/15/87	3664-3710	105	C
25	41.45529	-80.932	34-155-23064	Langasco Energy	#1 Everage	Trumbull/Ohio	Mesopotamia	12/28/83	3642-3854	13	C
26	41.44716	-80.92136	34-155-23214	P & S Energy	#4 Arnold	Trumbull/Ohio	Mesopotamia	8/10/88	3728-3885	298	C, Ms
27	41.44172	-80.90654	34-155-23236	Langasco Energy	#4 L. Champa	Trumbull/Ohio	Mesopotamia	10/23/88	3748-3905	18	C
28	41.43557	-80.8859	34-155-22594	Lomak/Envirogas	H. Griffin #3	Trumbull/Ohio	Bloomfield	1/29/85	3754-3862	175	C
29	41.43326	-80.87618	34-155-22772	General Electric	Fenstermaker Unit #2	Trumbull/Ohio	Bloomfield	6/28/85	3781-3957	500	C, Ms
30	41.42859	-80.86626	34-155-21722	I.R.D. Corp/Exchequer Energy	A.P.J. & S.G.Sulek #3	Trumbull/Ohio	Bloomfield	3/15/81	3876-4026	1000	C, Ms
31	41.4173	-80.84915	34-155-22425	Clinton Oil Co.	E. Hillman Unit #1-742	Trumbull/Ohio	Bristol	1/30/84	3949-4028	100	C
32	41.41094	-80.84118	34-155-21925	Ohio Partners Oil Co.	Bowers #1	Trumbull/Ohio	Bristol	9/17/81	3956-3982	20	C
33	41.39608	-80.82522	34-155-22357	Clinton Oil Co.	J. Bolek #3-681	Trumbull/Ohio	Bristol	1/9/84	4043-4138	40	C
34	41.3982	-80.81398	34-155-20702	Flint Oil & Gas	Ralph E. Meacham #2083	Trumbuill/Ohio	Bristol	11/24/77	4024-4095	71	C
35	41.38947	-80.79944	34-155-21794	P.O.I. Energy	Restemeirer #1	Trumbull/Ohio	Mecca	3/30/81	4087-4183	125	C
36	41.38722	-80.77333	34-155-21651	Gasearch	Passell #2	Trumbull/Ohio	Mecca	7/22/81	4106-4146	500	C
37	41.35972	-80.73306	34-155-20744	Eastern Petroleum Services	Governor #1	Trumbull/Ohio	Mecca	8/4/78	4260-4356	300	C
38	41.3553	-80.71427	34-155-21454	Berea Oil & Gas	M. Brobst #2	Trumbull/Ohio	Mecca	7/21/81	4487-4513	12	C
39	41.35574	-80.7014	34-155-21622	Ohio Oil & Gas	O.L.M. #2	Trumbull/Ohio	Johnston	3/22/81	4430-4442	350	C
40	41.34848	-80.68502	34-155-21970	Ohio Oil & Gas	Wilson #1	Trumbiull/Ohio	Fowler	11/3/81	4526-4570	800	C
41	41.34333	-80.66944	34-155-21439	Ohio Oil & Gas	#2 Sigler	Trumbull/Ohio	Fowler	5/27/80	4560-4634	1000	C
42	41.32611	-80.62501	34-155-22218	General Electric	#9 Consumer	Trumbull/Ohio	Fowler	8/19/82	4559-4672	600	C
43	41.31697	-80.61179	34-155-21933	General Electric	#4 Consumer	Trumbull/Ohio	Hartford	11/2/81	4572-4628	425	C
44	41.29665	-80.58708	34-155-22187	Titan Energy	Jones #1	Trumbull/Ohio	Hartford	1/10/85	4833-4881	500	C
45	41.29694	-80.56778	34-155-21785	Berea Oil & Gas	Pucak-Johnson #1	Trumbull/Ohio	Hartford	8/22/81	4879-5031	50	C, Ms
46	41.29509	-80.55054	34-155-22197	Atlas Energy Group	B. Miller #1	Trumbull/Ohio	Hartford	6/18/82	4887-4947	168	C
47	41.29712	-80.53283	34-155-22470	Titan Energy	Whitmore Unit #2	Trumbull/Ohio	Hartford	2/1/84	4863-4918	400	C
48	41.28854	-80.52562	34-155-22405	Titan Energy	Moschillo Unit #1	Trumbull/Ohio	Hartford	1/19/84	4906-4988	600	C
49	41.30047	-80.51793	37-085-20408	Cyclops Corp.	Sump #2	Mercer/Pennsylvania	(Orangeville)	5/25/82	4800-4853	1400	M
50	41.28522	-80.50446	37-085-20409	Cyclops Corp.	Joseph Yasnowski #1	Mercer/Pennsylvania	(Orangeville)	5/16/82	4884-4922	1400	M
51	41.26944	-80.45338	37-085-20594	Mark Resources	McBurney #1	Mercer/Pennsylvania	(Sharpsville)	4/10/84	4872-5014	852	M
52	41.25602	-80.4626	37-085-20534	Mark Resources	Planchak #1	Mercer/Pennsylvania	(Sharpsville)	10/27/83	5179-5316	185	M, W
53	41.24778	-80.39306	37-085-20866	Atlas Resources	Cornman #1	Mercer/Pennsylvania	(Sharon East)	3/23/89	5215-5287	1020	M
54	41.2399	-80.39336	37-085-20591	Mark Resources	J. Hirschmann #1	Mercer/Pennsylvania	(Sharon East)	3/26/84	5251-5328	313	M
55	41.22571	-80.37936	37-085-20745	Haddad & Brooks	#5 E. Horvath	Mercer/Pennsylvania	(Sharon East)	11/10/85	5384-5448	980	M
56	41.22612	-80.37297	37-085-20670	Haddad & Brooks	Horvath-Johnson Unit #1	Mercer/Pennsylvania	(Greenfield)	12/8/84	5434-5563	500	M, W
57	41.22297	-80.36152	37-085-20655	Haddad & Brooks	E. Horvath #4	Mercer/Pennsylvania	(Greenfield)	11/29/84	5480-5532	600	M
58	41.22228	-80.35024	37-085-20721	Haddad & Brooks	#1 D. Root unit	Mercer/Pennsylvania	(Greenfield)	8/14/85	5556-5616	962	M
59	41.21111	-80.30722	37-085-21421	Atlas Resources	Hoagland #1	Mercer/Pennsylvania	(Greenfield)	3/7/92	5535-5608; 5680-5690	1090	M, W
60	41.20556	-80.30306	37-085-21407	Atlas Resources	Firth #1	Mercer/Pennsylvania	(Greenfield)	1/4/92	5506-5670; 5741-5748	980	M, W
61	41.19889	-80.30222	37-085-21556	Atlas Resources	Long #2	Mercer/Pennsylvania	(Greenfield)	10/29/92	5584-5642; 5716-5726	470	M, W
62	41.18278	-80.28472	37-085-21515	Atlas Resources	Hover #3	Mercer/Pennsylvania	(Greenfield)	7/13/92	5703-5760; 5842-5861	770	M, W
63	41.17556	-80.26861	37-085-21585	Atlas Resources	Fedorchak #1	Mercer/Pennsylvania	(Greenfield)	10/2/92	5815-5886; 5955-5965	80	M, W
64	41.16694	-80.26056	37-085-20390	Dorso Energy	Gideon Byler #4	Mercer/Pennsylvania	(Greenfield)	3/6/82	5961-5981	160 Nat; 819 AF	M
65	41.15556	-80.25333	37-085-21235	Capital Oil & Gas	#1 B. & Z. Cooper	Mercer/Pennsylvania	(Greenfield)	3/7/91	5830-5977	130	M, W
66	41.14861	-80.245	37-085-21218	Capital Oil & Gas	#2. K. Burke	Mercer/Pennsylvania	(Mercer)	2/20/91	5852	120	M, W
67	41.14861	-80.24083	37-085-21545	Capital Oil & Gas	#1 C. & E. Atkinson	Mercer/Pennsylvania	(Mercer)	3/4/93	5856-6000	120	M, W
68	41.12278	-80.22611	37-085-21608	Capital Oil & Gas	#1 D. & C. Rice	Mercer/Pennsylvania	(Mercer)	12/22/92	6101-6256	130	M
69	41.12917	-80.18803	37-085-21688	Atlas Resources	Brown #3A	Mercer/Pennsylvania	(Mercer)	1/30/93	6174-6250; 6314-6324	670	M, W
70	41.10358	-80.03939	37-019-90063	Manufacturers Light & Heat Co	Hockenberry #1	Butler/Pennsylvania	(Slippery Rock)	11/10/44	gas shows 9505-10; 9745-71		
71	41.13919	-79.96592	37-019-21313	Cabot Oil & Gas	Samuel Sherman #1	Butler/Pennsylvania	(Barkeyville)	12/29/87		250	M

Map No.
1. Used for control and shown on section D-D'
3. Used for control but not shown on section D-D'
67. Used for control, shown on section D-D', and ties with Ryder section A-A'

Table containing selected data relevant to drill holes used in construction of transect D-D'.

(IP)* MCFG
After Fracturing [unless noted]
Nat [Natural Flow]
M = Medina Group
W = Whirlpool Sandstone
C = "Clinton" sand
Ms = Medina sand

Selected References

Berry, W.B.N., and Boucot, A.J., 1973, Glacio-eustatic control of Late Ordovician-Early Silurian platform sedimentation and faunal change: Geological Society of America Bulletin, v. 84, p.275-284.

Brett, C.E., Goodman, W.M., and LoDuca, S.T., 1990, Sequences, cycles, and basin dynamics in the Silurian of the Appalachian Foreland Basin: Sedimentary Geology, v. 69, no. 3/4, p. 617-634.

Brett, C.E., Tepper, D.H., Goodman, W.M., LoDuca, S.T., and Eckert, Bea-Yeh, 1995, Revised stratigraphy and correlations of the Niagaran Provincial Series (Medina, Clinton, and Lockport Groups) in the type area of western New York: U.S. Geological Survey Bulletin 2086, 66 p.

Cotter, E., 1982, Tuscarora Formation of Pennsylvania: Society of Economic Paleontologists and Mineralogists Eastern Section 1982 Field trip guidebook, 105p.

Cotter, E., 1983, Shelf, paralic, and fluvial environments and eustatic sea level fluctuations in the origin of the Tuscarora Formation (Lower Silurian) of central Pennsylvania: Journal of Sedimentary Petrology, v. 53, no. 1, p. 25-49.

Duke, W.L., Fawcett, P.J., and Brusse, W.C., 1991, Prograding shoreline deposits in the Lower Silurian Medina Group, Ontario and New York: storm- and tide-influenced sedimentation in a shallow epicontinental sea, and the origin of enigmatic shore-normal channels encapsulated by open shallow-marine deposits, in Swift, D.J.P., Oertel, G.F., Tillman, R.W., and Thorne, R.W., eds., Shelf sand and sandstone bodies, The International Association of Sedimentologists Special Publication 14, p. 339-375.

Johnson, M.E., 1980, Paleoecolological structure in Early Silurian platform seas of the North American midcontinent: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 30, p. 191-216.

Knight, W.V., 1969, Historical and economic geology of Lower Silurian Clinton sandstone of northeastern Ohio: The American Association of Petroleum Geologists Bulletin, v. 53, no. 7, p. 1421-1452.

Laughrey, C.D., 1984, Petrology and reservoir characteristics of the Lower Silurian Medina Group sandstones, Athens and Geneva Fields, Crawford County, Pennsylvania: Commonwealth of Pennsylvania Department of Environmental Resources Office of Management, Bureau of Topography and Geological Survey Mineral Resource Report 85, 125 p.

McKerrow, W.S., 1979, Orodovician and Silurian changes in sea level: Geological Society of London Quarterly Journal, v. 136, p. 137-145.

Nelson, B.E., and Coogan, A.H., 1984, The Silurian Brassfield-Rochester Shale sequence in the subsurface of eastern Ohio: Northeastern Geology, v. 6, no. 1, p. 4-11.

Piotrowski, R.G., 1982, Geology and natural gas production of the Lower Silurian Medina Group and equivalent rock units in Pennsylvania: Commonwealth of Pennsylvania Department of Environmental Resources Office of Resource Management, Bureau of Topography and Geological Survey Mineral Resource Report 82, 21 p.

Ross, C.A., and Ross, J.R.P., 1996, Silurian sea-level fluctuations, in Witzke, B.J., Ludvigson, G.A., and Day, J., eds., Paleozoic Sequence Stratigraphy: Views from the North American Craton: Geological Society of America Special Publication 306, p. 187-192.

Ryder, R.T., 1995, Appalachian basin province (067), in Gautier, D.L., Dolton, G.L., Takahashi, K.I., and Varnes, K.L., eds., 1995 national assessment of United States oil and gas resources - Results, methodology, and supporting data: U.S. Geological Survey Digital Data Series DDS-30, 144 p., 28 figs.

Ryder, R.T., 1998, Characteristics of discrete and basin-centered parts of the Lower Silurian regional oil and gas accumulation, Appalachian basin: U.S. Geological Survey Open-File Report 98-216, 71p.

Ryder, R.T., Aggen, K.L., Hettinger, R.D., Law, B.E., Miller, J.J., Nuccio, V.F., Perry, W.J., Jr., Prensky, S.F., San Filipo, J.R., and Wandrey, C.J., 1996, Possible continuous-type (unconventional) gas accumulation in the Lower Silurian "Clinton" sands, Medina Group, and Tuscarora Sandstone in the Appalachian basin: A progress report of 1995 project activities: U.S. Geological Open File Report 96-42, 82 p.

Yeakel, L.S., Jr., 1962, Tuscarora, Juniata, and Bald Eagle paleocurrents and paleogeography in the central Appalachians: Geological Society of America Bulletin, v. 73, p. 1515-1540.

Zagorski, W.A., 1991, Models of local and regional hydrocarbon traps in the Lower Silurian Medina Sandstone Group Cooperstown gas field, Crawford and Venango Counties, Pennsylvania: unpublished M.S. thesis, University of Pittsburgh, 132 p.

Acknowledgments

I wish to thank all who assisted in gathering data and materials necessary for this investigation. Many of the logs used were located (and purchased from) Rileys Log, Inc.; some data were obtained from Mike Wallen, Cabot Oil. Much assistance in tracking down data was provided by the Ohio Division of Geological Survey, and the Pennsylvania Topographic and Geologic Survey. Craig Wandrey was essential in retrieving and plotting many data.

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards (or with the North American Stratigraphic Code). Any use of trade, product or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.