DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1267-D

WEED—OIL AND GAS RESOURCES OF OTTER CREEK WILDERNESS, W. VA.

STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas on Federal lands to determine their mineral resource potential. Results must be made available to the public and be submitted to the Administration and the Congress. This map presents an analysis of the oil and gas resources of Otter Creek Wilderness in the Monongahela National Forest, Randolph and Tucker Counties, West Virginia, which was established as a Wilderness by Public Law 93-622, January 3, 1975.

INTRODUCTION

The Otter Creek Wilderness comprises about 20,000 acres (an area about 8 mi long and 4 mi wide) in northeastern West Virginia northeast of Elkins (fig. 1). The wilderness lies in the Monongahela National Forest, is drained by Otter Creek, and includes parts of McGowan and Green Mountains.

STRATIGRAPHY

Paleozoic rocks of Late Devonian, Mississippian, and Pennsylvanian age crop out in the Otter Creek Wilderness and are overlain locally by Quaternary alluvium (Warlow, 1981). The subsurface stratigraphy in the vicinity of the wilderness (fig. 2) is interpreted from nearby deep wells (fig. 3, table 1) to include rocks of Ordovician, Silurian, and Early Devonian age. The oldest rocks penetrated by deep wells in Randolph and Tucker Counties belong to the Trenton Group of Middle Ordovician age (Cardwell, 1974). East of these counties, crystalline basement has been identified from seismic data (Jacobeen and Kanes, 1975) and, in eastern West Virginia, is thought to be overlain by limestones and dolomites of Cambrian and Early Ordovician age (Perry, 1964).

Principal stratigraphic units chosen for oil and gas exploration in the vicinity of the Otter Creek Wilderness are the Ordovician carbonate rocks, the Tuscarora Sandstone of Early Silurian age, the Lower Devonian Helderberg Group and overlying Oriskany Sandstone, and the Middle Devonian Huntersville Chert. Younger rocks in the vicinity of the wilderness (see fig. 2) have not produced oil and gas.

STRUCTURE

The Otter Creek Wilderness lies in the North Potomac syncline west of the Allegheny Front in the east-central part of the Appalachian basin. The syncline extends more than 100 miles from north of Hyndman, Bedford County, Pennsylvania, across western Maryland into Pocahontas County, West Virginia (Berryhill and others, 1956; Flint, 1965; Reger, 1931; Reger and others, 1923). It trends approximately N. 25° E. and, in West Virginia, plunges gently northeast. Dips of beds in the syncline range from almost flat in the trough to about 15° (Warlow, 1981). The wilderness is bordered by the Blackwater anticline on the east and the Deer Park anticline on the west (fig. 3). Locally the mountains and valleys reflect the anticlines and synclines.

Rodgers (1963) suggested that when these folds were formed, Devonian and Carboniferous strata slipped along a zone of décollement (a large nearly flat-lying thrust fault) in the Silurian evaporite deposits, leaving the subjacent Paleozoic rocks and the Proterozoic basement beneath undisturbed. Gwinn (1964) and Rodgers (1970) noted that the anticlines in the vicinity of Otter Creek Wilderness are unfaulted on the surface and highly faulted at intermediate depths. Harris and Milici (1977) showed that the décollement is controlled by contrasts in rock competency and is accompanied by ramping, splay faulting, and shattering of the more brittle rocks, which generate zones of fracture porosity. Milici (1980) showed that the relationship of the regional structure to oil and gas producing areas is different in different regions of the Appalachian basin, and that production in the vicinity of Otter Creek Wilderness is from wells in fractured anticlines.

Two types of lineaments occur in the Otter Creek Wilderness, structural lineaments and cross-strike structural discontinuities. The axes of the anticlines and synclines appear to be offset along a structural lineament (fig. 4) trending northwest-southeast across the wilderness along the Randolph-Tucker county line, roughly perpendicular to the trend of the North Potomac syncline. This lineament is discernible on a Landsat image of eastern West Virginia (West Virginia Geological and Economic Survey, 1976) and was earlier identified by Gwinn (1964) in his analysis of the mechanics of deformation of the Appalachian folds. This northwest-trending structural lineament may reflect tear faulting along the edge of advancing thrust blocks (Gwinn, 1964).

The second type of lineament is a cross-strike structural discontinuity (CSD), defined by Wheeler (1979) as a zone of structural disruption, but not a fault zone, containing unusually fractured rock and showing no evidence of basement involvement. Studies by Wheeler (1979) and Dixon (1979) confirm that two zones of structural disruption having patches of twice the normal joint intensity—the Parsons and Petersburg lineaments, each several kilometers wide and more than 50 km long—occur in the vicinity of the wilderness. These cross the regional structural strike and intersect near the Otter Creek Wilderness (fig. 4).

OIL AND GAS POTENTIAL

Consideration of the thermal maturity of the rocks, the rock permeability and porosity, and the production history were included in determining the oil and gas potential for the Otter Creek Wilderness.

The thermal maturity of the rocks, the extent to which rocks have been heated by depth of burial since deposition, is a factor controlling the volume of gas available from source beds and is considered an indicator of hydrocarbon potential. Results of two methods for determining thermal maturity—the fixed carbon ratio (White, 1915) and the conodont color alteration index (CAI)(Harris and others, 1978)—are available for northeastern West Virginia. White (1915) showed that oil and gas had not been found in the northern part of the Appalachian basin in rocks closely associated with coals having more than 65 percent fixed carbon, as do the coals of that specific part of the basin. Harris and others (1978), using conodont color alteration as an indicator of the thermal maturity, determined isograds for the Appalachian basin. Their maps indicate that oil production is not anticipated in the Otter Creek Wilderness because the rocks are too thermally altered; however, the thermal maturity of Ordovician and younger rocks in the wilderness is appropriate for the occeurrence of natural gas.

The presence of gas in reservoir rocks depends on adequate porosity and permeability. All production in the vicinity of the Otter Creek Wilderness has required stimulation of the wells by hydraulic fracturing to increase permeability. Compaction, which may be concommitant with thermal maturation, may have reduced the original porosity and permeability in the clastic rocks thus decreasing their reservoir capacity for gas. Faulting and fracturing associated with the décollement, the northwest trending lineament separating Blackwater and Glady anticlines, and the Parsons and Petersburg lineaments may have created structural traps having fracture porosity with potential for containing gas derived from local source beds. Furthermore, tectonically induced fractures may have increased permeability and become pathways for migration of gas into fracture reservoirs. Fractures may also, however, allow gas to escape from poorly sealed traps. Existing data is insufficient to determine the presence or absence of reservoirs in the wilderness.

Oil and gas occurrence and production from a representative sample of wells in the vicinity of the Otter Creek Wilderness are shown by the well records in table 1. About 2,000 ft of Upper Devonian and younger sandstone, shale, and siltstone are exposed in and near the wilderness. Because most of these beds crop out on the flanks of anticlines, it is likely that any gas that they might have originally contained has migrated to the atmosphere. Oil has not been produced and gas production has been limited chiefly to anticlines in rocks of Middle and Early Devonian and Silurian age, mostly from depths of 4,500 to 6,000 ft (Cardwell, 1974). Devonian formations that have yielded gas (table 1, fig. 2) include the Huntersville Chert, the Helderberg Group, and the Oriskany Sandstone. Gas has also been produced locally from the Tuscarora Sandstone of Silurian age (table 1, fig. 2).

Data from the post-Devonian rocks indicate no potential for oil production and little possibility of gas production in the Otter Creek Wilderness (de Witt, 1975). Data from about 6,000 ft of Devonian rocks, including about 1,000 ft of black shale, in the vicinity of the wilderness indicate gas shows and gas production in anticlines (de Witt and others, 1975). Data from a 2,000-ft thickness of Silurian rocks in the area show small gas production from the Tuscarora and indicate limited potential (de Witt and others, 1975). Data from the Upper and Middle Ordovician rocks, about 1,500 ft of carbonate rock and 3,000 ft of clastic rock in the vicinity of the wilderness, show no production and limited potential (Miller, 1975). Regional data suggests that the Lower Ordovician and Cambrian rocks may be about 6,000 ft in thickness in the vicinity of the wilderness, and crystalline basement may occur about 20,000 ft below sea level (Harris, 1975). No production is indicated for these rocks and their potential is unknown.

SUMMARY

The Otter Creek Wilderness shows no potential for oil production and a relatively low potential for gas production. Although local structure suggests the presence of splay and fracture zones having favorable fracture porosity, and recent exploration in similar structural settings in Pennsylvania has proven successful (Moser and Piotrowski, 1979), two recent exploration wells (Randolph 229 and 257) in a neighboring syncline were dry (Patchen and others, 1980). Source and reservoir rocks appear to be present, however maturation levels are high. Subsurface data are not available from within the wilderness, and data from nearby wells are insufficient to determine if structural traps exist at depth in the wilderness and if gas might be present in the traps. Seismic data are needed to determine if there are structural traps for oil and gas accumulation in the Otter Creek Wilderness, but presently available information suggests a very low oil and gas potential.

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Table 1.--*Representative wells near the Otter Creek Wilderness*

[Based on data from Cardwell (1974), Martens (1939), and from the Geological Sample Log Company and the West Virginia Geological and Economic Survey well records]

County and permit number	Operator-leasee and completion date	Altitude in feet (gl=ground level, kb=Kelly bushing)	Total depth in feet	Formations or lithologic zones (depths in feet)		Remarks (depths in feet, cf = cubic feet, M = thousand, MM = million)
Randolph-1	Potter Development Co. and others; Endress Hartman No. 1. Completed 9/1/32.	1960 gl	4480	Tully(?)	1037-1088	Dry. Gas show from Oriskany.
				Mahantango	1088-1200	
				Marcellus(?)	1200-1510	
				Huntersville	1510-1743	
				Oriskany	1743-1868	
				Helderberg	1868-2491	
				Tonoloway	2491-3175	
				Wills Creek	3175-3496	
				Williamsport	3496-3511	
				McKenzie	3511-3736	
				Keefer	3736-3750	
				Rose Hill	3750-4166	
				Tuscarora	4166-4480	
Randolph-3	Southern Pennsylvania Oil Co.; J. W. Isner No. 1. Completed 1/20/50.	1973 gl	6097	Huntersville	1480-1726	Dry. Fault with 1200 ft of repeated beds.
				Oriskany	1726-1876	
				Helderberg	1876-2550	
				Tonoloway	2550- ?	
				Fault		
				Huntersville repeated	3000-3058	
				Oriskany	3058-3188	
				Helderberg	3188-3813	
				Tonoloway	3813- ?	
				Wills Creek	? -4818	
				Williamsport	4818-4834	
				McKenzie	4834-5328	
				Keefer	5328-5348	
				Rose Hill	5348- ?	
Randolph-101	Columbian Carbon Co.; D. H. Hill-Arnold Consolidated No. 2. Completed 10/7/58.	2920 gl		Onondaga	4561-4630	Fractured. Glady field. Gas flow from Huntersville at 553 Mcf/day and Oriskany at 11,818 Mcf/day. Gas flow from Tuscarora at 1.6 MMcf/day. Acidized. Huntersville and Oriskany, final flow 2.1 MMcf/day. Shut in 7/12/60.
				Huntersville	4630-4770	
				Oriskany	4770-4954	
				Helderberg	4954	
-101D	Deepened; completed 1/19/60.		9815	Helderberg	-5540	
				Tonoloway	5540-6238	
				Wills Creek	6238-6534	
				Williamsport	6534-6557	
				McKenzie	6557-6727	
				Rose Hill	6727-7077	
				Tuscarora	7077-7815	
				Juniata	7815- ?	
				Fault	8715	
				Tuscarora	9035-9815	
Randolph-105	Columbian Carbon Co.; United States of America No. G-8. Completed 7/3/59.	3155 gl	6389	Onondaga	5632-5686	Fractured. Glady field. Gas flow from Huntersville chert at 2.2 MMcf/day. Gas show from Oriskany.
				Huntersville	5686-5895	
				Oriskany	5895-6336	
				Helderberg	6336-6389	
Randolph-106	Holly Oil & Gas Corp.; U.S.A. Department of Interior No. BW-1. Completed 6/21/59.	2258 gl	7053	Marcellus	6385-6570	Dry.
				Huntersville	6570-6838	
				Oriskany	6838-7046	
				Helderberg	7046-7053	
Randolph-110	Columbian Carbon Co., Julius Haddix et al No. 1. Completed 1/19/60.	3025 gl	6260	Tully(?)	5540-5550	Fractured. Glady field. Final gas flow from Huntersville and Oriskany at 569 Mcf/day.
				Onondaga	5830-5868	
				Huntersville	5868-6015	
				Oriskany	6015-6095	
				Helderberg	6095-6260	
Randolph-113	Barron Kidd (Hope Natural Gas Co.); C. C. & L. E. Riggleman No. 1. Completed 1/18/62.	1990 gl	3225	Marcellus	1945-2302	Dry.
				Onondaga	2302-2336	
				Huntersville	2336-2530	
				Oriskany	2530-2648	
				Helderberg	2648-3225	
Randolph-151	Consolidated Gas Supply Corp.; Union National Bank No. 11280. Completed 12/18/70.	2108 kb	5283	Onondaga	4964-4984	Dry. Well plugged.
				Huntersville	4984-5189	
				Oriskany	5189-5283	
Randolph-159	Eastern Operating; E. H. Cooper No. 1. Completed 9/14/77.	2192 kb	8060	Formations not reported, Oriskany	? -8060	Fractured and acidized. Huntersville and Oriskany, gas flow; details not reported. Well plugged.
Tucker-A	Parsons Pulp and Lumber Co. No. 1. Completed 1912.	1650 gl	4250	Huntersville	3825-3980	Dry.
				Oriskany	3980-4060	
				Helderberg	4060-4250	
Tucker-1	Ohio Oil Co.; West Virginia Power and Transmission No. 1. Completed 7/3/44.	3358 gl	8036	Pocono	top- ?	Gas discovery well. Canaan Valley field (Blackwater anticline). Gas flow from Oriskany at 1.5 MMcf/day.
				Hampshire	? -1975	
				Chemung	1975- ?	
				Tully	7320-7340	
				Mahantango	7340- ?	
				Marcellus	? -7820	
				Huntersville	7820-7968	
				Oriskany	7968-8036	
Tucker-8	Natural Resources Corp.; Tucker County Court No. 1. Completed 6/17/54.	1586 gl	5754	Tully(?)	4941-4953	Dry. Deer Park anticline. Gas show from shale at 521 ft.
				Mahantango	4953- ?	
				Marcellus	? -5334	
				Tioga	5334-5344	
				Onondaga	5344-5371	
				Huntersville	5371-5552	
				Oriskany	5552-5700	
				Helderberg	5700-5754	
Tucker-13	Columbian Carbon Co.; United States of America No. C-1. Completed 10/31/56.	1638 gl	6383	Tully	2915-2930	Dry. Deer Park anticline. Gas shows from Huntersville. Well plugged.
				Mahantango	2930- ?	
				Marcellus	?-3348	
				Tioga	3348-3352	
				Onondaga	3352-3375	
				Huntersville	3375-3540	
				Oriskany	3540-3650	
				Helderberg	3650-4251	
				Tonoloway	4251- ?	
				Fault	4370	
				Helderberg	4370-5208	
				Tonoloway	5208- ?	
				Wills Creek	?- ?	
				Williamsport	?-6383	
Tucker-15	Columbian Carbon Co.; United States of America No. D-1. Completed 12/10/55.	2073 gl	4509	Marcellus	? -4173	Dry. Leadmine field (Deer Park anticline). Gas pocket from brown shale at 3415 ft.
				Onondaga	4173-4224	
				Huntersville	4224-4374	
				Oriskany	4374-4486	
				Helderberg	4486-4509	
Tucker-35	United Producers Fund; Harr No. 1. Completed 5/13/70.	3325 kb	8552	Tully	7604- ?	Gas discovery well. Red Creek field (Blackwater anticline). Acidized. Gas flow from Tuscarora at 2.48 MMcf/day.
				Onondaga	8095-8145	
				Huntersville	8145-8205	
				Oriskany	8205-8450	
				Helderberg	8450-8552	
Tucker-38	Cities Service Oil Co.; L. E. Mullenax No. A-1. Completed 12/29/71.	1767 kb	6708	Tioga	3541-3571	Gas discovery well. Leadmine field (Deer Park anticline). Acidized. Gas flow from Tuscarora at 24.8 MMcf/day.
				Onondaga	3571-3594	
				Huntersville	3594-3740	
				Oriskany	3740-3860	
				Helderberg	3860-4455	
				Tonoloway	4455-4710	
				Wills Creek	4710-5040	
				Williamsport	5040-5210	
				McKenzie	5210-5472	
				Rose Hill	5472-6455	
				Tuscarora	6455-6708	
Tucker-40	Cities Service Oil Co.; A. Tennant No. A-1. Completed 8/20/72.	1834 kb	7395	Onondaga	3834-3860	Dry. Deer Park anticline.
				Huntersville	3860-4139	
				Oriskany	4139- ?	
				Rose Hill	6124-6669	
				Tuscarora	6669-7286	
				Juniata	7286-7395	
Tucker-41	Traverse Corp.; W. H. Wolford No. 1. Completed 2/07/74.	3671 kb	8770	Tully	7972- ?	Dry. Red Creek field (Blackwater anticline). Gas and salt water in Oriskany at 8750 ft; gas estimated at at 100 Mcf/day. Plugged.
				Onondaga	8466-8512	
				Huntersville	8512-8617	
				Oriskany	8617-8770	

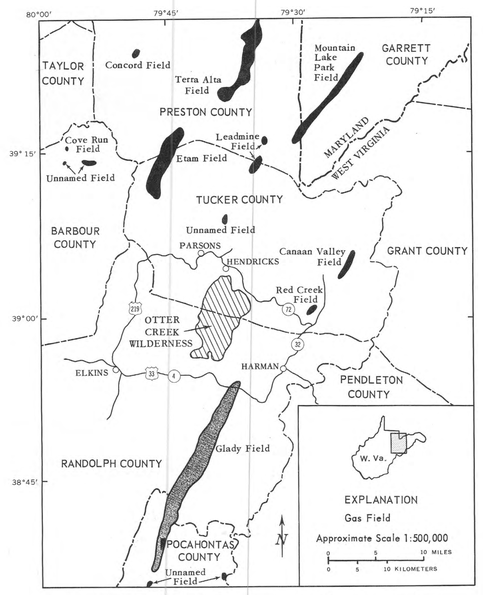

Figure 1.—Location of the Otter Creek Wilderness and nearby gas fields. Modified from Cardwell and others (1970).

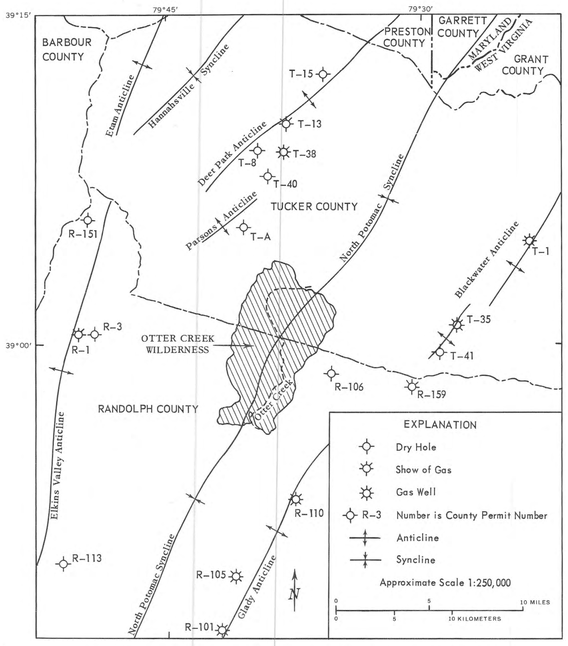

Figure 3.—Location of representative wells and anticlines and synclines near the Otter Creek Wilderness. Modified from Cardwell and others (1970) and Cardwell (1974).

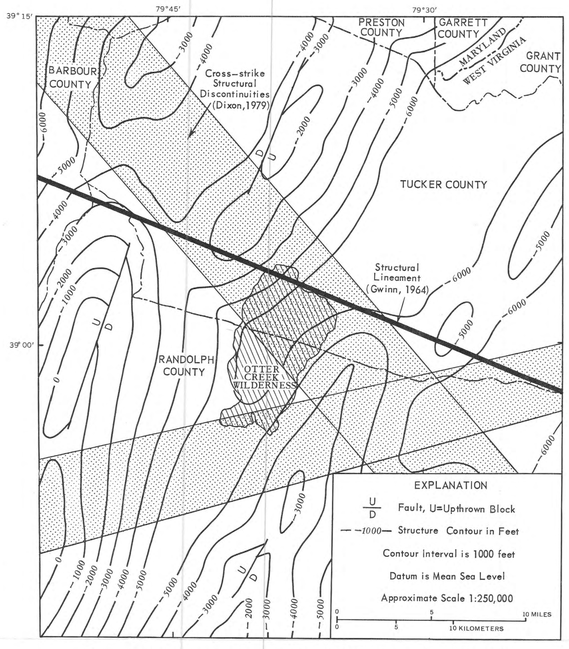

Figure 4.—Structure contour map on top of the Onondaga Limestone or its equivalents. Modified from Cardwell (1974).

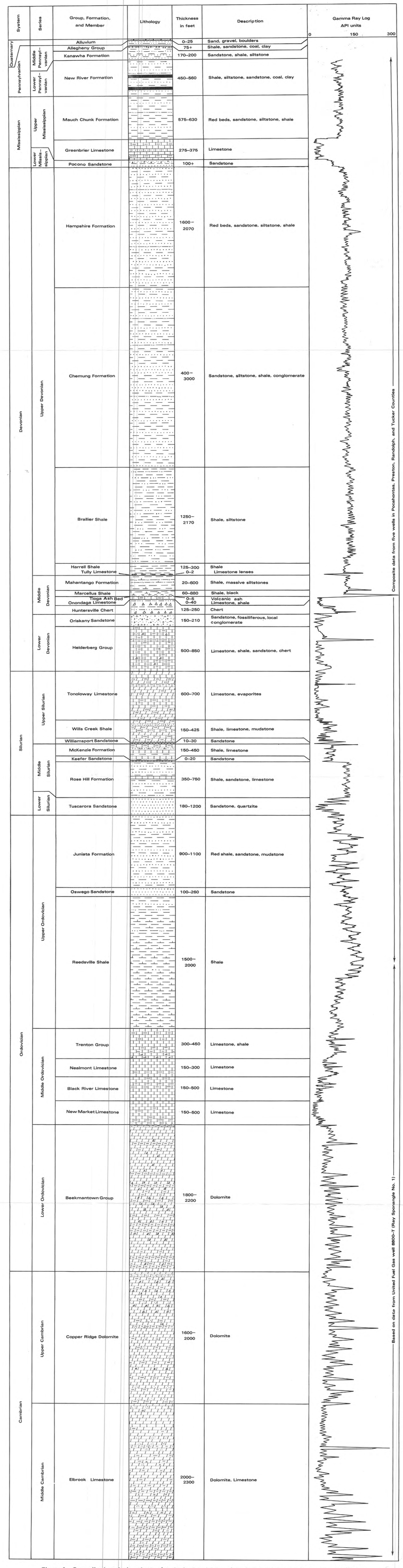

Figure 2.—Generalized geologic column of rocks in the vicinity of the Otter Creek Wilderness. The thicknesses given include the area near the Otter Creek Wilderness; the lithology is shown using average thickness estimated for the wilderness based on data from Avary (1979), Cardwell and others (1968), Martens (1939, 1945), Patchen (1968), Warlow (1981), and Geological Sample Log Company and West Virginia Geological and Economic Survey well records.

OIL AND GAS RESOURCES OF THE OTTER CREEK WILDERNESS, RANDOLPH AND TUCKER COUNTIES, WEST VIRGINIA

By
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