

Undiscovered Oil and Gas Resources Underlying the U.S. Portions of the Great Lakes, 2005

The U.S. Geological Survey recently completed allocations of oil and gas resources underlying the U.S. portions of the Great Lakes. These allocations were developed from the oil and gas assessments of the U.S. portions of the Appalachian Basin and the Michigan Basin. With the completion of the assessments of these two basins, the following quantities of undiscovered, technically recoverable oil and gas resources were allocated to the U.S. portions of the Great Lakes: (1) a mean value of 312 million barrels of oil, (2) a mean value of 5.2 trillion cubic feet of natural gas, and (3) a mean value of 122 million barrels of natural gas liquids.

Introduction

The U.S. Geological Survey (USGS) completed an assessment of the undiscovered oil and gas potential of the U.S. portions of the Appalachian Basin and the Michigan Basin in 2002 and 2004, respectively. Following the assessments of these two basins, oil and gas allocations were assigned to the U.S. portions of the Great Lakes (fig. 1) — Lake Superior (Michigan, Minnesota, and Wisconsin), Lake Michigan (Illinois, Indiana, Michigan, and Wisconsin), Lake Huron (Michigan), Lake Erie (Michigan, New York, Ohio, and Pennsylvania), and Lake Ontario (New York). Allocations for Lake St. Clair (Michigan) were included with those of Lake Erie.

The allocations are based on the geologic elements of each total petroleum system (TPS) defined in the region and the projected extent of those elements from onshore beneath each of the lakes. These geologic elements include the hydrocarbon source rocks, reservoir rocks, and traps. By using this geologic framework, the USGS defined 8 total petroleum systems and 21 assessment units (AUs) within the Great Lakes and estimated the quantity of undiscovered technically recoverable oil and gas resources within 16 of the 21 AUs in the Great Lakes (table 1).

Total Petroleum Systems

The eight total petroleum systems identified in the U.S. portions of the Great Lakes are the (1) Precambrian Nonesuch TPS, (2) Ordovician Foster TPS, (3) [Ordovician] Utica-Lower Paleozoic TPS, (4) Ordovician to Devonian Composite TPS, (5) Silurian Niagara/Salina TPS, (6) Devonian Antrim TPS, (7) Devonian Shale-Middle and Upper Paleozoic TPS, and (8) Pennsylvanian Saginaw TPS. Each TPS is named according to the petroleum source rock(s) of that system. For most of the systems, each TPS is associated with only one source rock. The Ordovician to Devonian Composite TPS, however, is a composite petroleum system having contributions from one or more of the following different source rocks: Ordovician Collingwood Shale, Devonian Detroit River Group, and Devonian Antrim Shale.

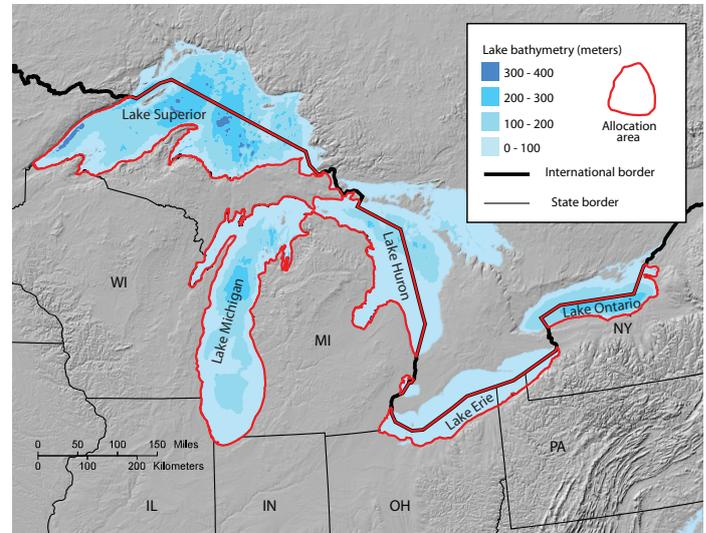


Figure 1. Map showing the allocated areas (U.S. portions) of the Great Lakes. Allocation areas do not include islands within the lakes.

Assessment Units

Of the AUs, 13 are characterized as conventional oil and gas accumulations, and 8 are characterized as continuous (unconventional) accumulations. The 13 conventional AUs (and associated basins) are as follows:

1. Devonian to Mississippian Berea/Michigan Sandstones AU (Michigan Basin);
2. Middle Devonian Carbonates AU, which includes the Detroit River Group, Dundee Limestone, and Traverse Group (Michigan Basin);
3. [Devonian] Oriskany Sandstone-Stratigraphic AU (Appalachian Basin);
4. Devonian Sylvania Sandstone AU (Michigan Basin);
5. [Silurian] Lockport Dolomite AU (Appalachian Basin);
6. Silurian A-1 Carbonate AU (Michigan Basin);
7. Silurian Niagara AU (Michigan Basin);
8. Silurian Burnt Bluff AU (Michigan Basin);
9. [Ordovician] Black River-Trenton Hydrothermal Dolomite AU (Appalachian Basin);
10. Ordovician Trenton/Black River AU (Michigan Basin);
11. [Ordovician] Knox Unconformity AU (Appalachian Basin);
12. Ordovician Sandstones and Carbonates AU, which includes the Prairie du Chien Group, St. Peter Sandstone, Glenwood Formation, and equivalent stratigraphic units (Michigan Basin); and
13. Precambrian Nonesuch AU (Michigan Basin).

All these conventional AUs were assessed quantitatively, except for the Precambrian Nonesuch AU, which lacked sufficient data to assess quantitatively.

Table 1. Great Lakes oil and gas resource allocations by total petroleum system and assessment unit.

[All tabulated results are for technically recoverable resources. MMBO is million barrels of oil. BCFG is billion cubic feet of gas. MMBNGL is million barrels of natural gas liquids. Results shown are fully risked estimates. For gas fields, all liquids are included under the NGL (natural gas liquids) category. F95 represents a 95-percent chance of at least the amount tabulated. Other fractiles are defined similarly. Fractiles are additive under the assumption of perfect positive correlation. TPS is total petroleum system. AU is assessment unit. Gray shade indicates not applicable or not assessed quantitatively]

Resource type	Total petroleum systems	Assessment units	Lake	State	Field type	Total undiscovered resources														
						Oil (MMBO)						Gas (BCFG)						NGL (MMBNGL)		
						F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5
Devonian Shale-Middle and Upper Paleozoic TPS	Devonian to Silurian Niagara/Salina TPS	Oriskany Sandstone-Stratigraphic AU	Lake Erie	Ohio	Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
			Lake Erie	Pennsylvania	Gas	0.00	0.00	0.00	0.00	9.31	31.89	77.29	36.06	0.07	0.25	0.65	0.29	0.00	0.00	
			Lake Erie		Gas	0.00	0.00	0.00	0.00	4.31	14.55	34.71	16.41	0.03	0.11	0.29	0.13	0.00	0.00	
			Lake Erie	Michigan	Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
			Lake Erie	Michigan	Oil	0.28	3.34	11.09	4.21	0.54	6.66	23.60	8.65	0.04	0.50	1.90	0.68	0.00	0.00	
			Lake Michigan	Michigan	Oil	38.86	90.59	163.97	94.74	72.90	181.49	362.23	194.89	5.20	13.78	30.16	15.22	0.00	0.00	
			Lake Michigan	Michigan	Gas					117.27	273.60	507.52	287.74	6.82	17.13	34.58	18.42	0.00	0.00	
			Lake Michigan	Wisconsin	Oil	0.01	0.17	0.56	0.21	0.03	0.33	1.18	0.44	0.00	0.03	0.10	0.03	0.00	0.00	
			Lake Huron	Michigan	Oil	32.31	75.55	144.54	80.23	60.77	151.61	315.02	165.05	4.35	11.54	26.09	12.89	0.00	0.00	
			Lake Erie	Michigan	Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
			Lake Huron	Michigan	Gas	1.88	4.76	9.33	5.01	0.85	2.28	4.96	2.50	0.03	0.09	0.21	0.10	0.00	0.00	
			Lake Erie	Michigan	Gas	0.00	0.00	0.00	0.00	10.80	30.06	63.47	32.75	0.40	1.18	2.68	1.31	0.00	0.00	
			Lake Michigan	Illinois	Oil	0.00	0.02	0.08	0.03	0.00	0.00	0.01	0.04	0.01	0.00	0.00	0.00	0.00	0.00	
			Lake Michigan	Indiana	Oil	0.00	0.07	0.32	0.10	0.00	0.00	0.03	0.16	0.05	0.00	0.00	0.01	0.00	0.00	
Lake Michigan	Michigan	Oil	2.26	10.91	37.08	14.13	1.07	5.33	18.96	7.05	0.08	0.42	1.56	0.56	0.00	0.00				
Lake Michigan	Wisconsin	Oil	0.04	0.68	3.16	1.02	0.02	0.33	1.60	0.51	0.00	0.03	0.13	0.04	0.00	0.00				
Lake Huron	Michigan	Oil	6.03	26.17	69.62	30.51	2.84	12.71	36.08	15.21	0.21	0.99	3.00	1.22	0.00	0.00				
Lake Huron	Michigan	Gas					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Lake Huron	Michigan	Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Lake Michigan	Illinois	Gas	0.00	0.00	0.00	0.00	1.36	6.89	26.03	9.37	0.03	0.13	0.53	0.19	0.00	0.00				
Lake Michigan	Michigan	Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.22	0.08	0.00	0.00	0.00	0.00	0.00				
Lake Michigan	Wisconsin	Oil	0.00	0.00	0.00	0.00	3.86	13.32	35.21	15.60	0.07	0.26	0.73	0.31	0.00	0.00				
Lake Huron	Michigan	Gas	0.00	0.00	0.00	0.00	0.12	1.61	6.54	2.24	0.00	0.03	0.13	0.04	0.00	0.00				
Lake Huron	Michigan	Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Lake Erie	Ohio	Oil	0.79	11.41	47.98	16.16	4.67	16.34	45.02	19.43	0.09	0.32	0.93	0.39	0.00	0.00				
Lake Erie	Michigan	Gas	0.78	11.35	48.54	16.18	0.58	8.41	38.31	12.51	0.01	0.16	0.79	0.25	0.00	0.00				
Lake Michigan	Illinois	Oil	0.03	0.51	2.13	0.72	0.07	0.99	4.40	1.45	0.00	0.07	0.31	0.10	0.00	0.00				
Lake Michigan	Indiana	Oil	0.03	0.51	2.15	0.72	0.07	0.99	4.40	1.44	0.00	0.07	0.32	0.10	0.00	0.00				
Lake Michigan	Michigan	Gas					0.02	0.38	1.70	0.55	0.00	0.01	0.04	0.01	0.00	0.00				

Additional oil and gas resources

The eight continuous AUs (and associated basins) are as follows:

1. Pennsylvanian Saginaw Coal Bed Gas AU (Michigan Basin),
2. [Devonian] Northwestern Ohio Shale AU (Appalachian Basin),
3. [Devonian] Marcellus Shale AU (Appalachian Basin),
4. Devonian Antrim Continuous Gas AU (Michigan Basin),
5. Devonian Antrim Continuous Oil AU (Michigan Basin),
6. [Silurian] Clinton-Medina Transitional AU (Appalachian Basin),
7. [Ordovician] Utica Shale Gas AU (Appalachian Basin), and
8. Ordovician Collingwood Shale Gas AU (Michigan Basin).

Of these eight continuous AUs, only the following four AUs were assessed quantitatively: [Silurian] Clinton-Medina Transitional AU, Devonian Antrim Continuous Gas AU, [Devonian] Marcellus Shale AU, and [Devonian] Northwestern Ohio Shale AU. The other four continuous AUs lacked sufficient data to assess quantitatively.

Resource Summary

For the U.S. portions of the Great Lakes, the USGS estimated the following quantities of undiscovered, technically recoverable oil and gas resources (table 1):

1. a mean value of 312 million barrels of oil,
2. a mean value of 5.2 trillion cubic feet of natural gas, and
3. a mean value of 122 million barrels of natural gas liquids.

These estimates are mean estimates. The ranges of uncertainty of these estimates are shown in table 1.

Oil and Gas Resource Allocations by Lake

Allocated oil and gas resources were compiled for each of the Great Lakes (tables 1 and 2). The only identified petroleum system beneath Lake Superior is the Precambrian Nonesuch TPS, which lacked sufficient data to assess quantitatively.

Oil and Gas Resource Allocations by State

Allocated oil and gas resources were compiled for each of the Great Lakes States (tables 1 and 3). The only identified petroleum system in the Minnesota portion of the Great Lakes is the Precambrian Nonesuch TPS, which lacked sufficient data to assess quantitatively.

Additional Information

Supporting geologic studies of the U.S. portions of the Great Lakes total petroleum systems, assessment units, and allocations are in progress. The results of this work, as well as information on the assessment methodology, are posted on the USGS Web site at <http://energy.cr.usgs.gov/oilgas/noga> as they become available. Assessment results for undiscovered oil and gas resources of the U.S. portions of the Appalachian and Michigan Basins may be found online at <http://pubs.usgs.gov/fs/fs-009-03> and <http://pubs.usgs.gov/fs/2005/3070/>, respectively.

Table 2. Summary of mean values of Great Lakes oil and gas resource allocations by lake.

[Compiled from table 1, which contains the full range of statistical values]

Lake	Total undiscovered resources		
	Oil (million barrels), mean	Gas (trillion cubic feet), mean	Natural gas liquids (million barrels), mean
Lake Erie	46.10	3.013	40.68
Lake Huron	141.02	0.797	42.49
Lake Michigan	124.59	1.308	37.40
Lake Ontario	0.00	0.112	1.12
Lake Superior	not assessed quantitatively		
Total	311.71	5.23	121.69

Table 3. Summary of mean values of Great Lakes oil and gas resource allocations by State.

[Compiled from table 1, which contains the full range of statistical values]

State	Total undiscovered resources		
	Oil (million barrels), mean	Gas (trillion cubic feet), mean	Natural gas liquids (million barrels), mean
Illinois	0.75	0.003	0.14
Indiana	0.82	0.003	0.14
Michigan	282.48	2.157	83.27
Minnesota	not assessed quantitatively		
New York	0.00	0.564	6.49
Ohio	25.71	1.942	24.72
Pennsylvania	0.00	0.552	6.58
Wisconsin	1.95	0.008	0.34
Total	311.71	5.229	121.68

By James L. Coleman, Christopher S. Swezey, Robert T. Ryder, and Ronald R. Charpentier

Great Lakes Review Team

James L. Coleman (Co-Task Leader; jlcoleman@usgs.gov), Christopher S. Swezey (Co-Task Leader; cswezey@usgs.gov), Robert T. Ryder (Co-Task Leader; rryder@usgs.gov), Ronald R. Charpentier, Robert C. Milici, Joseph R. Hatch, Troy A. Cook, Timothy R. Klett, Richard M. Pollastro, Christopher J. Schenk, and James W. Schmoker.