

Chapter 1
**Executive Summary—Petroleum
Systems and Geologic Assessment of
Undiscovered Hydrocarbon Resources
of the Western Oregon and Washington
Province**



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Chapter 1 of 4
**Geologic Assessment of Undiscovered Hydrocarbon Resources
of the Western Oregon and Washington Province**

By U.S. Geological Survey Western Oregon and Washington Province Assessment Team

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Using a geology-based assessment methodology, the U.S. Geological Survey estimated mean volumes of 2.2 trillion cubic feet (TCF) of undiscovered natural gas and 15 million barrels of oil (MMBO) in the Western Oregon and Washington Province. More than 67 percent, or 1.5 TCF, of the undiscovered natural gas is continuous accumulations of coalbed gas in Tertiary coals in western Oregon and Washington.

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Introduction

The U.S. Geological Survey (USGS) recently completed an assessment of the undiscovered, technically recoverable oil and gas resources of the Western Oregon and Washington Province (fig. 1) (Brownfield and others, 2008). The province includes all of Oregon and Washington north of the Klamath Mountains and west of the crest of the Cascade Range, and extends offshore to the 3-mi limit of State waters on the west and to the International Boundary in the Straits of Juan de Fuca and Canada on the north. It measures about 450 mi north–south and 50 to 160 mi east–west, encompassing more than 51,000 mi² (fig. 1).

The assessment of the Western Oregon and Washington Province is geology based and used the total petroleum system (TPS) concept. The geologic elements of a TPS include hydrocarbon source rocks (source rock maturation and hydrocarbon generation and migration), reservoir rocks (quality and distribution), and traps for hydrocarbon accumulation. Using these geologic criteria, two conventional and one unconventional (continuous) total petroleum systems were defined, with one assessment unit (AU) in each TPS: (1) the Cretaceous-Tertiary Composite TPS and the Western Oregon and Washington Conventional Gas AU, (2) the Tertiary Marine TPS and the Tertiary-Marine Gas AU, and (3) the Tertiary Coalbed Gas TPS and the Eocene Coalbed Gas AU, in which a cell-based methodology was used to estimate coalbed-gas resources.

The province (fig. 1) occupies a complex geologic setting along the northwest continental margin of North America. Some 5,000 ft to more than 23,000 ft of Paleogene volcanic rocks, marine mudstone and arkosic and lithic sandstone, and nonmarine arkosic and lithic sandstone, mudstone,

carbonaceous shale, and coal are present in western Oregon and Washington; these rocks include potentially mature source rocks and reservoir rocks.

Before 1979, the only oil and gas production was in the Washington part of the province. Small amounts of gas were produced from the Paleogene Chuckanut Formation below Quaternary gravels near Bellingham (fig. 1), and about 12,000 barrels of oil and associated gas were produced near Grays Harbor from 1957 to 1961 (fig. 1) from the upper Oligocene to middle Miocene Hoh Formation (McFarland, 1983). Currently, the only hydrocarbon production within the province is from the Mist gas field discovered in May 1979 in northwestern Oregon (fig. 1). The Mist field has produced about 65 billion cubic feet of gas (BCFG) through 2008 from reservoirs in the upper part of the Eocene Cowlitz Formation.

Resource Summary

The USGS assessed both undiscovered technically recoverable conventional oil and gas and continuous (unconventional) coalbed gas in the Western Oregon and Washington Province (table 1), resulting in an estimated total mean of 2.2 trillion cubic feet of gas (TCFG) and a mean of 15 million barrels of oil (MMBO). More than 67 percent of the total mean gas (1.5 TCFG) is contained within the hypothetical Eocene Coalbed Gas AU, which encompasses an area of more than 11 million acres. In this continuous AU, the Eocene coals, such as the coal-bearing Eocene Coaledo Formation (fig. 2), serve as both the source rock and reservoir. Mean volumes were estimated at 454 BCFG for the Western Oregon-Washington Conventional Gas AU and 15 MMBO of conventional oil and



Figure 1. Map showing the Western Oregon and Washington Province located in western Oregon and Washington; boundary is shown in red. Cretaceous-Tertiary Composite Total Petroleum System (TPS) is shown in orange. Tertiary Coalbed Gas TPS is shown in dark blue. Tertiary Marine TPS shown in dark green. Eastern Oregon and Washington Province boundary is shown in yellow (Brownfield and others, 2006; Brownfield, 2008). Location of the Coos Bay coal field shown as a solid brown oval and the Mist gas field shown as a solid red circle.

Table 1. Western Oregon and Washington Province assessment results.

[MMBO, million barrels of oil; BCFG, billion cubic feet of gas; MMBNGL, million barrels of natural gas liquids. Results shown are fully risked estimates. For gas accumulations, all liquids are included as the NGL (natural gas liquids). Undiscovered gas resources are the sum of nonassociated and associated gas. F95 represents a 95 percent chance of at least the amount tabulated; other fractiles are defined similarly. TPS, total petroleum system; AU, assessment unit; CBG, coalbed gas. Gray shading indicates not applicable]

Total Petroleum System (TPS) and Assessment Unit (AU)		Field Type	Total Undiscovered Resources											
			Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Conventional Resources														
Cretaceous-Tertiary Composite TPS														
Western Oregon and Washington Conventional Gas AU	<i>Oil</i>	0	0	0	0	0	0	0	0	0	0	0	0	
	<i>Gas</i>					79	403	1,000	454	0	1	2	1	
Tertiary Marine TPS														
Tertiary Marine Gas AU	<i>Oil</i>	2	9	45	15	3	14	70	22	0	1	4	1	
	<i>Gas</i>					34	195	646	249	1	5	17	6	
Total Conventional Resources			2	9	45	15	116	612	1,716	725	1	7	23	8
Continuous Resources														
Tertiary Coalbed Gas TPS														
Eocene Coalbed Gas AU	<i>CBG</i>	0	0	0	0	565	1,307	3,024	1,489	0	0	0	0	
Total Continuous Resources			0	0	0	0	565	1,307	3,024	1,489	0	0	0	0
Total Undiscovered Oil and Gas Resources			2	9	45	15	681	1,919	4,740	2,214	1	7	23	8

249 BCFG for the Tertiary Marine AU, which contains Paleogene turbidite rocks (fig 3). In this AU there are numerous gas and oil seeps; potential source rocks are marine shales, and the reservoir rocks are arkosic and lithic turbidite sandstones.

For Additional Information

Supporting geologic studies of TPS and AU, and reports on the methodology used in the Western Oregon and Washington Province assessment are in other chapters within this publication. Assessment results are also available at the USGS Central Energy Team website, <http://energy.cr.usgs.gov/oilgas/noga/>.

Western Oregon and Washington Province Assessment Team

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Figure 2. Outcrop of part of the deltaic lower member of the middle Eocene Coaledo Formation at Shore Acres State Park, near Coos Bay, Oregon (fig. 1). Strata are dipping eastward toward the trough of the South Slough syncline in the Coos Bay coal field (fig. 1).



Figure 3. Upper Eocene turbidite sandstones along the northwest shore of the Olympic Peninsula, northwestern Washington. Cape Flattery in the distance. Turbidite units are potential reservoirs within the Tertiary Marine Total Petroleum System and the Tertiary Marine Gas Assessment Unit.



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