

An Estimate of Undiscovered Conventional Oil and Gas Resources of the World, 2012

Using a geology-based assessment methodology, the U.S. Geological Survey estimated means of 565 billion barrels of conventional oil and 5,606 trillion cubic feet of undiscovered conventional natural gas in 171 priority geologic provinces of the world, exclusive of the United States.

Introduction

The authors of this report summarize a geology-based assessment of undiscovered conventional oil and gas resources of priority geologic provinces of the world, completed between 2009 and 2011 as part of the U.S. Geological Survey (USGS) World Petroleum Resources Project (fig. 1). One hundred seventy-one geologic provinces were assessed in this study (exclusive of provinces of the United States), which represent a complete reassessment of the world since the last report was published in 2000 (U.S. Geological Survey World Energy Assessment Team, 2000). The present report includes the recent oil and gas assessment of geologic provinces north of the Arctic Circle (U.S. Geological Survey Circum-Arctic Resource Appraisal Assessment Team, 2008). However, not all potential oil- and gas-bearing provinces of the world were assessed in the present study.

The methodology for the assessment included a complete geologic framework description for each province based mainly on published literature, and the definition of petroleum systems and assessment units (AU) within these systems. In this study, 313 AUs were defined and assessed for



Eolian dunes of the An Nefud sand sea, northern Saudi Arabia. (Photograph by C.J. Schenk, U.S. Geological Survey.)

undiscovered oil and gas accumulations. Exploration and discovery history was a critical part of the methodology to determine sizes and numbers of undiscovered accumulations. In those AUs with few or no discoveries, geologic and production analogs were used as a partial guide to estimate sizes and numbers of undiscovered oil and gas accumulations, using a database developed by the USGS following the 2000 assessment (Charpentier and others, 2008). Each AU was assessed for undiscovered oil and nonassociated gas accumulations, and co-product ratios were used to calculate the volumes of associated gas (gas in oil fields) and volumes of natural gas liquids. This assessment is for conventional oil and gas resources only; unconventional resource assessments (heavy oil, tar sands, shale gas, shale oil, tight gas, coalbed gas) for priority areas of the world are being completed in an ongoing but separate USGS study.

Resource Summary

The USGS assessed undiscovered conventional oil and gas resources in 313 AUs within 171 geologic provinces. In this report the results are presented by geographic region, which correspond to the eight regions used by the U.S. Geological Survey World Energy Assessment Team (2000) (table 1). For undiscovered, technically recoverable resources, the mean totals for the world are as follows: (1) 565,298 million barrels of oil (MMBO); (2) 5,605,626 billion cubic feet of gas (BCFG); and (3) 166,668 million barrels (MMBNGL) of natural gas liquids. The ranges of resource estimates (between the 95 and 5 fractiles) reflect the geologic uncertainty in the assessment process (table 1). The assessment results indicate that about 75 percent of the undiscovered conventional oil of the world is in four

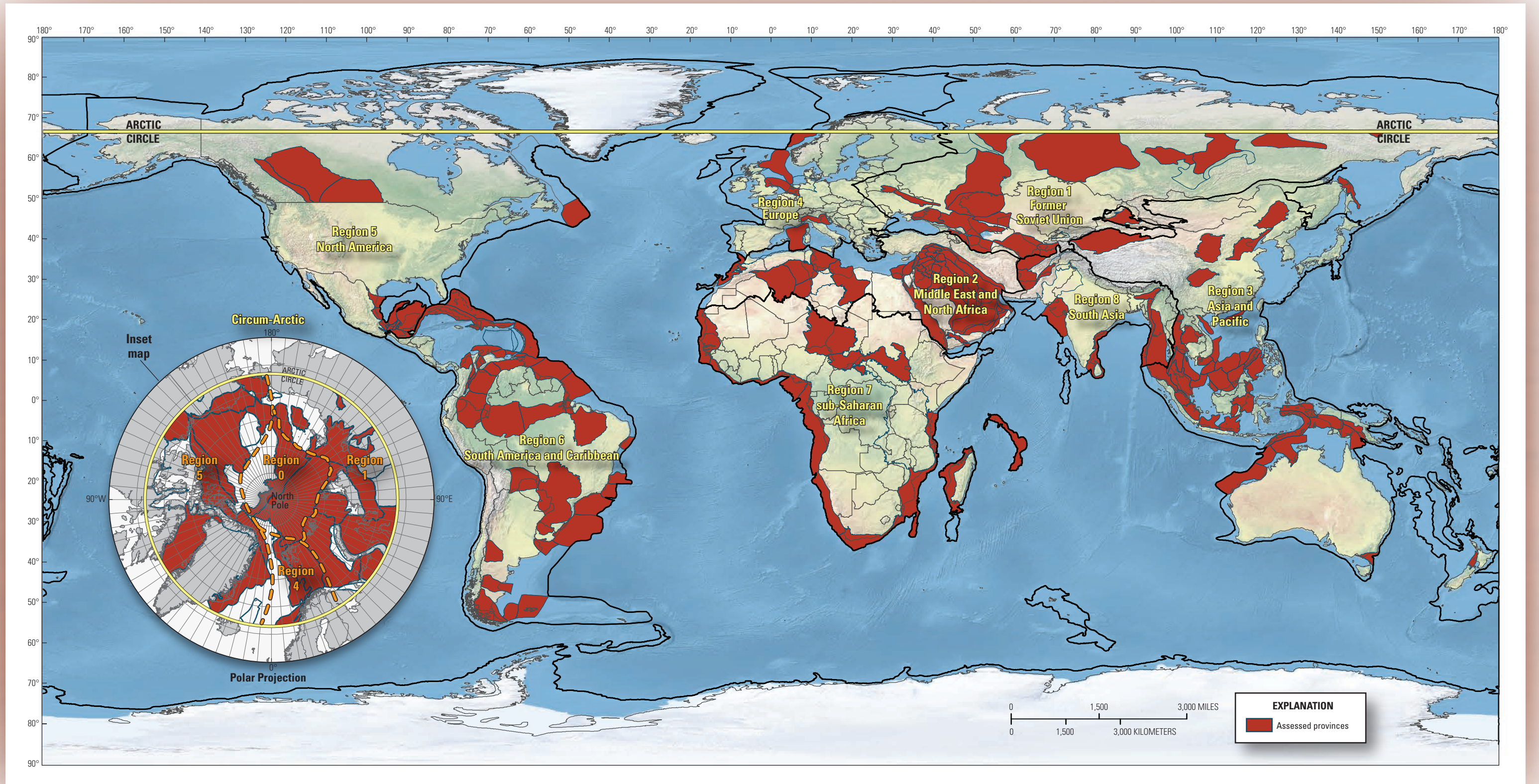


Figure 1. Locations of 171 geologic provinces (red areas) of the world assessed in this study. Inset map shows assessed provinces of the Arctic in a polar projection; Arctic is defined as provinces above the Arctic Circle (yellow line). Arctic provinces are included in Regions 0, 1, 4, and 5.

regions: (1) South America and Caribbean, (2) sub-Saharan Africa, (3) Middle East and North Africa, and (4) the Arctic provinces portion of North America. Significant undiscovered conventional gas resources remain in all of the world's regions (table 1).

Regions 0 and 1 (29 assessed provinces) encompass geologic provinces within countries of the former Soviet Union and include many provinces of the Arctic (fig. 1). Of the mean undiscovered estimate of 66 billion barrels of oil (BBO) in this region, about 43 percent is estimated to be in Arctic provinces. This region also contains significant gas resources [mean of 1,623 trillion cubic feet of gas (TCFG)], about 58 percent of which is estimated to be in three Arctic AUs:

South Kara Sea AU (622 TCFG); South Barents Basin AU (187 TCFG), and North Barents Basin AU (127 TCFG).

Region 2 (26 assessed provinces), the Middle East and North Africa, includes the Zagros Fold Belt of Iran, Arabian Peninsula, southern Turkey, and geologic provinces of North Africa from Egypt to Morocco. This region is estimated to contain a mean of 111 BBO, about 60 percent (65 BBO) of which is estimated to be in the Zagros and Mesopotamian provinces. This region is estimated to contain a conventional gas resource mean of 941 TCFG, about 60 percent (566 TCFG) of which is estimated to be in the Zagros Fold Belt and the offshore areas of the Red Sea Basin, Levantine Basin, and Nile Delta provinces.

Region 3 (39 assessed provinces), Asia and Pacific, includes geologic provinces of China, Vietnam, Thailand, Malaysia, Cambodia, Philippines, Brunei, Indonesia, Papua New Guinea, East Timor, Australia, and New Zealand. Of the total mean undiscovered oil resources of 48 BBO, about 33 percent is estimated to be in China provinces (15.7 BBO), and 10 percent is in Australian provinces (5 BBO). Other significant oil resources are in offshore Brunei (3.6 BBO), Kutei Basin (3 BBO), and South China Sea (2.5 BBO) provinces. Of the undiscovered mean total of 738 TCFG, about 45 percent (335 TCFG) is in provinces of Australia (227 TCFG) and China (108 TCFG). The rest of the gas resource is distributed across the other provinces of Southeast Asia.

Table 1. Assessment results for mean, undiscovered, technically recoverable oil, gas, and natural gas liquids for provinces of the world by region.

[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 NGL (natural gas liquids). Total 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. Field type: Oil—oil, associated gas, and NGL in oil fields; Gas—nonassociated gas and liquids in gas fields. Gray shading indicates not applicable]

Regions	Field type	Total undiscovered resources											
		Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
		F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
0. Arctic Ocean	Oil	15,984	45,559	177,175	66,211	54,892	178,640	606,787	237,485	2,083	6,487	19,754	8,193
1. Former Soviet Union	Gas					343,396	1,058,432	3,448,972	1,385,046	8,009	25,058	76,955	31,786
2. Middle East and North Africa	Oil	43,316	101,406	212,678	111,201	49,194	124,226	308,443	144,787	1,578	4,026	10,389	4,764
	Gas					334,063	729,200	1,490,538	796,513	10,363	23,220	50,605	25,912
3. Asia and Pacific	Oil	20,950	43,607	87,744	47,544	52,579	117,354	253,416	130,483	1,173	2,742	6,346	3,125
	Gas					269,523	562,461	1,110,663	607,845	7,517	16,340	33,736	17,917
4. Europe	Oil	4,344	8,561	19,417	9,868	6,605	16,422	50,460	21,171	245	570	1,616	710
	Gas					54,072	109,589	249,678	127,454	912	1,924	4,401	2,219
5. North America	Oil	25,500	62,618	208,032	83,386	42,498	112,675	398,902	152,847	879	2,685	11,923	4,103
	Gas					117,885	300,810	1,111,423	420,890	2,910	10,489	43,785	15,164
6. South America and Caribbean	Oil	44,556	108,098	261,862	125,900	99,532	246,922	637,661	295,475	2,909	7,570	20,048	9,119
	Gas					130,015	324,762	838,345	383,062	3,941	9,937	26,532	11,882
7. sub-Saharan Africa	Oil	40,777	102,961	232,090	115,333	40,553	104,711	262,898	122,188	1,237	3,394	9,237	4,089
	Gas					278,230	557,579	1,190,770	621,341	9,425	20,584	49,935	23,879
8. South Asia	Oil	3,323	5,575	9,339	5,855	8,404	14,648	25,087	15,419	189	337	586	356
	Gas					68,651	134,622	250,144	143,620	1,623	3,197	6,155	3,450
Total conventional resources					565,298				5,605,626				166,668

Region 4 (6 assessed provinces) includes Europe and several Arctic provinces. Of the mean of 9.9 BBO of undiscovered oil, about 50 percent (5 BBO) is estimated to be in the North Sea province. Of the undiscovered gas resource of 149 TCFG, the Arctic provinces are estimated to contain about 40 percent (58 TCFG). Significant undiscovered gas resources are estimated to be in the Norwegian continental margin, Provencal Basin, and Po Basin provinces.

Region 5 (21 assessed provinces), North America exclusive of the United States, includes Mexico, Canada, and several Arctic provinces. Of the mean oil resource of 83 BBO, about 75 percent (61 BBO) is estimated to be in Arctic provinces, and 23 percent (19 BBO) is estimated to be in Mexican Gulf provinces. In this region about 83 percent (459 TCFG) of the undiscovered conventional gas is in the Arctic provinces.

Region 6 (31 assessed provinces) includes South America and the Caribbean area. Of the mean estimate of 126 BBO in this region, about

44 percent (55.6 BBO) is estimated to be in offshore subsalt reservoirs in the Santos, Campos, and Espirito Santo basin provinces. Other significant mean oil resources are estimated to be in the Guyana–Suriname Basin (12 BBO), Santos Basin (11 BBO), Falklands (5.3 BBO), and Campos Basin (3.7 BBO) provinces. Undiscovered gas resources are less concentrated and are distributed among many provinces.

Region 7 (13 assessed provinces), sub-Saharan Africa, is estimated to contain a mean 115 BBO, of which about 75 percent is estimated to be in coastal provinces related to the opening of the Atlantic Ocean, such as Senegal, Gulf of Guinea, West African Coastal, and West-Central Coastal provinces. Of the undiscovered gas resource mean of 744 TCFG, more than half is estimated to be in provinces of offshore east Africa, including those offshore Tanzania, Mozambique, Madagascar, and Seychelles.

Region 8 (6 assessed provinces), South Asia, includes India, Pakistan, Afghanistan, Bangladesh, and Burma. Of the mean of 5.9 BBO, about 1.8 BBO

is estimated to be in the Central Burma Basin province and 1.4 BBO is in the Bombay province. Of the undiscovered gas resource of 159 TCFG, about 39 percent (62 TCFG) of the undiscovered gas resource is in the three provinces of offshore eastern India.

Although unconventional oil and gas resources, such as heavy oil, tar sands, shale gas, shale oil, tight gas, and coalbed gas, are not included in this study, unconventional resource volumes can be truly significant. For example, the mean estimate for recoverable heavy oil from the Orinoco Oil Belt in Venezuela alone is 513 BBO (U.S. Geological Survey Orinoco Oil Belt Assessment Team, 2009), compared to mean conventional resources of 565 BBO for 171 provinces reported in this study.

References Cited

- Charpentier, R.R., Klett, T.R., and Attanasi, E.D., 2008, Database for assessment–unit analogs (exclusive of the United States), Version 1.0: U.S. Geological Survey Open-File Report 2007–1404, 36 p.
- U.S. Geological Survey World Energy Assessment Team, 2000, U.S. Geological Survey world petroleum assessment 2000—Description and results: U.S. Geological Survey Digital Data Series DDS–60, 4 CD-ROMs.
- U.S. Geological Survey Circum-Arctic Resource Appraisal Assessment Team, 2008, Circum-Arctic resource appraisal: Estimates of undiscovered oil and gas north of the Arctic Circle: U.S. Geological Survey Fact Sheet 2008–3049, 4 p.
- U.S. Geological Survey Orinoco Oil Belt Assessment Team, 2009, An estimate of recoverable heavy oil resources of the Orinoco Oil Belt, Venezuela: U.S. Geological Survey Fact Sheet 2009–3028, 4 p.



Vertical limestone beds forming cliffs along Three Pagodas Fault Zone, near Hua Hin, Thailand. (Photograph by C.J. Schenk, U.S. Geological Survey.)



1, Icebergs immediately offshore from Ilulissat, Greenland; 2, Snowy peaks and muddy tidal flats of Cook Inlet, south of Anchorage, Alaska; and 3, Valley of the Atigun River with the Trans-Alaska Pipeline near Galbraith, Alaska. (Photographs by C.J. Schenk, U.S. Geological Survey.)

For Further Information

Supporting studies of the geologic models and the methodology used in the assessment of priority world provinces are in progress. Assessment results are available at the USGS Energy Program website, <http://energy.cr.usgs.gov/oilgas/>.

Contact: Christopher J. Schenk, Task Leader (schenk@usgs.gov),
U.S. Geological Survey, MS 939, Box 25046, Denver, Colorado, USA 80225

World Conventional Resources Assessment Team *(in alphabetical order)*

**Michael E. Brownfield, Ronald R. Charpentier, Troy A. Cook, Donald L. Gautier,
Debra K. Higley, Mark A. Kirschbaum, Timothy R. Klett, Janet K. Pitman,
Richard M. Pollastro, Christopher J. Schenk (Task Leader),
Marilyn E. Tennyson, Craig J. Wandrey, and Katherine J. Whidden.**