

# Assessment of Undiscovered Oil and Gas Resources of Four West Africa Geologic Provinces

Four geologic provinces located along the northwest and west-central coast of Africa recently were assessed for undiscovered oil, natural gas, and natural gas liquids resources as part of the U.S. Geological Survey's (USGS) World Oil and Gas Assessment. Using a geology-based assessment methodology, the USGS estimated mean volumes of 71.7 billion barrels of oil, 187.2 trillion cubic feet of natural gas, and 10.9 billion barrels of natural gas liquids.

## Introduction

The main objective of the U.S. Geological Survey's (USGS) World Petroleum Resources Project is to assess the potential for undiscovered, technically recoverable oil and natural gas resources of the world, exclusive of the United States. As part of this program, the USGS recently completed an assessment of four geologic provinces located along the northwest and west-central African coast and extending offshore to a water depth of 4,000 meters (m) (fig. 1). From north to south, the provinces are: (1) the Senegal, containing the passive-marginal Senegal Basin of Middle Jurassic to Holocene age; (2) the Gulf of Guinea, characterized by transform tectonics; (3) the Niger Delta, containing more than 9,100 m of sediments; and (4) the West-Central Coastal, containing the Aptian salt basin and dominated by both rift and sag tectonics including the Congo Basin. These provinces were assessed previously as part of the USGS World Assessment 2000 (U.S. Geological Survey World Energy Assessment Team, 2000), resulting in estimated mean volumes of 71.5 billion barrels of oil (BBO), 235.2 trillion cubic feet of gas (TCFG), and 10.8 billion barrels of natural gas liquids (BBNGL).

More than 275 new fields have been discovered in the four western Africa provinces since the 2000 assessment. The provinces were reassessed because of increased activity and because of new oil and gas discoveries within the provinces. The assessment was based on geology 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, seven conventional total petroleum systems and nine assessment units (AU) in the four provinces were defined, and the undiscovered, technically recoverable oil and gas resources were assessed (table 1).

Several geologic studies have reported on the potential for undiscovered hydrocarbon resources and descriptions of the total petroleum systems, assessment units, hydrocarbon-source rocks, reservoir rocks, and potential traps for hydrocarbon accumulation for the four provinces (Tuttle, Brownfield, and Charpentier, 1999; Tuttle, Charpentier, and Brownfield, 1999; Brownfield and Charpentier, 2003; Brownfield and Charpentier, 2006a, b).



**Figure 1.** Locations of the four assessed geologic provinces located along the northwest and west-central coast of Africa.

## Resource Summary

The results of the USGS assessment of undiscovered, technically recoverable conventional oil and gas resources in the west African provinces are given in table 1. The mean volumes are estimated at (1) 2,350 million barrels of oil (MMBO), 18,706 billion cubic feet of gas (BCFG), and 567 million barrels of natural gas liquids (MMBNGL) for the Coastal Plain and Offshore AU in the Senegal Province; (2) 4,071 MMBO, 34,451 BCFG, and 1,145 MMBNGL for the Coastal Plain and Offshore AU in the Gulf of Guinea Province; and (3) 15,534 MMBO, 58,221 BCFG, and 6,326 MMBNGL for the Agbada Reservoirs and Akata Reservoirs Aus in the Niger Delta Province. The West-Central Coastal Province was divided into the Gabon Subsalt, Gabon Suprasalt, Central Congo Delta and Carbonate Platform, Central Congo Turbidites, and

Kwanza-Namibe AUs. The estimated mean volumes for these five AUs are 49,736 MMBO, 75, 8790 BCFG, and 2,877 MMNGL. This assessment for the west Africa provinces indicates that most of the oil and gas potential remains in the offshore waters.

## References

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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.

## For Additional Information

Assessment results are available at the USGS Central Energy Resources Team website: <http://energy.cr.usgs.gov/oilgas/noga/> or contact Michael E. Brownfield, the assessing geologist ([mbrownfield@usgs.gov](mailto:mbrownfield@usgs.gov)).

## West Africa Provinces Assessment Team

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**Table 1.** West Africa Provinces assessment results for undiscovered, technically recoverable oil, gas, and natural gas liquids.

[Largest expected mean field size in million barrels of oil and billion cubic feet of gas; 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 natural gas liquids (NGL). 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. AU, assessment unit; AU probability is the chance of at least one accumulation of minimum size within the AU. NGL, natural gas liquids. TPS, total petroleum system. Gray shading indicates not applicable]

Province, Total Petroleum Systems (TPS) and Assessment Units (AU)	Field Type	Largest Expected Mean Field Size	Total Undiscovered Resources											
			Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
<b>Senegal Province–Cretaceous-Tertiary Composite TPS</b>														
Coastal Plain and Offshore AU	Oil	579	720	2,073	4,914	2,350	1,343	3,914	9,519	4,465	35	105	261	121
	Gas	3,505					4,353	12,563	29,747	14,241	134	391	942	446
<b>Gulf of Guinea Province–Cretaceous Composite TPS</b>														
Coastal Plain and Offshore AU	Oil	1,737	563	2,966	11,409	4,071	1,347	7,224	29,054	10,126	68	365	1,466	513
	Gas	10,409					3,382	17,704	68,094	24,335	87	457	1,782	632
<b>Niger Delta Province–Tertiary Niger Delta TPS</b>														
Agbada Reservoirs AU	Oil	274	526	1,437	3,326	1,616	1,904	5,387	13,011	6,139	65	245	904	339
	Gas	981					751	2,742	7,817	3,315	30	120	397	155
Akata Reservoirs AU	Oil	4,119	4,321	12,271	29,129	13,918	5,432	16,270	45,864	19,779	143	433	1,253	535
	Gas	13,355					5,862	21,723	78,443	28,988	1,030	3,886	14,491	5,297
<b>West-Central Coastal Province–Melania-Gamba TPS</b>														
Gabon Subsalt AU	Oil	2,559	2,042	6,492	16,805	7,589	1,134	3,783	12,115	4,863	57	191	617	247
	Gas	7,384					1,883	9,196	43,246	13,891	83	410	1,934	620
<b>West-Central Coastal Province–Cretaceous-Tertiary Composite TPS</b>														
Gabon Suprasalt AU	Oil	2,550	2,047	6,446	16,710	7,548	941	3,250	11,378	4,385	24	83	302	115
	Gas	6,583					1,241	7,356	39,177	11,822	38	227	1,224	370
<b>West-Central Coastal Province–Congo Delta Composite TPS</b>														
Central Congo Delta and Carbonate Platform AU	Oil	1,249	1,111	3,379	8,514	3,917	841	2,758	8,541	3,492	42	139	431	176
	Gas	3,305					645	4,009	20,577	6,307	33	208	1,091	334
Central Congo Turbidites AU	Oil	2,148	3,186	8,133	17,597	8,967	1,850	4,885	11,567	5,567	94	247	589	282
	Gas	2,014					215	1,304	10,437	2,814	9	58	466	126
<b>West-Central Coastal Province–Kwanza Composite TPS</b>														
Kwanza-Namibe AU	Oil	5,093	6,417	19,200	45,677	21,715	2,789	8,406	20,537	9,613	74	224	566	260
	Gas	7,729					1,306	7,640	44,892	13,036	34	199	1,198	347
<b>Total Conventional Resources</b>			<b>20,933</b>	<b>62,397</b>	<b>154,081</b>	<b>71,691</b>	<b>37,219</b>	<b>140,114</b>	<b>504,016</b>	<b>187,178</b>	<b>2,080</b>	<b>7,988</b>	<b>29,914</b>	<b>10,915</b>