

# Assessment of Undiscovered Conventional Oil and Gas Resources in Presalt Reservoirs of the West-Central Coastal Province of Africa, 2022

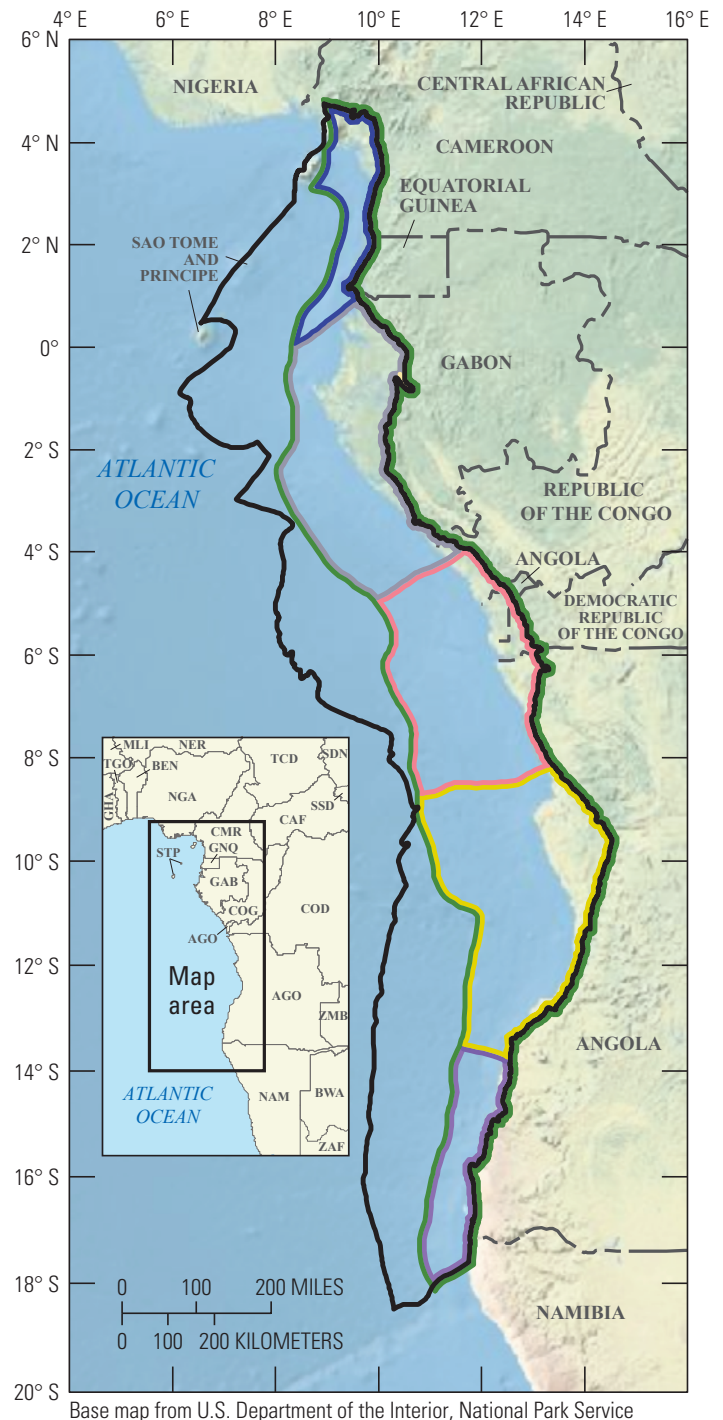
Using a geology-based assessment methodology, the U.S. Geological Survey estimated undiscovered, technically recoverable mean conventional resources of 12.1 billion barrels of oil and 50 trillion cubic feet of gas in presalt reservoirs within the West-Central Coastal Province of Africa.

## Introduction

The U.S. Geological Survey (USGS) assessed undiscovered, technically recoverable, conventional oil and gas resources in the Douala-Rio Muni, Gabon, Congo, Kwanza-Benguela, and Namibe Basins of the West-Central Coastal Province of Africa (fig. 1). The assessment focused on the potential for undiscovered conventional oil and gas resources in reservoirs stratigraphically below a regionally extensive layer of Aptian salt (presalt or subsalt reservoirs) that is present in all five basins (fig. 2).

The tectonic evolution of the West-Central Coastal Province began with the initial separation of Africa from South America as Pangaea began to fragment in the Late Triassic to Early Jurassic (Torsvik and others, 2009; Guiraud and others, 2010; De Matos and others, 2021; De Matos, 2021). Rifting formed a broad complex region of horsts and grabens that occur throughout the length of the province (Jackson and Hudec, 2009; Baudino and others, 2018). As much as several kilometers of synrift clastic sediments were deposited in the grabens, including organic-rich lacustrine shales that represent major petroleum source rocks. As rifting waned in the Early Cretaceous, thermal subsidence formed accommodation space (or sag) that filled with regionally extensive fluvial and lacustrine sediments. Complex water chemistries led to microbial fixation of chert, dolomite, and limestone in mounds that are important oil and gas reservoirs. A series of transgressions beginning in the late Aptian caused marine waters to intermittently flow over the volcanic Walvis Ridge and across extended continental crust; associated evaporation resulted in deposition of more than one kilometer of late Aptian salt (Kamer and Gambôa, 2007; Greenhalgh and others, 2012; Cowie and others, 2016; Pichel and others, 2023). Where subsequent salt halokinesis has not occurred, salt forms an important regional seal for oil and gas contained in some presalt reservoirs.

- EXPLANATION**
- Douala-Rio Muni Presalt Reservoirs AU
  - Gabon Basin Presalt Reservoirs AU
  - Congo Basin Presalt Reservoirs AU
  - Kwanza-Benguela Basin Presalt AU
  - Namibe Basin Presalt Reservoirs AU
  - Berriasian–Barreman Total Petroleum System
  - West Central Coastal Province boundary



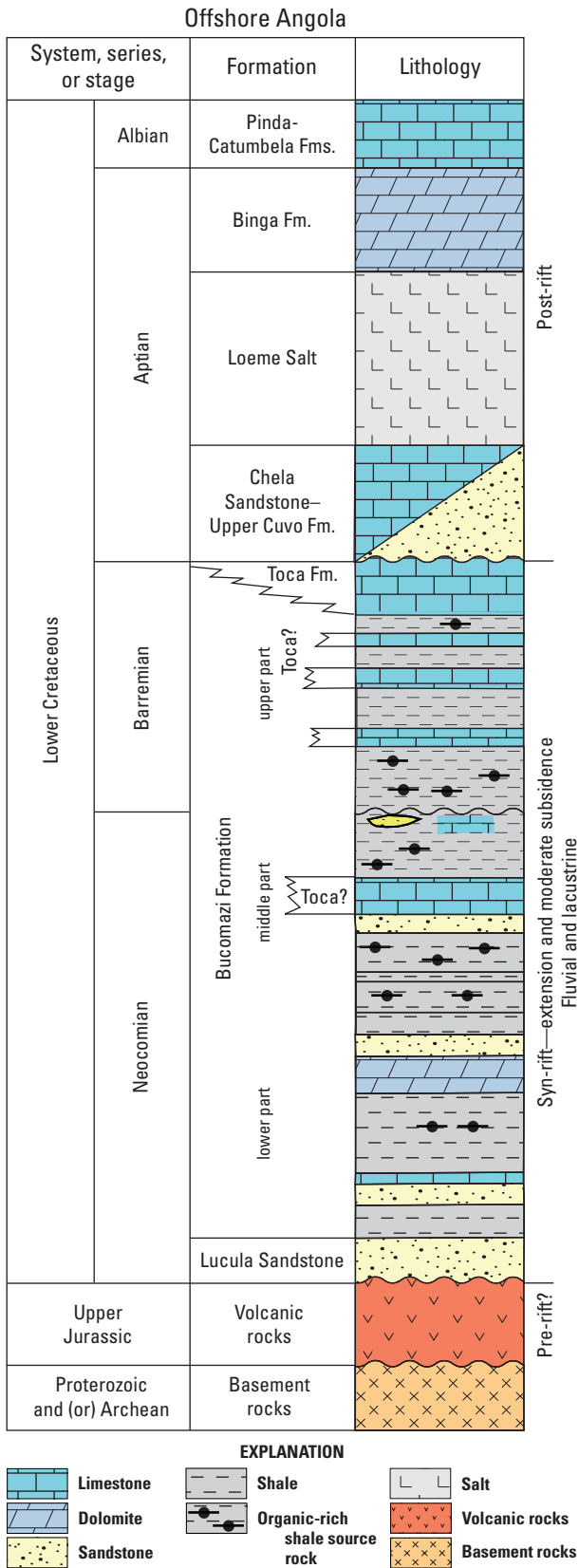
**Figure 1.** Map showing five conventional assessment units (AUs) in the presalt of the West-Central Coastal Province of Africa.

## Total Petroleum System and Assessment Units

The USGS defined a Berriasian–Barremian Lacustrine Total Petroleum System (TPS) within the presalt stratigraphic section and five conventional assessment units (AUs) within this TPS (fig. 1). The five conventional AUs in general share similar petroleum source rocks, reservoirs rocks, traps, seals, and timing of oil and gas generation (Beglinger and others, 2012). The main petroleum source rocks are Berriasian–Barremian synrift organic-rich lacustrine shales with total organic carbon (TOC) content as much as 20 weight percent, hydrogen index values as much as 800 milligrams hydrocarbon per gram of TOC and thickness as much as 600 meters (Brownfield and Charpentier, 2006; Greenhalgh and others, 2012). Synrift reservoirs in this TPS include alluvial-fluvial conglomerates and sandstones, and marginal lacustrine to deep-water lacustrine sandstones. Reservoirs in the overlying sag section are extensive fluvial and lacustrine sandstones and an unusual type of reservoir related to microbial deposition from chemically complex waters (Saller and others, 2016; Cui and others, 2023; Moragas and others, 2023). Detailed descriptions of these microbial reservoirs have also been published from occurrences in the age-equivalent rocks in the Santos Basin of Brazil (Cazier and others, 2014; Farias and others, 2019; Gomes and others, 2020). These reservoirs typically form mounds or build ups composed of microbially deposited chert, dolomite, and limestone, in which the cherts and dolomites may exhibit excellent porosity and permeability. Traps in the TPS are formed by facies changes within the synrift section, by draping of sandstones over horsts, by reservoirs adjacent to tilted fault blocks, and by stratigraphic traps formed by microbial mounds within the sag section. Seals are provided by intraformational mudstones within the synrift section and by evaporites overlying the sag reservoirs. Oil generation may have begun from synrift lacustrine shales in the Aptian, and gas generation may have begun in the Oligocene (Brownfield and Charpentier, 2006). Assessment input data are summarized in table 1 and in Schenk (2024).

## Undiscovered Resources Summary

The USGS quantitatively assessed oil and gas resources in five conventional AUs in basins of the West-Central Coastal Province of Africa (table 2). For undiscovered, technically recoverable continuous oil and gas resources, the mean totals are 12,104 million barrels of oil (MMBO), or 12.1 billion barrels of oil, with an F95 to F5 fractile range from 4,221 to 26,433 MMBO; 49,977 billion cubic feet of gas (BCFG), or 50 trillion cubic feet of gas, with an F95 to F5 fractile range from 17,121 to 109,925 BCFG; and 2,634 million barrels of natural gas liquids (MMBNGL), or 2.6 billion barrels, with an F95 to F5 fractile range from 882 to 5,841 MMBNGL.



**Figure 2.** Generalized stratigraphic column showing ages, formation and member names, hydrocarbon source rocks, and tectonic stages for the Lower Cretaceous in the Kwanza Basin, offshore Angola. The Aptian Loeme Salt separates presalt strata from postsalt strata. The Bucomazi Formation and equivalents are the main hydrocarbon source rocks in the West Central Coastal Province. Modified from Brownfield and Charpentier, (2006). (Fm., Formation; Fms., Formations)

**Table 1.** Key input data for five conventional assessment units in the presalt of the West Central Province of Africa.

[Shading indicates not applicable. AU, assessment unit; MMBO, million barrels of oil; BCFG, billion cubic feet of gas]

Assessment input data— Conventional AUs	Douala-Rio Muni Presalt Reservoirs AU				Gabon Basin Presalt Reservoirs AU			
	Minimum	Median	Maximum	Calculated mean	Minimum	Median	Maximum	Calculated mean
Number of oil fields	1	15	30	15.4	1	70	140	71.7
Number of gas fields	1	30	60	30.7	1	30	90	31.9
Sizes of oil fields (MMBO)	5	8	1,000	20.5	5	8	5,000	45.4
Sizes of gas fields (BCFG)	30	48	6,000	123.3	30	48	12,000	168.0
AU probability	1.0				1.0			
Assessment input data— Conventional AUs	Congo Basin Presalt Reservoirs AU				Kwanza-Benguela Basin Presalt Reservoirs AU			
	Minimum	Median	Maximum	Calculated mean	Minimum	Median	Maximum	Calculated mean
Number of oil fields	1	60	120	61.5	1	90	180	92.2
Number of gas fields	1	30	70	31.1	1	40	120	42.5
Sizes of oil fields (MMBO)	5	8	5,000	45.4	5	8	6,000	50.5
Sizes of gas fields (BCFG)	30	48	12,000	168.0	30	48	10,000	154.1
AU probability	1.0				1.0			
Assessment input data— Conventional AUs	Namibe Basin Presalt Reservoirs AU							
	Minimum	Median	Maximum	Calculated mean				
Number of oil fields	1	20	50	20.9				
Number of gas fields	1	20	50	20.9				
Sizes of oil fields (MMBO)	5	8	6,000	50.5				
Sizes of gas fields (BCFG)	30	48	10,000	154.1				
AU probability	1.0							

**Table 2.** Assessment results for five conventional assessment units in the presalt of the West Central Coastal Province of Africa.

[Results shown are fully risked estimates. F95 represents a 95-percent chance of at least the amount tabulated; other fractiles are defined similarly. Shading indicates not applicable. AU, assessment unit; MMBO, million barrels of oil; BCFG, billion cubic feet of gas; BCFG, billion cubic feet of gas; NGL, natural gas liquids; MMBNGL, million barrels of natural gas liquids]

Total petroleum system and assessment units (AUs)	AU probability	Accumulation type	Total undiscovered resources											
			Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Berriasian–Barreman Lacustrine Total Petroleum System														
Douala-Rio Muni Basin Presalt Reservoirs AU	1.0	Oil	116	258	726	316	151	336	946	411	9	20	55	24
		Gas					1,649	3,377	7,414	3,799	41	85	186	95
Gabon Basin Presalt Reservoirs AU	1.0	Oil	1,181	2,799	6,831	3,252	3,188	7,556	18,438	8,780	51	121	295	140
		Gas					1,558	4,433	12,638	5,381	28	80	227	97
Congo Basin Presalt Reservoirs AU	1.0	Oil	960	2,365	6,165	2,803	1,147	2,838	7,381	3,364	34	85	222	101
		Gas					1,750	4,348	11,940	5,238	23	57	156	68
Kwanza-Benguela Basin Presalt Reservoirs AU	1.0	Oil	1,770	4,125	9,438	4,680	4,068	9,482	21,709	10,763	224	522	1,194	592
		Gas					2,181	5,707	14,032	6,603	308	805	1,979	931
Namibe Basin Presalt Reservoirs AU	1.0	Oil	194	687	3,273	1,053	447	1,582	7,538	2,422	25	87	414	133
		Gas					982	2,565	7,889	3,216	139	362	1,113	453
<b>Total undiscovered conventional resources</b>			<b>4,221</b>	<b>10,234</b>	<b>26,433</b>	<b>12,104</b>	<b>17,121</b>	<b>42,224</b>	<b>109,925</b>	<b>49,977</b>	<b>882</b>	<b>2,224</b>	<b>5,841</b>	<b>2,634</b>

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## For More Information

Assessment results are also available at the U.S. Geological Survey Energy Resources Program website at <https://www.usgs.gov/programs/energy-resources-program>.

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