

National and Global Petroleum Assessment Project

Assessment of Undiscovered Oil and Gas Resources of the Paris Basin, France, 2015

Using a geology-based assessment methodology, the U.S. Geological Survey estimated means of 222 million barrels of unconventional oil; 2,092 billion cubic feet of unconventional gas; 18 million barrels of conventional oil; and 47 billion cubic feet of conventional gas resources in the Paris Basin of France.

Introduction

The U.S. Geological Survey (USGS) quantitatively assessed the potential for undiscovered, technically recoverable oil and gas resources in the Paris Basin of France (fig. 1) as part of an effort to assess priority European basins. The Paris Basin composes part of the USGS Anglo-Paris Basin Province, but for this study, only the Paris Basin was evaluated for undiscovered conventional and unconventional (shale oil, shale gas, tight gas) oil and gas resources. More than 35 conventional oil and gas fields have been discovered in the Paris Basin since the 1950s, with the largest oil field, Chaunoy, discovered in 1983. The assessment of undiscovered conventional resources in these oil and gas fields is straightforward, due to the fields' geology, along with their discovery and exploration history, and what is known of the Lower Jurassic source rocks. This study focuses on the geologic evaluation of unconventional (continuous) oil and gas source-reservoir rock systems and potential resources.

For conventional resources, the USGS defined a Mesozoic Reservoirs Assessment Unit (AU) to encompass petroleum that was generated from Lower Jurassic organic-rich shales, then migrated and was trapped in Triassic, Jurassic, and Lower Cretaceous reservoirs. Migration of petroleum across tens of kilometers occurred from the areas of thermally mature Lower Jurassic source rocks. In contrast to the conventional petroleum system, Lower Jurassic source rocks were evaluated for potential source-reservoir rock systems that retained moveable oil. For this assessment, an unconventional (continuous) source-reservoir rock system must: (1) contain greater than 2 weight percent total organic carbon (TOC), (2) be within the proper thermal maturity window for oil or gas generation, (3) have greater than 15 meters of organic-rich shale, and (4) contain Type I or Type II organic matter (Charpentier and Cook, 2011). After potential areas for assessment were defined, the tectonic history, thermal history, and timing of maturation and generation were used to evaluate the risk of retention of hydrocarbons within the source rock. The USGS defined a Toarcian-Domerian Continuous Oil AU (including the "schistes carton") and a Lotharingian-Sinemurian Continuous Oil AU. The USGS also defined a Permo-Carboniferous Tight Gas AU, which involves coal-sourced gas that migrated locally into low-permeability, or "tight" fluvial sandstones within Permo-Carboniferous rift systems, similar to the Lower Saxony Basin of Germany (Wuestefeld and others, 2014). The presence of rifts, "tight" fluvial reservoirs, and coal-sourced gas are all highly uncertain in the Paris Basin, and the uncertainty is reflected in the F95 fractile of zero resource.

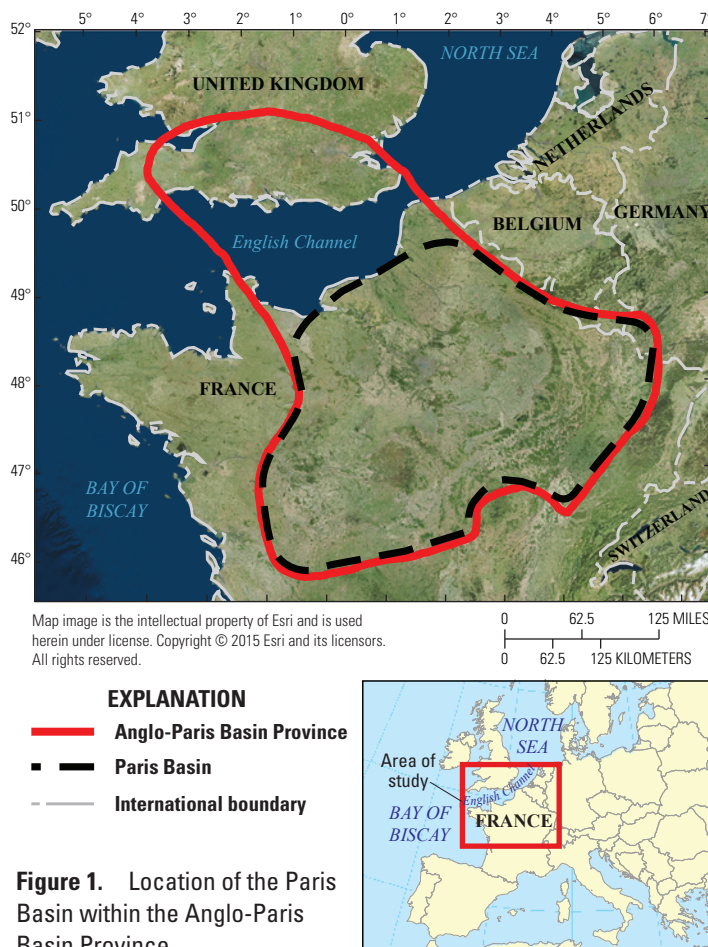


Figure 1. Location of the Paris Basin within the Anglo-Paris Basin Province.

The assessment input data for three unconventional (continuous) AUs are shown in table 1.

Resource Summary

The USGS quantitatively assessed undiscovered oil and gas resources in four assessment units within the Paris Basin (table 2). For undiscovered technically recoverable resources, the mean totals are: 222 million barrels of continuous oil (MMBO), with a fractile (F95–F5, respectively) range from 42–527 MMBO; 2,092 billion cubic feet of continuous gas (BCFG), with a fractile range from 3–5,547 BCFG; 18 million barrels of conventional oil, with a fractile range from 10–31 MMBO; and 47 BCFG of conventional gas, with a fractile range from 13–114 BCFG.

Of the mean total continuous oil resource of 222 MMBO, 140 MMBO are estimated to be in the Toarcian-Domerian Continuous Oil AU, and 82 MMBO are in the Lotharingian-Sinemurian Continuous Oil AU. Nearly all potential continuous gas resources occur in the Permo-Carboniferous Tight Gas AU (mean of 2,074 BCFG, with a range from 0 to 5,503 BCFG). The ranges of resource estimates reflect the geologic uncertainty of the

source-reservoir rock systems. Much of the uncertainty is interpreted to be related to the quantity of oil remaining in the source rocks following migration.

Using mean estimated ultimate recoveries, total potential areas, drainage areas, and success ratios (table 2), we estimate a mean of about 6,400 hydraulically fractured wells would be needed to exploit the continuous oil and gas resources.

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References Cited

Charpentier, R.R., and Cook, T.A., 2011, USGS methodology for assessing continuous petroleum resources: U.S. Geological Survey Open-File Report 2011–1167, 75 p., <http://pubs.usgs.gov/of/2011/1167/>.

Wuestefeld, Patrick, Hilgers, Christoph, and Koehrer, Bastian, 2014, Structural diagenesis in an Upper Carboniferous tight gas sandstones analog: American Association of Petroleum Geologists, Search and Discovery Article #41491, 21 p.

For Further Information

Assessment results are available at the USGS Energy Resources Program website, <http://energy.usgs.gov/oilgas/>.

Table 1. Key assessment input data for the three unconventional (continuous) assessment units in the Paris Basin.

[EUR (estimated ultimate recovery per well), well drainage area, and success ratios are from U.S. shale-gas and shale-oil analogs. The average EUR input is the minimum, median (not the mode), maximum, and calculated mean. AU, assessment unit, %, percent; MMBO, million barrels of oil; BCFG, billion cubic feet of gas]

Assessment input data	Toarcian-Domerian Continuous Oil AU				Lotharingian-Sinemurian Continuous Oil AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	2,690	269,000	1,485,000	585,563	3,370	337,000	691,000	343,790
Average drainage area of wells (acres)	80	160	320	187	80	160	320	187
Success ratios (%)	10	50	90	50	10	50	90	50
Average EUR (MMBO, oil; BCFG, gas)	0.04	0.08	0.2	0.086	0.04	0.08	0.2	0.086
	Permo-Carboniferous Tight Gas AU							
	Minimum	Mode	Maximum	Calculated mean				
Potential production area of AU (acres)	0	382,000	1,892,000	758,000				
Average drainage area of wells (acres)	40	110	180	110				
Success ratios (%)	10	50	90	50				
Average EUR (MMBO, oil; BCFG, gas)	0.25	0.6	1.5	0.645				

Table 2. Assessment results for unconventional (continous) and conventional oil and gas resources in the Paris Basin.

[MMBO, million barrels of oil. BCFG, billion cubic feet of gas; MMBNGL, million barrels of natural gas liquids; TPS, total petroleum system; AU, assessment unit. Results shown are fully risked estimates. For gas accumulations, 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 assumption of perfect positive correlation. Shading indicates not applicable.]

Total petroleum systems (TPS) and Assessment Units (AUs)	AU probability	Accumula- tion type	Total undiscovered resources											
			Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Toarcian-Domerian TPS														
Toarcian-Domerian Continuous Oil AU	1.0	Oil	24	113	346	140	2	9	29	11	0	0	0	0
Lotharingian-Sinemurian TPS														
Lotharingian-Sinemurian Continuous Oil AU	1.0	Oil	18	72	181	82	1	6	15	7	0	0	0	0
Permo-Carboniferous Composite TPS														
Permo-Carboniferous Tight Gas AU	0.9	Gas					0	1,657	5,503	2,074	0	12	43	15
Total unconventional resources			42	185	527	222	3	1,672	5,547	2,092	0	12	43	15
Mesozoic Composite TPS														
Mesozoic Reservoirs AU	1.0	Oil	10	17	31	18	1	2	3	2	0	0	0	0
		Gas					12	35	111	45	0	0	1	0
Total conventional resources			10	17	31	18	13	37	114	47	0	0	1	0
Total undiscovered resources			52	202	558	240	16	1,709	5,661	2,139	0	12	44	15