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National and Global Petroleum Assessment

Assessment of Continuous Oil and Gas Resources in the Neuquén Basin Province, Argentina, 2016

Using a geology-based assessment methodology, the U.S. Geological Survey assessed undiscovered, technically recoverable mean continuous resources of 14.4 billion barrels of oil and 38 trillion cubic feet of gas in the Neuquén Basin Province, Argentina.

Introduction

The U.S. Geological Survey (USGS) assessed the potential for undiscovered, technically recoverable continuous (unconventional) oil and gas resources within the Neuquén Basin Province, Argentina (figs. 1–3). As defined by the USGS, the province encompasses the basin (or "embayment"), the platform in the eastern part of the province, and the fold belt in the western part of the province. This study estimated potential volumes of undiscovered continuous oil and gas in three petroleum source rocks that occur in the basin and in the fold belt: the Jurassic Los Molles Formation, the Jurassic–Early Cretaceous Vaca Muerta Formation, and the Early Cretaceous Agrio Formation. The USGS defined a Los Molles Total Petroleum System (TPS), a Vaca Muerta TPS, and an Agrio TPS, following similar published definitions of these systems (Urien and Zambrano, 1994; Legarreta and Villar, 2015). Twelve continuous resource assessment units (AUs) were defined within these three TPSs (table 1).

Geologic Model for Assessment

Three main assumptions underlie the geologic model that forms the foundation of this assessment. First, some portion of the oil and gas generated in each of the three source rocks was retained within each source rock interval and constitutes potentially recoverable oil or gas. Second, multiple phases of structural deformation in the fold belt negatively affected the volumes of oil or gas retained in source rocks compared to those retained in the basin or embayment area. Third, the assessment was based mainly (but not entirely) on vertical wells, which affects the input data for the USGS assessment methodology (for example, well drainage areas, estimated ultimate recoveries, and success ratios). Given the geologic model, the definition of AUs was based on (1) whether the source rock resides within the fold belt or embayment, (2) the level of thermal maturation, (3) the percent of total organic carbon, and (4) the thickness of viable source rock. Source rock data for the Los Molles TPS, Vaca Muerta TPS, and Agrio TPS from published sources are summarized in table 2 (Legarreta and others, 2005; Tyson and others, 2005; Martinez and others, 2008; Schmidt and others, 2013;

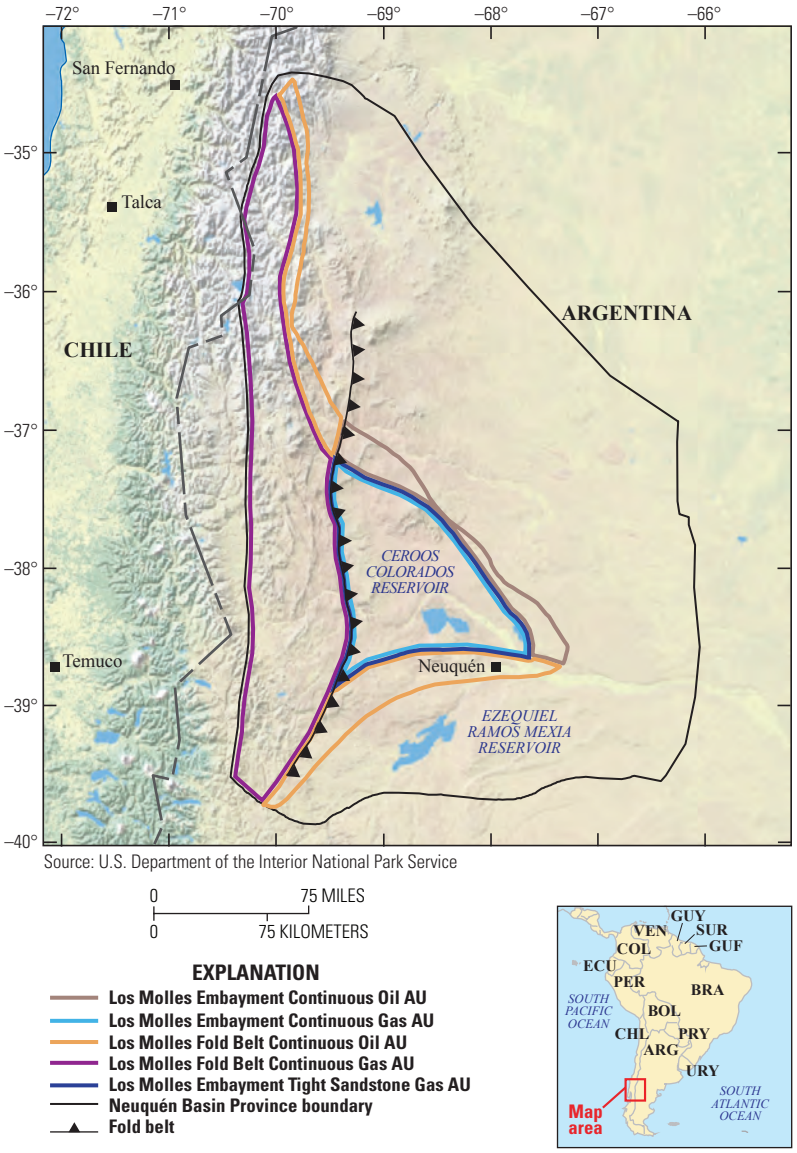

Figure 1. Location of the five assessment units (AUs) in the Los Molles Total Petroleum System of the Neuquén Basin Province, Argentina.

Figure 2. Location of the five assessment units (AUs) in the Vaca Muerta Total Petroleum System of the Neuquén Basin Province, Argentina.

Barredo and Stinco, 2014; Legarreta and Villar, 2015; Licitra and others, 2015; Rimedio and others, 2015). The lower limits of thickness of effective source rock (15 meters), total organic carbon (2 weight percent), and hydrogen index (200 milligrams hydrocarbon per gram of total organic carbon) are the thresholds used by the USGS to define a viable continuous accumulation (table 2).

Key assessment input data for 12 AUs are summarized in table 1. Data for estimated ultimate recovery, well drainage area, and success ratios were based on U.S. analogs for continuous oil and gas reservoirs.

Undiscovered Resources Summary

The USGS assessed potential undiscovered, technically recoverable continuous resources in the Neuquén Basin Province, Argentina (table 3). The USGS estimated mean totals of 14,370 million barrels of continuous oil (MMBO), or 14.4 billion barrels of oil, with an F95–F5 range from 4,139 to 27,913 MMBO; 37,966 billion cubic feet of continuous gas (BCFG), or 38 trillion cubic feet of continuous gas, with an F95–F5 range from 10,382 to 76,102 BCFG; and 482 million barrels of natural gas liquids (MMBNGL) with an F95–F5 range from 113 to 1,055 MMBNGL (table 3).

In the Los Molles TPS, the estimated mean totals for continuous oil and gas resources are 847 MMBO with an F95–F5 range from 220 to 1,775 MMBO, 18,137 BCFG with an F95–F5 range from 4,993 to 36,000 BCFG, and 184 MMBNGL with an F95–F5 range from 44 to 400 MMBNGL. The Vaca Muerta TPS has estimated mean totals for continuous oil and gas resources of 12,848 MMBO with an F95–F5 range from 3,750 to 24,696 MMBO, 19,155 BCFG with an F95–F5 range from 5,232 to 38,597 BCFG, and 287 MMBNGL with an F95–F5 range from 67 to 630 MMBNGL. In the Agrio TPS, the estimated mean totals for continuous oil and gas resources are 675 MMBO with an F95–F5 range from 169 to 1,442 MMBO, 674 BCFG with an F95–F5 range from 157 to 1,505 BCFG, and 11 MMBNGL with an F95–F5 range from 2 to 25 MMBNGL.

Most of the continuous oil resources (12,848 MMBO or 89 percent) are estimated to be in three assessment units of the Vaca Muerta TPS. Half of the mean continuous gas resources (19,155 BCFG or 50 percent) is in the Vaca Muerta TPS, and 48 percent (18,137 BCFG) is in the Los Molles TPS.

Figure 3. Location of the two assessment units (AUs) in the Agrio Total Petroleum System of the Neuquén Basin Province, Argentina.

Table 1. Key assessment input data for 12 continuous assessment units in the Neuquén Basin Province, Argentina.

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

Assessment input data	Los Molles Embayment Continuous Oil AU				Los Molles Embayment Continuous Gas AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	2,400	480,000	960,000	480,800	4,800	1,556,000	3,112,000	1,557,600
Average drainage area of wells (acres)	20	60	120	67	80	120	160	120
Success ratios (%)	50	70	90	70	50	70	90	70
Average EUR (MMBO, oil; BCFG, gas)	0.08	0.1	0.3	0.111	0.2	0.4	1.0	0.431
AU probability	1.0				1.0			
Assessment input data	**Los Molles Fold Belt Continuous Oil AU**				**Los Molles Fold Belt Continuous Gas AU**			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	600	717,000	2,391,000	1,036,200	3,000	2,407,000	8,670,000	3,693,333
Average drainage area of wells (acres)	40	80	120	80	80	120	160	120
Success ratios (%)	10	30	50	30	10	30	50	30
Average EUR (MMBO, oil; BCFG, gas)	0.03	0.06	0.1	0.062	0.2	0.35	0.8	0.373
AU probability	1.0				1.0			
Assessment input data	**Los Molles Embayment Tight Sandstone Gas AU**				**Vaca Muerta Embayment Continuous Oil AU**			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	9,600	1,800,000	3,112,000	1,640,533	3,000	2,407,000	3,438,000	1,949,333
Average drainage area of wells (acres)	40	80	120	80	20	60	120	67
Success ratios (%)	65	75	85	75	75	85	95	85
Average EUR (BCFG, gas; MMBO, oil)	0.2	0.6	1.4	0.637	0.2	0.4	0.7	0.412
AU probability	1.0				1.0			
Assessment input data	**Vaca Muerta Embayment Continuous Gas AU**				**Vaca Muerta Fold Belt Continuous Oil AU**			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	6,000	928,000	1,325,000	753,000	600	1,005,000	3,350,000	1,451,867
Average drainage area of wells (acres)	80	120	160	120	40	80	120	80
Success ratios (%)	75	85	95	85	10	30	50	30
Average EUR (BCFG, gas; MMBO, oil)	0.2	0.8	2.0	0.856	0.03	0.06	0.10	0.062
AU probability	1.0				1.0			
Assessment input data	**Vaca Muerta Fold Belt Continuous Gas AU**				**Vaca Muerta Picún Leufú Basin Continuous Oil AU**			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	1,200	1,332,000	4,439,000	1,934,067	3,000	690,000	986,000	559,667
Average drainage area of wells (acres)	80	120	160	120	20	60	120	67
Success ratios (%)	10	30	50	30	70	80	90	80
Average EUR (BCFG, gas; MMBO, oil)	0.2	0.35	0.8	0.373	0.1	0.2	0.35	0.206
AU probability	1.0				1.0			
Assessment input data	**Agrio Embayment Continuous Oil AU**				**Agrio Fold Belt Continuous Oil AU**			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	2,400	268,000	535,000	268,467	600	1,085,000	3,615,000	1,566,867
Average drainage area of wells (acres)	20	60	120	67	40	80	120	80
Success ratios (%)	50	70	90	70	10	30	50	30
Average EUR (MMBO)	0.06	0.09	0.3	0.102	0.03	0.06	0.1	0.062
AU probability	1.0				1.0			

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Table 2. Summary of source rock data for three total petroleum systems in the Neuquén Basin Province, Argentina.

[TPS, total petroleum system; m, meters; wt %, weight percent; % R_o, percent vitrinite reflectance; mg HC/g TOC, milligrams of hydrocarbon per gram of total organic carbon]

	Los Molles TPS	Vaca Muerta TPS	Agrio TPS
Maximum formation thickness (m)	2,100	1,200	1,500
Thickness of effective source rock (m)	15–800	15–450	15–400
Total organic carbon (wt %)	2–5	2–12	2–7
Maximum thermal maturation (% R_o)	3	2	3.6
Hydrogen index (mg HC/g TOC)	200–500	200–800	200–550
Kerogen type	III/II	I/II/IIS	II/III

Table 3. Assessment results for 12 assessment units in the Neuquén Basin Province, Argentina.

[MMBO, million barrels of oil; BCFG, billions of cubic feet of gas; NGL, natural gas liquids; MMBNGL, million barrels of natural gas liquids. Results shown are fully risked estimates. For gas accumulations, all liquids are included as natural gas liquids. F95 represents a 95-percent chance of at least the tabulated amount being present; other fractiles are defined similarly. Fractiles are additive under the assumption of perfect positive correlation. Shading indicates not applicable]

Total petroleum systems 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
Los Molles Total Petroleum System														
Los Molles Embayment Continuous Oil AU	1.0	Oil	163	544	1,236	601	151	528	1,298	601	2	8	21	9
Los Molles Embayment Continuous Gas AU	1.0	Gas					1,116	3,644	7,631	3,913	15	52	126	59
Los Molles Fold Belt Continuous Oil AU	1.0	Oil	57	215	539	246	54	210	562	246	1	3	9	4
Los Molles Fold Belt Continuous Gas AU	1.0	Gas					779	2,982	7,665	3,450	10	43	124	52
Los Molles Embayment Tight Sandstone Gas AU	1.0	Gas					2,893	9,374	18,844	9,927	16	55	120	60
Total resources			**220**	**759**	**1,775**	**847**	**4,993**	**16,738**	**36,000**	**18,137**	**44**	**161**	**400**	**184**
Vaca Muerta Total Petroleum System														
Vaca Muerta Embayment Continuous Oil AU	1.0	Oil	3,228	10,365	21,092	11,008	3,004	10,057	22,253	11,007	39	144	363	165
Vaca Muerta Embayment Continuous Gas AU	1.0	Gas					1,329	4,261	8,587	4,512	17	61	141	68
Vaca Muerta Fold Belt Continuous Oil AU	1.0	Oil	79	303	753	345	74	294	785	344	1	4	13	5
Vaca Muerta Fold Belt Continuous Gas AU	1.0	Gas					412	1,562	3,972	1,798	5	23	64	27
Vaca Muerta Picún Leufú Basin Continuous Oil AU	1.0	Oil	443	1,415	2,851	1,495	413	1,370	3,000	1,494	5	20	49	22
Total resources			**3,750**	**12,083**	**24,696**	**12,848**	**5,232**	**17,544**	**38,597**	**19,155**	**67**	**252**	**630**	**287**
Agrio Total Petroleum System														
Agrio Embayment Continuous Oil AU	1.0	Oil	82	272	629	303	76	264	661	303	1	4	11	5
Agrio Fold Belt Continuous Oil AU	1.0	Oil	87	325	813	372	81	317	844	371	1	5	14	6
Total resources			**169**	**597**	**1,442**	**675**	**157**	**581**	**1,505**	**674**	**2**	**9**	**25**	**11**
Total undiscovered continuous resources			**4,139**	**13,439**	**27,913**	**14,370**	**10,382**	**34,863**	**76,102**	**37,966**	**113**	**422**	**1,055**	**482**

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For More Information

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