

Recovering Historical Decline Rates and Maximizing Production in a Mature Field*

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Abstract

A restoration plan has been applied in the Señal Picada Field since 2012 to recover the historical decline rate, which had deteriorated and doubled in the period 2007-2012. This situation led to P1 reserves loss in the same period. The field was discovered in 1963 and had several drilling campaigns, mainly between 1960's and 1980's. In the 1970's water injection for IOR was implemented. Currently the field has 270 producers and 110 injector wells.

This restoration plan involves drilling replacement and infill wells, and also includes work-over and maintenance activities for existing wells. An integrated subsurface model was proposed as the primary decision tool. A full field static model was finished in 2012. In 2012-2014 we used data from the static model to propose new wells, either replacement or infill. We used and compared a set of static and dynamic data as a method to maximize production:

- OOIP, RF, injected pore volume per layer and pattern, acreage.
- Last production rate and date in original wells (criteria for replacement wells).
- DCA analysis per pattern.
- Well integrity analysis, used to select work-overs (both injectors and producers)

This method has proved to be successful, considering that the project was profitable and decline rate recovered to near historical values at the end of 2013. Major surface modifications were also needed to achieve this goal. In 2014 the method showed

marginal results and the need for a full field dynamic model was clear if we wanted to maximize production and profit. This was created using dynamic software to evaluate current recovery factors and to assess new wells to be drilled in the field (replacement or infill). We had to validate fluid production and injection for more than 400 wells (with 3 or more active layers) and nearly 50 years of field history.

Current investment proposal in the field is supported by this tool, adding to the previous criteria the following:

- Current and final oil saturation, RF, and injected pore volume per pattern and layer. Identifies poorly drained zones.
- Scenario analysis (e.g. do nothing vs. drill) with production curves supported by a model (not only by DCA method)

Now we are drilling new wells and initial results are as forecasted by the model. We continue to gather new data from wells (e.g. logs not acquired before, such as NMR or RFT) to improve the static and dynamical models.



EXTENDING MATURE FIELDS' LIFE CYCLES: THE ROLE OF NEW TECHNOLOGIES & INTEGRATED STRATEGIES

11-12 May 2015 | Buenos Aires, Argentina

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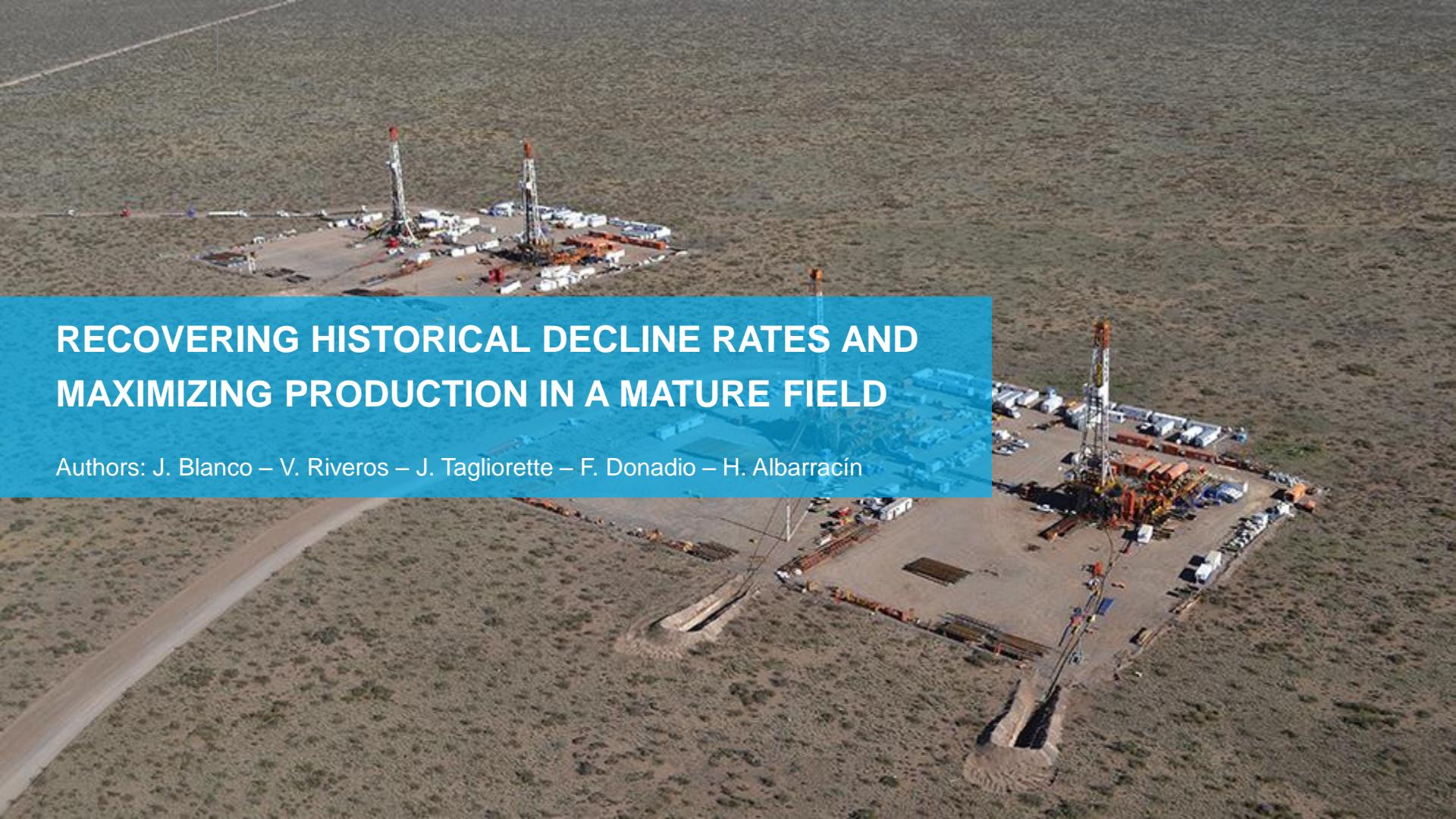
Este documento contiene ciertas afirmaciones que YPF considera constituyen estimaciones sobre las perspectivas de la compañía ("forward-looking statements") tal como se definen en la Ley de Reforma de Litigios Privados de 1995 ("Private Securities Litigation Reform Act of 1995").

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En el futuro, la situación financiera, ratios financieros, operativos, de reemplazo de reservas y otros, resultados operativos, estrategia de negocio, concentración geográfica y de negocio, volúmenes de producción y comercialización, reservas, gastos de capital e inversiones de YPF y expansión y otros proyectos, actividades exploratorias, intereses de los socios, desinversiones, ahorros de costos y políticas de pago de dividendos, así como futuras condiciones económicas y otras como el precio del petróleo y sus derivados, márgenes de refino y marketing y tasas de cambio podrían variar sustancialmente en comparación a aquellas contenidas expresa o implícitamente en dichas estimaciones. Factores importantes que pudieran causar esas diferencias incluyen pero no se limitan a fluctuaciones en el precio del petróleo y sus derivados, niveles de oferta y demanda, tasa de cambio de divisas, resultados de exploración, perforación y producción, cambios en estimaciones de reservas, éxito en asociaciones con terceros, pérdida de participación en el mercado, competencia, riesgos medioambientales, físicos y de negocios en mercados emergentes, modificaciones legislativos, fiscales, legales y regulatorios, condiciones financieras y económicas en varios países y regiones, riesgos políticos, guerras, actos de terrorismo, desastres naturales, retrasos de proyectos o aprobaciones, así como otros factores descriptos en la documentación presentada por YPF y sus empresas afiliadas ante la Comisión Nacional de Valores en Argentina y la Securities and Exchange Commission de los Estados Unidos de América y, particularmente, aquellos factores descriptos en la ítem 3 titulada "Key information— Risk Factors" y la ítem 5 titulada "Operating and Financial Review and Prospects" del Informe Anual de YPF en Formato 20-F para el año fiscal finalizado el 31 de Diciembre de 2013, registrado ante la Securities and Exchange Commission. En vista de lo mencionado anteriormente, las estimaciones incluidas en este documento pueden no ocurrir.

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Este material no constituye una oferta de venta de bonos, acciones o ADRs de YPF S.A. en Estados Unidos u otros lugares.



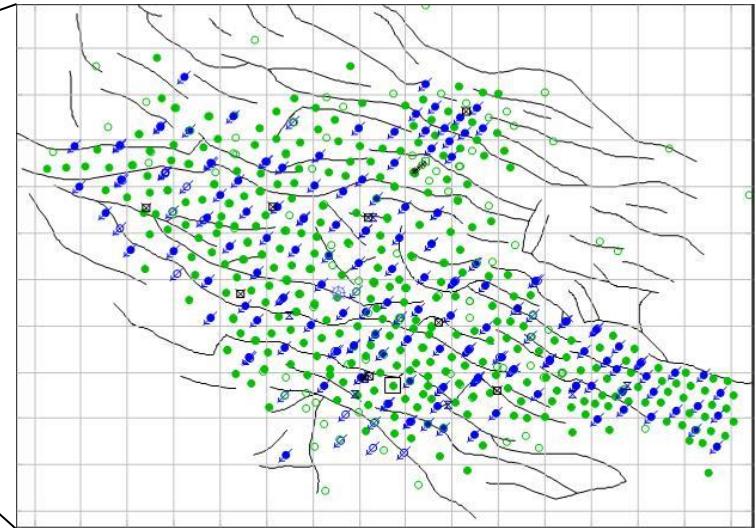
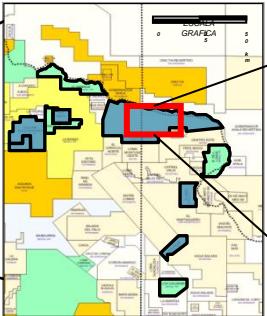
RECOVERING HISTORICAL DECLINE RATES AND MAXIMIZING PRODUCTION IN A MATURE FIELD

Authors: J. Blanco – V. Riveros – J. Tagliorette – F. Donadio – H. Albarracín

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- Problem description 
- Methodology proposed 
- Initial Results 
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- Remarks & Final Conclusions 

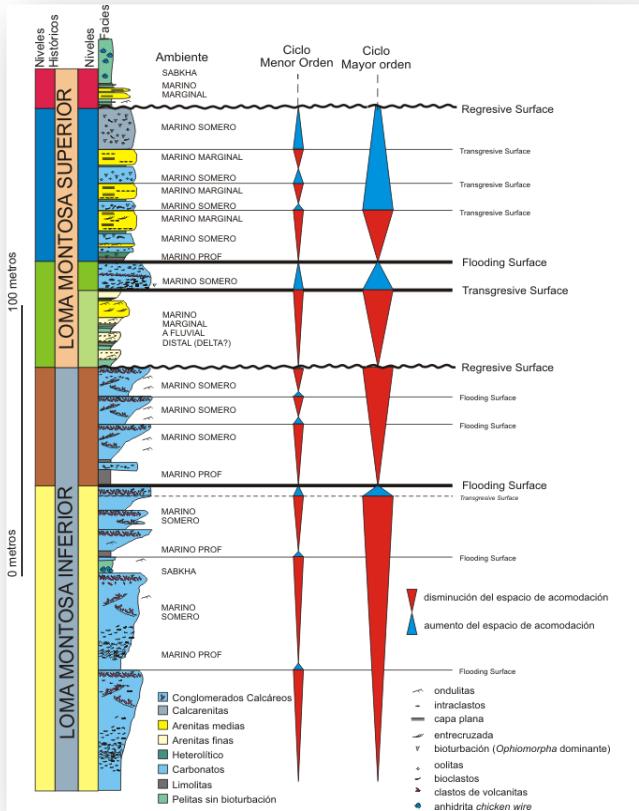
Geographic Location



Señal Picada field is located in Neuquén Basin, in Río Negro and Neuquén States, 60 km from Catriel town and 190 km from Neuquén City.

Geology

RECOVERING HISTORICAL DECLINE RATES AND MAXIMIZING PRODUCTION IN A MATURE FIELD



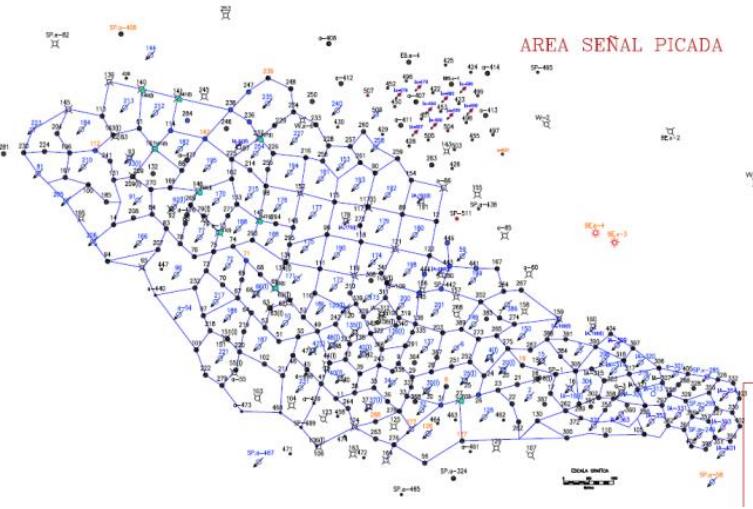
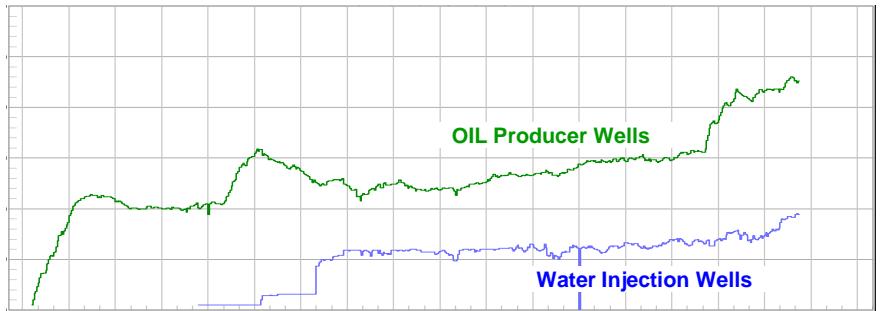
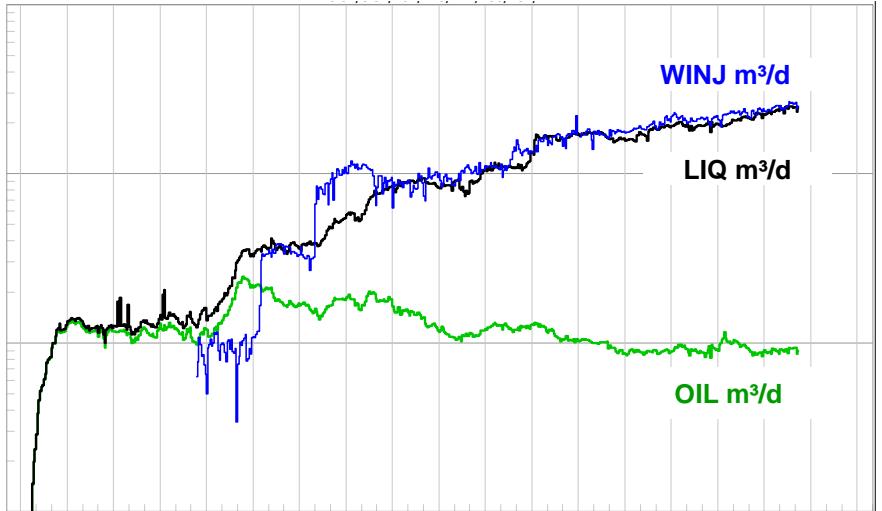
Upper Fm Loma Montosa is the main reservoir in Señal Picada field. Hydrocarbon production also provides from the Lower Member of It and Centenario Fm.

The reservoirs of Upper Loma Montosa Fm consist of shallow marine deposits represented by Sandstone, Limestone Sandy and less Cluster Limestone. Its petrophysical properties are good.

The reservoirs of Lower Loma Montosa Fm consist of Limestone Conglomerates, Limestone and Sandstone. It has worse petrophysical conditions than the Upper Member.

Production and Injection History

RECOVERING HISTORICAL DECLINE RATES AND MAXIMIZING PRODUCTION IN A MATURE FIELD



First oil (year)	1965
Production Wells	+250
Injection Wells	+100
Oil bbl/d	5600
Water inj bbl/d	157000

Water cut %	>96
RF %	27
Lease exp. date	2027

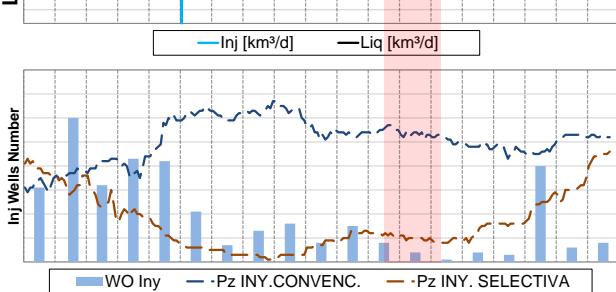
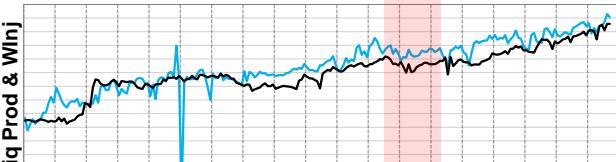
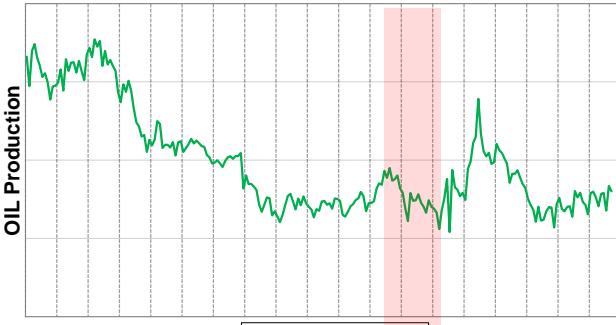
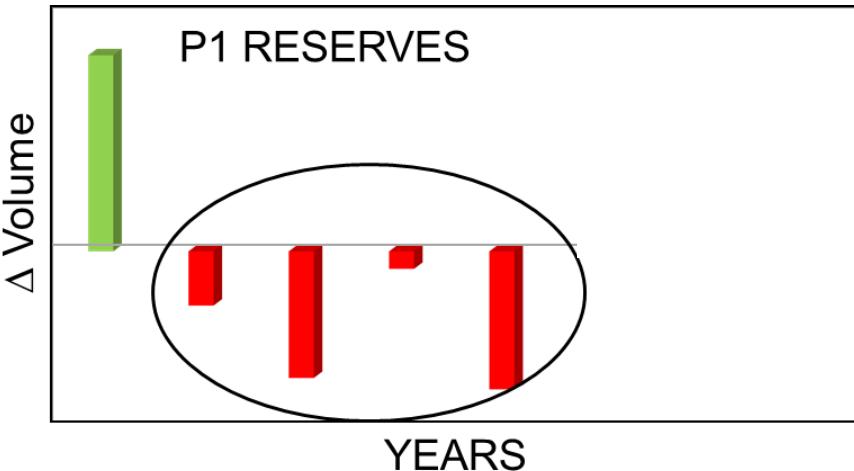


Problem description

In the period highlighted the field had a severe decline rate (twice than previous rate), the main reasons were:

- Shut down of injector and producer wells by mechanical integrity.
- Poor vertical sweep efficiency (% conventional wells)
- Surface injection system damaged (pipes, tanks, pumps). Water injection was discontinuous.

As a result the field lost P1 Reserves in consecutive periods



Methodology

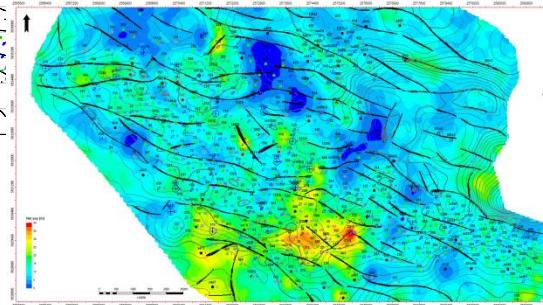
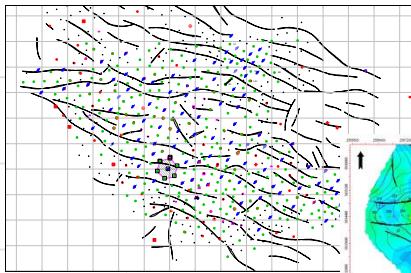
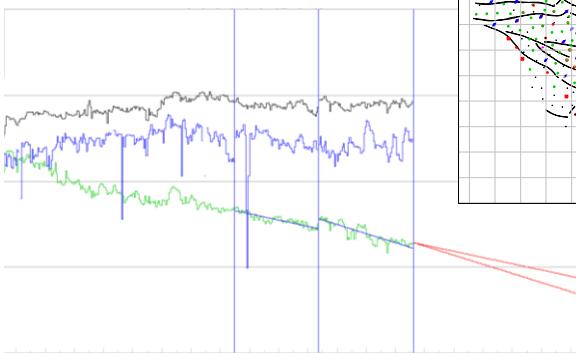
To recover the historical decline of the Field we focus on optimizing Oil production & Water Injection by:

- Workover in injection and producer wells.
- Replacement of injection and producing wells.
- Run selective completion in new injection wells
- Identification of new pay zones.
- Drill infill wells
- Repair and build surface facilities

Well Selection Period 2012 - 2014

In the period 2012-2014 we use data from the static model to propose new wells, either replacement or infill. We used and compared a set of static and dynamic data as a method to maximize production:

- Last production rate and mechanical condition in original wells (criteria for replacement wells).
- DCA per pattern.
- OOIP, RF, acreage, Net Pay.
- Well integrity analysis: used to select workovers (both injectors and producers).

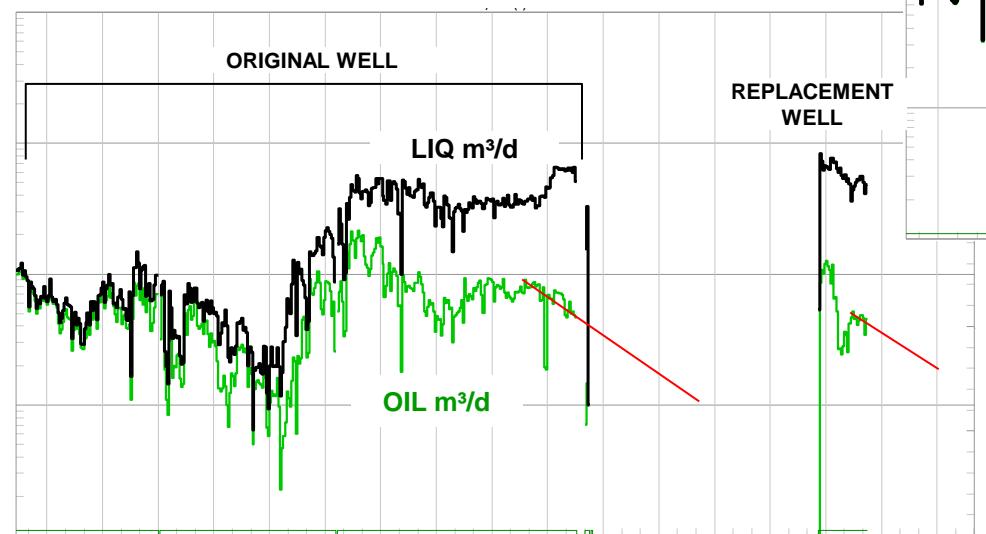
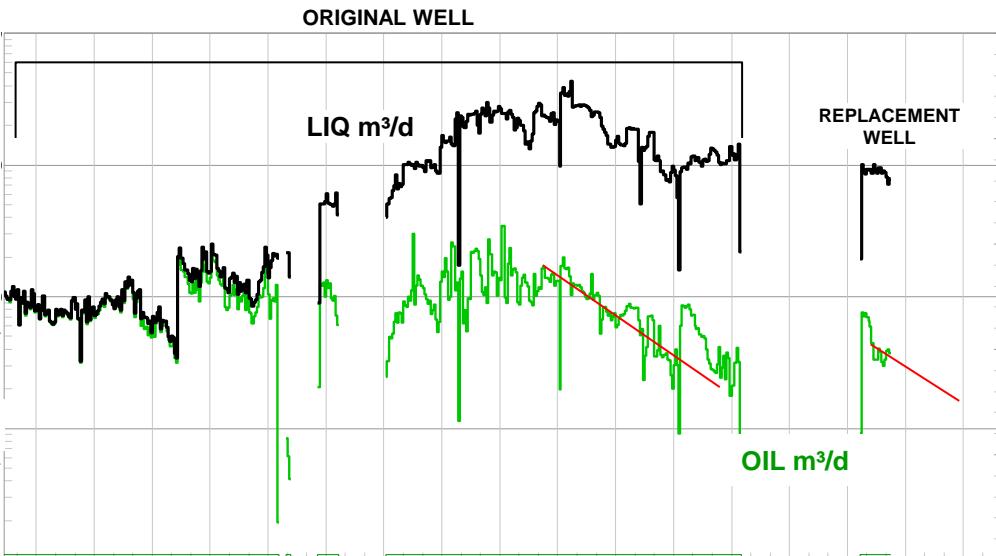


**YPF GERENCIA DE PERFORACION UNAO
INGENIERIA DE WORKOVER**
PROTOCOLO VALORACION DEL RIESGO EN WORKOVER DE POZOS INYECTORES

Condición del CASING		30%
1	Maximo	Estado Desconectado
1.1	25%	No
1.2	15%	Mas de 200 ms
1.3	15%	Entre 4 & 8 años
1.4	10%	Bueno
1.5	15%	No
1.6	15%	Riesgo Casing
		15
Condición de Instalación de Inyección Actual		70%
2	Maximo	Riesgo
2.1	20%	No
2.2	20%	Conveniente
2.3	20%	No
2.4	10%	Aceptable
2.5	5%	2.7%
2.6	5%	Menor a 4 años
2.7	5%	
		dago Instalación
		79
Posibilidad de Cumplimiento del Objeto:		

Well Selection Period 2012 - 2014

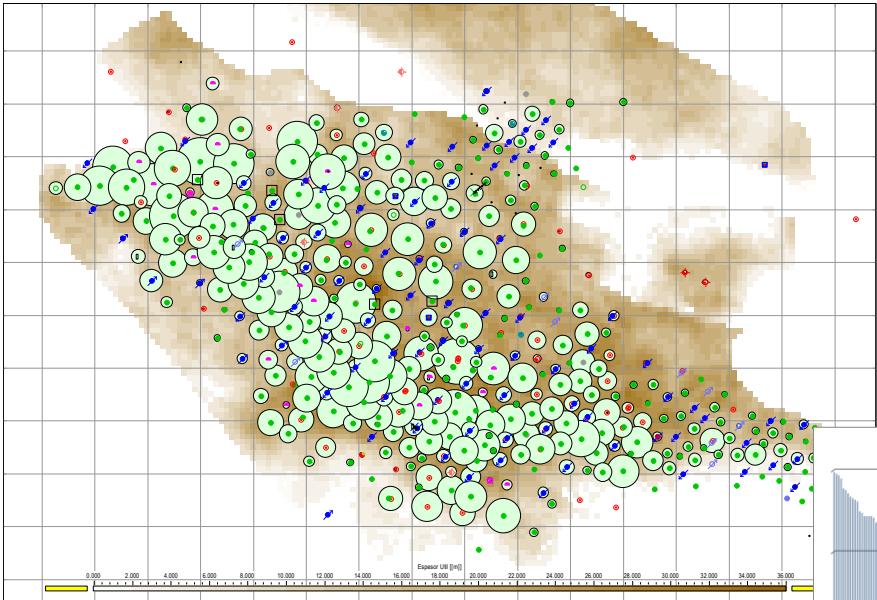
- Last production rate and mechanical condition in original wells (criteria for replacement wells)



Only productive wells with integrity issues were replaced.

Well Selection Period 2012 - 2014

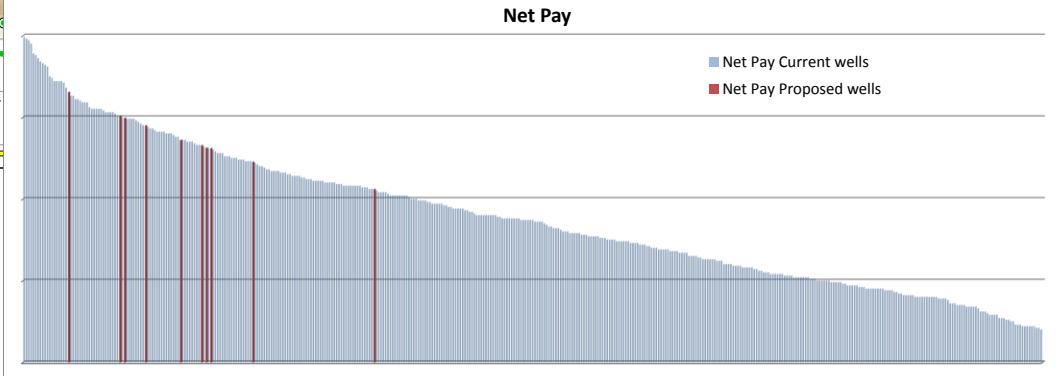
- OOIP, RF, acreage (Infill Wells)



For the selection of Infill Wells, we calculated the drainage radios of wells in Señal Picada field, with the following considerations:

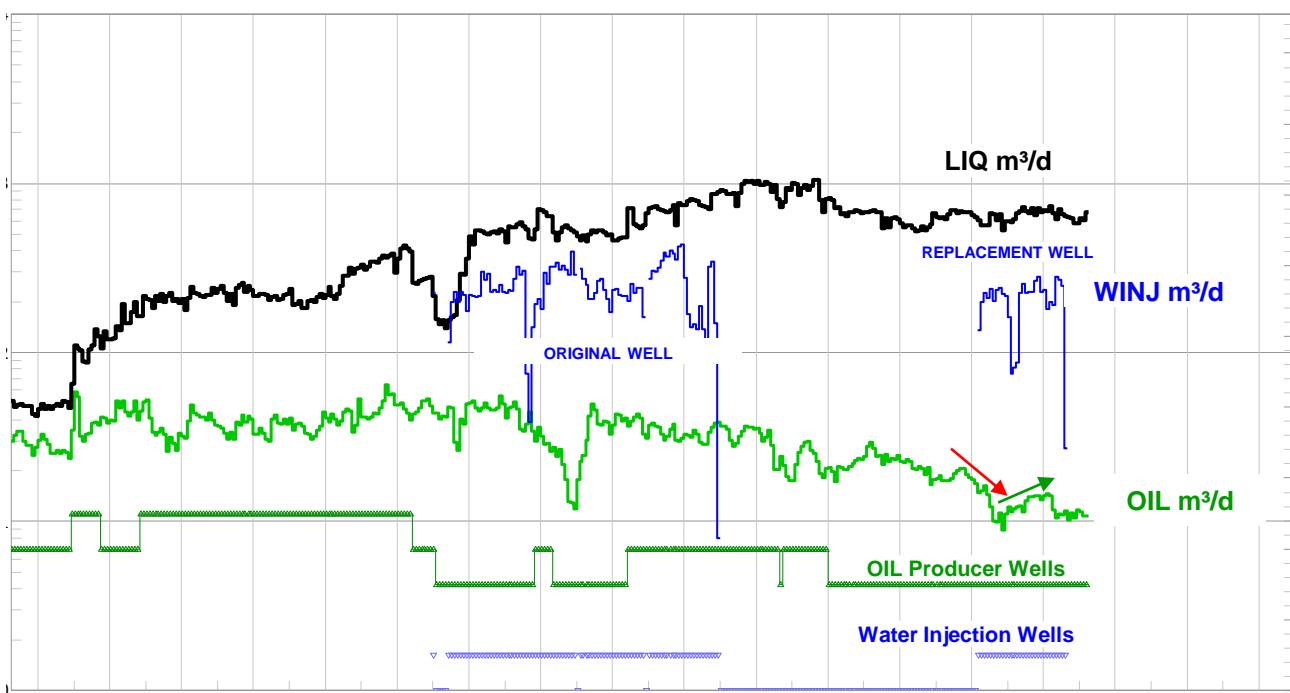
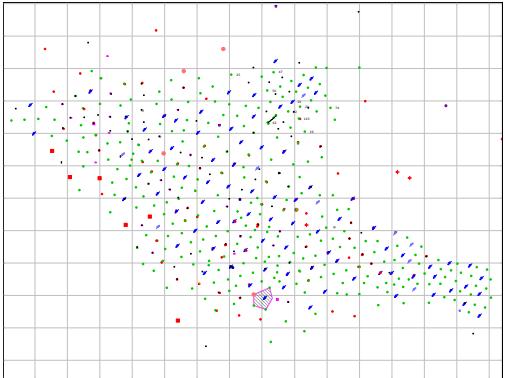
$$Rd = \sqrt{\frac{Np \cdot Bo}{\pi \cdot Hutil \cdot (1 - Sw_{ini}) \cdot Phi \cdot FR}}$$

We considered that the selected positions were in zones with good net pay.



Well Selection Period 2012 - 2014

- DCA per pattern.



Well Selection Period 2012 - 2014

- Well integrity analysis: used to select workovers (both injectors and producers)

GERENCIA DE PERFORACION UNAO INGENIERIA DE WORKOVER		
PROTOCOLO VALORACION DEL RIESGO EN WORKOVER DE POZOS PRODUCTORES		
1	Condición del Casing	40%
1.1	Maximo Estado	
1.2	5% Bueno	7
1.3	25% Buena	
1.4	15% Por encima de la Guia	
1.5	10% Bueno	
1.6	10% Entre 4 & 8 años	
1.7	10% No	
	Riesgo Casing	4
2	Condición de Instalación de Productor	60%
2.1	Maximo Riesgo	
2.2	20% PCP	
2.3	30% SPESCA	
2.4	15% Poco daño	
2.5	20% Menor a 4 años	
2.6	15% Vertical	
	Riesgo Instalación	9
Posibilidad de Cumplimiento del Objetivo:		
		87

GERENCIA DE PERFORACION UNAO INGENIERIA DE WORKOVER		
PROTOCOLO VALORACION DEL RIESGO EN WORKOVER DE POZOS INYECTORES		
1	Condición del Casing	30%
1.1	Maximo Desconocido	
1.2	25% No	
1.3	15% Mas de 200 mts	
1.4	10% Entre 4 & 8 años	
1.5	10% Poco daño	
1.6	10% No	
	Riesgo Casing	15
2	Condición de Instalación de Inyección Actual	70%
2.1	Maximo No	
2.2	10% No	
2.3	10% Conocido	
2.4	15% No	
2.5	15% Algun daño	
2.6	20% Menor a 4 años	
2.7	Riesgo Instalación	6
Posibilidad de Cumplimiento del Objetivo:		
		79

Calculated WO 2012

Well	Percent of Success
WO_INY_1	43%
WO_INY_2	77%
WO_INY_3	55%
WO_INY_4	38%
WO_INY_5	42%
WO_INY_6	58%
WO_INY_7	49%
WO_INY_8	70%
WO_INY_9	73%
WO_INY_10	86%
WO_INY_11	63%
WO_INY_12	62%
WO_INY_13	80%
WO_INY_14	64%
WO_INY_15	80%
WO_INY_16	39%
WO_INY_17	58%
Average % Success	61%

Current

Campaign	Interventions (Total/Failure)	% Success
2012	44 / 15	66
2013	7 / 0	100
2014	12 / 1	92
Total	63 / 16	75

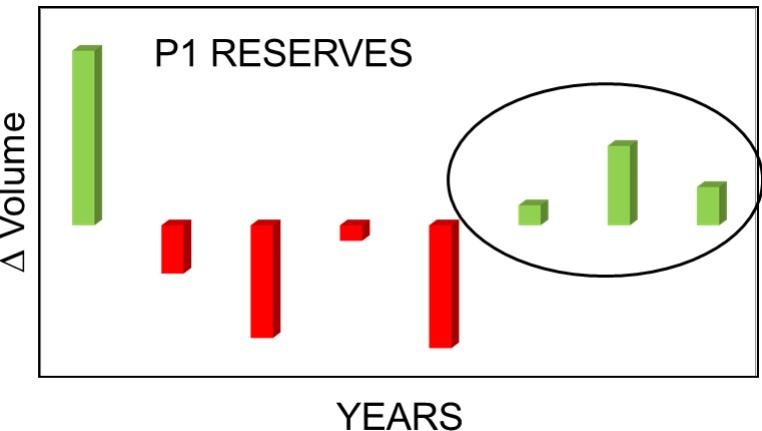
Calculated
(2015+)

Well	% Success
WO-1	67
WO-2	91
WO-3	91
WO-4	87
WO-5	61
WO-6	73
WO-7	66
WO-8	62
WO-9	72
WO-10	71
WO-11	91
WO-12	71
WO-13	64
WO-14	87
Promedio	75



Initial Results 2012 - 2014

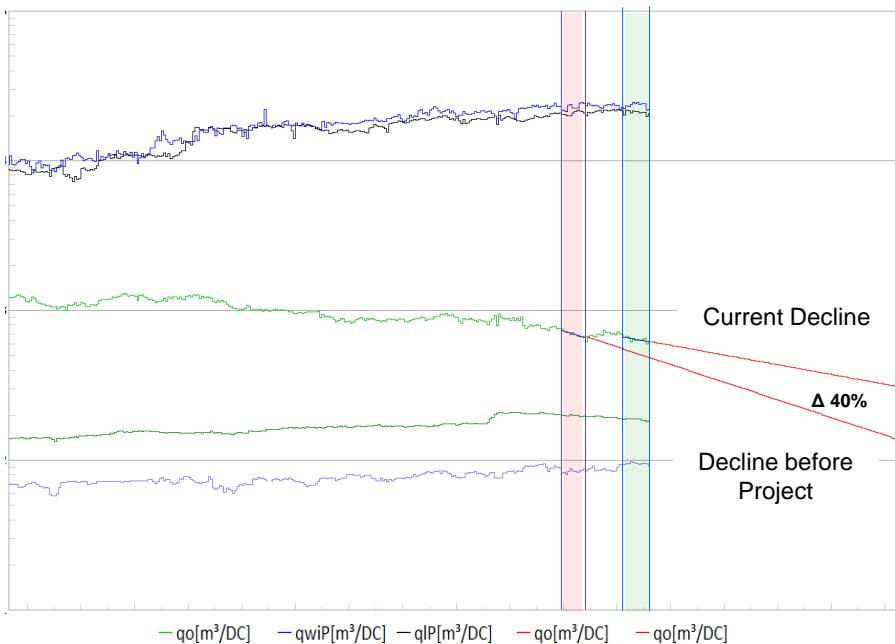
- After 3 years overall results were satisfactory. The project included new wells, workovers and investment in surface facilities.
- Campaigns 2012-2013 showed results higher than forecasted.
- Field decline rate was improved.
- P1 Reserves were added in consecutive periods
- But campaign 2014 exhibited poorer results, especially in new wells.
- Methodology had to be improved



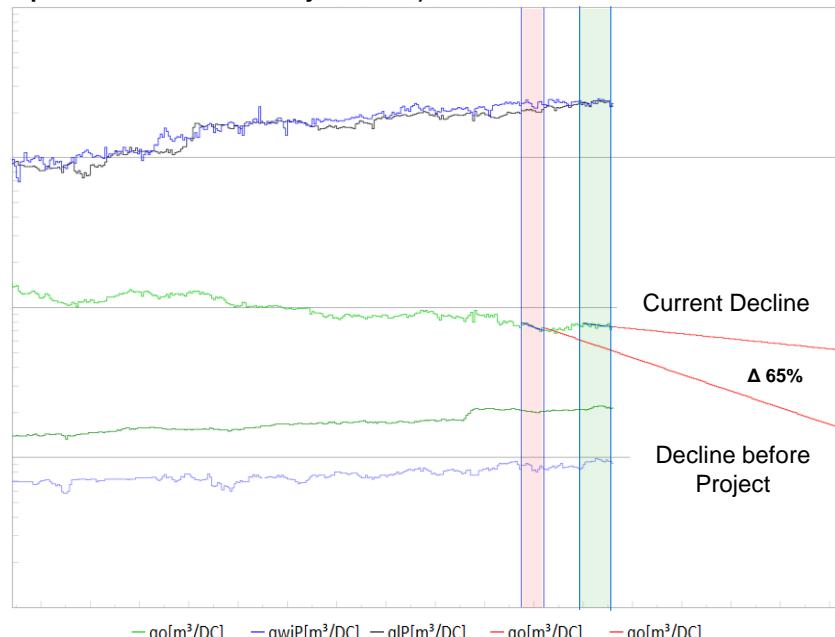
Initial Results 2012 - 2014

Field decline rate was improved.

New Injection wells and WO

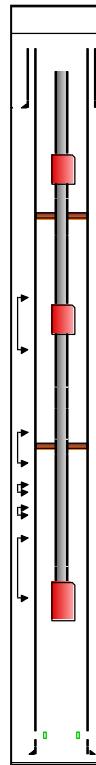


Entire Project (New Wells and Workovers, both
producers and injectors)



Proposed methodology 2015+

- To reduce uncertainties a full field dynamic model was proposed. Time to deliver was a constraint and an analytic tool was chosen to build the model.
 - Static model was used as an input for layer properties, well tops, OOIP, etc.
 - Extensive data gathering and analysis: more than 400 wells (with 3 or more active layers) and 50 years of field history. Data quality is poor if it is old (>15 years).
- Time expended to build up the model: 10 months
- When the model was adjusted, it allowed us to:
 - Evaluate current and final So, RF, PVI
 - Identifies poor drained areas
 - Make scenario analysis
 - Support for new data acquisition: NMR logs, RFT, cores, well test.



Well Selection Period 2015+

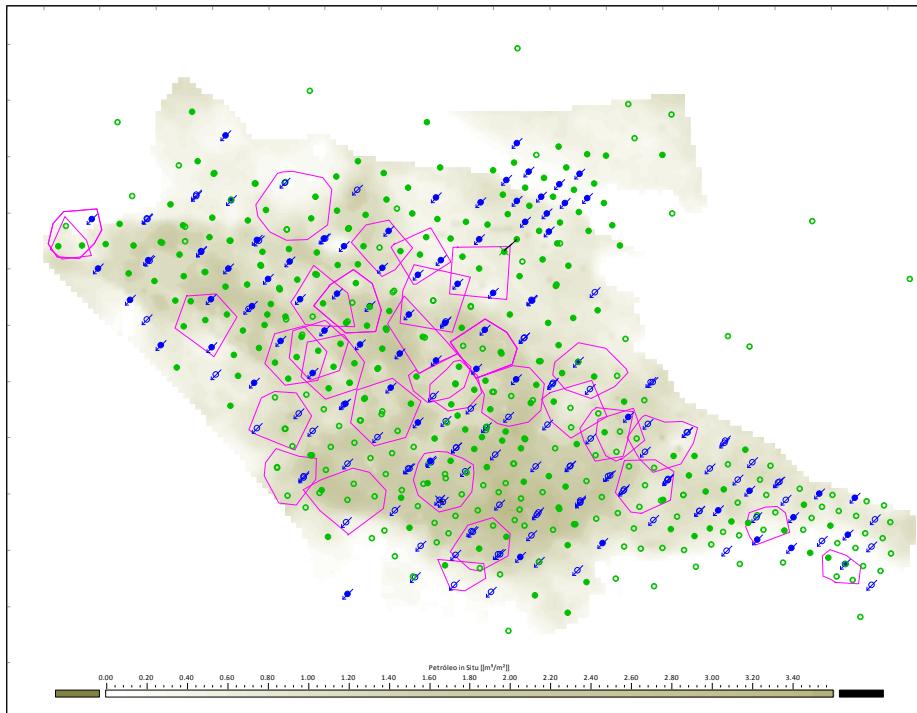
- Pre-selection

Replacement Wells

Current RF of abandoned wells or wells that are going to be abandoned soon

Infill Wells

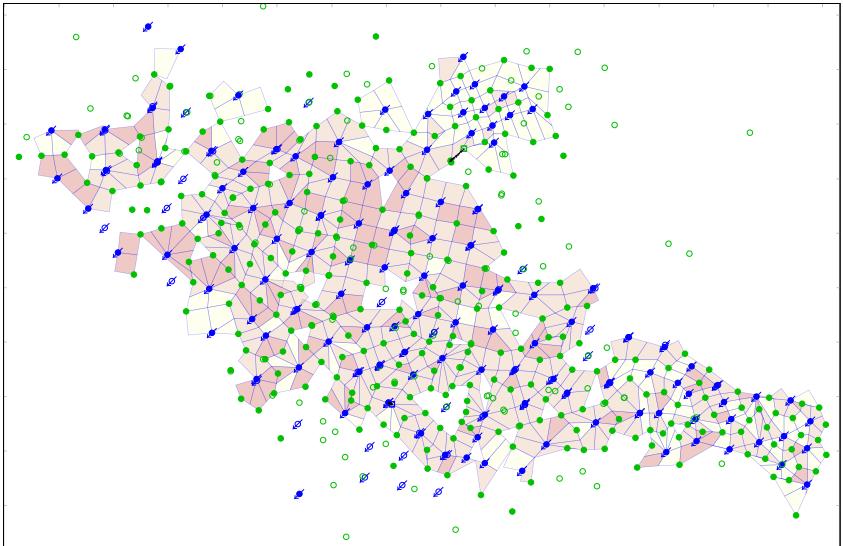
Current RF of locations with larger acreage than field average.



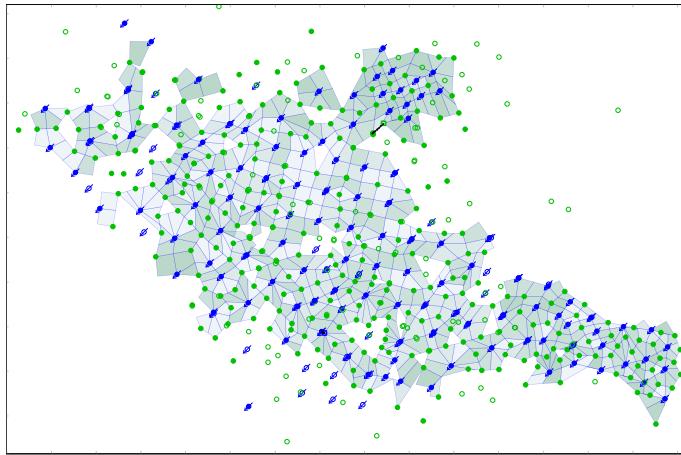
Well Selection Period 2015+

- Dynamic Model

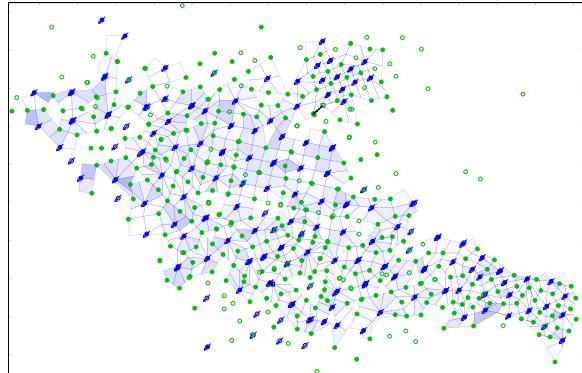
RF



So



PVI

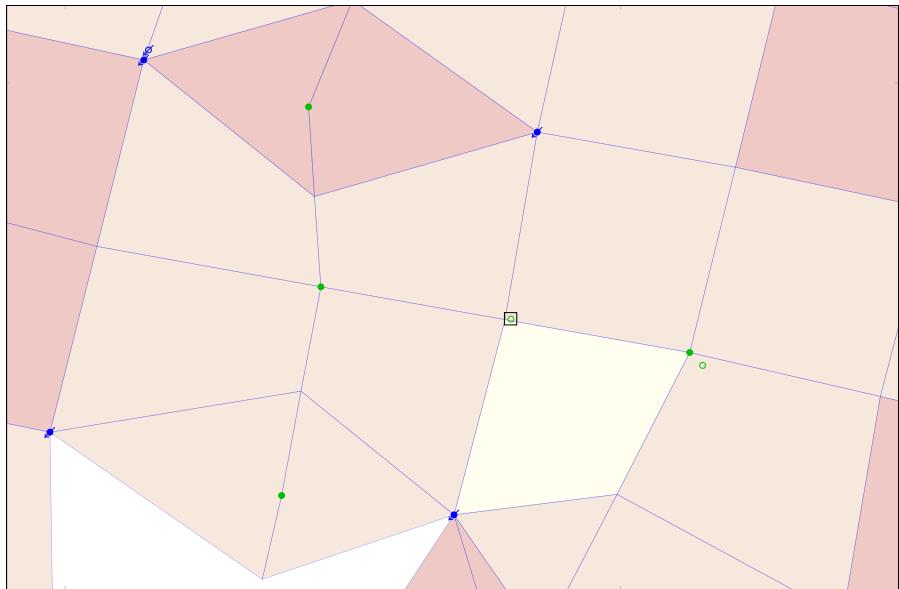


Well Selection Period 2015+

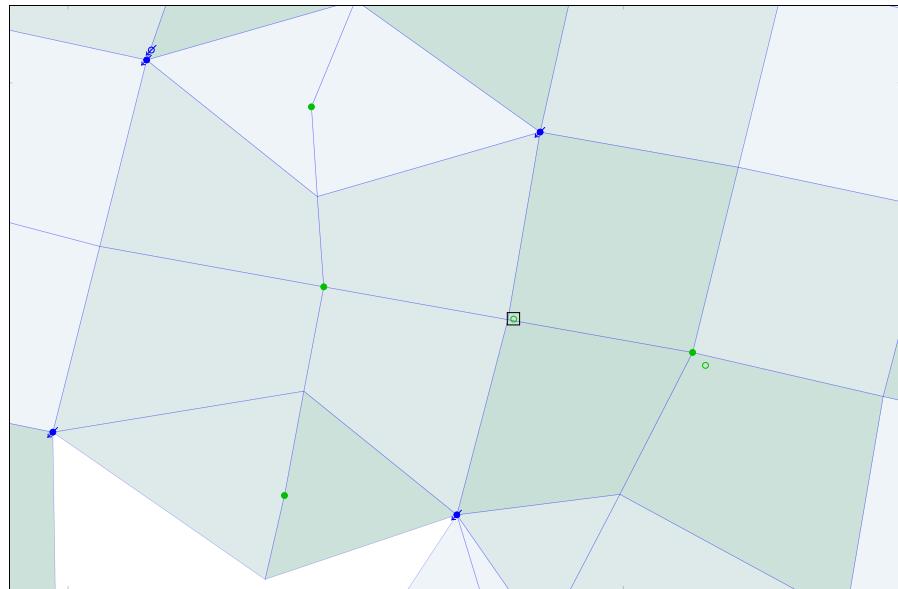
Infill well proposed

RF y So: better than field average

FR



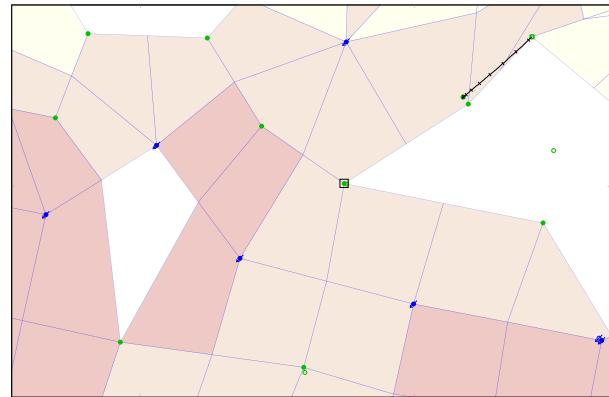
So_{AVG}



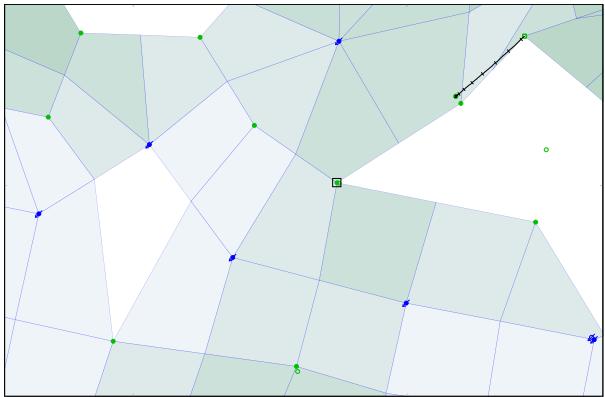
Well Selection Period 2015+

Replacement proposed: producer well

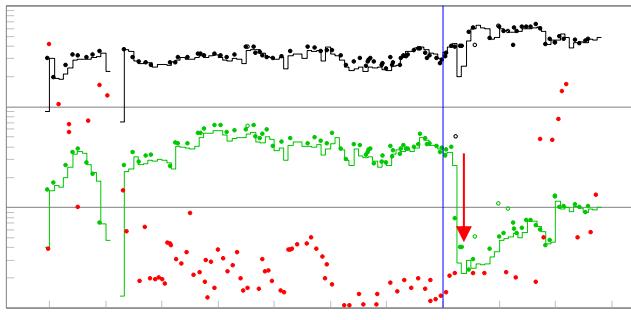
RF



So_{AVG}



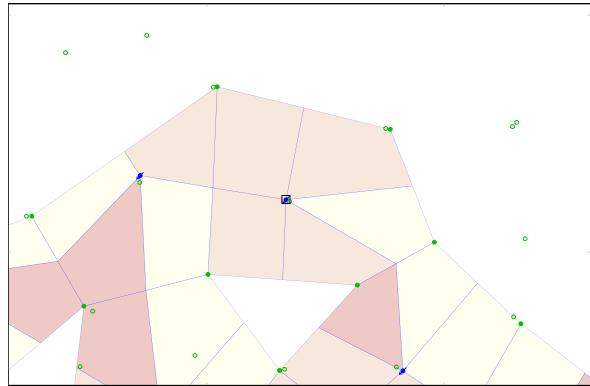
Production lost in original well



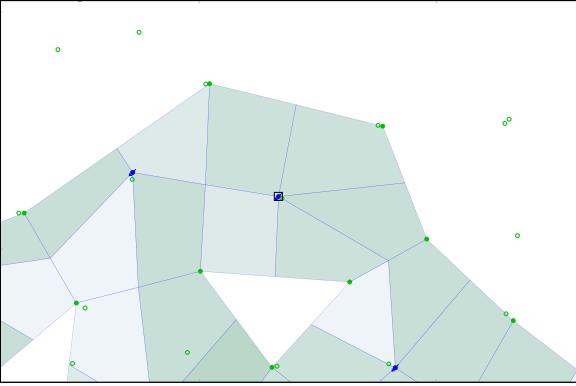
Well Selection Period 2015+

Replacement proposed: injector well

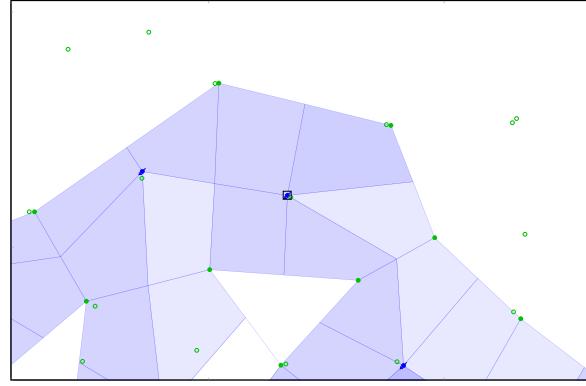
RF



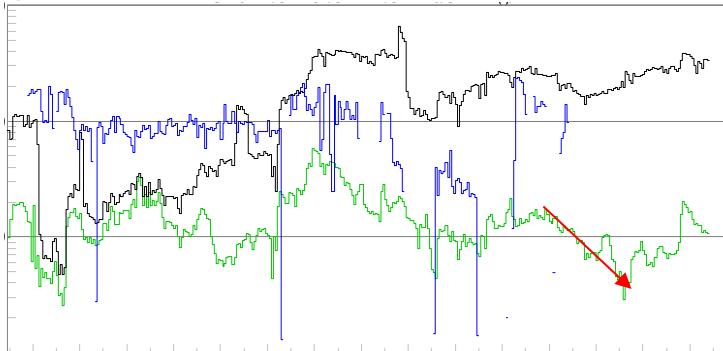
So_{AVG}



PVI



Production lost in original
injection pattern



Scenario Analysis



Do nothing vs Proposed wells

RF increase 0,4% (12 years period)



- The project showed initial success.
- Decline rate was restored and P1 reserves were added
- Even if successful, a methodology needs to be reviewed periodically to maximize profit in a mature field
- Until now analytic software for dynamic full field model is our best decision making tool. It is recommended to evaluate feasibility of a numerical full field model (cost-benefit of the tool).
- New wells drilled in 2015 showed results according to dynamic model simulation

A landscape photograph showing a tall drilling rig on the left, situated in a dry, hilly terrain. In the background, a range of mountains is covered with snow. The sky is blue with scattered white clouds.

Thanks

YPF
NUESTRA ENERGÍA