

Challenges and Opportunities in a Large Oil Field With Poor Quality Data: Integrated Modelling Solution for the Barrancas Field, Cuyana Basin, Argentina*

Héctor J. Campos¹, Gaston Manestar², Fabricio Nissero², Silvana Gandi², Fabian D'Andrea², Elena Morettini², Anthony Thompson², Alejandro Fabian Saccomano², and Jazmin Propato²

Search and Discovery Article #20324 (2015)**

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Abstract

In Argentina, a number of fields have declined significantly while applying historical development strategies. These fields typically have a long production history and a large number of wells, often with incomplete and inconsistent data sets. Redevelopment strategies based on integrated models are needed to extract remaining oil, overcoming contradictory electric log signatures, old lithostratigraphic correlation, and poor understanding of dynamic behavior. The fault-bounded Barrancas anticline is one of the aforementioned fields, with more than 400 wells and over 60 years of oil production history. Early water-flood showed an excellent response in the field; yet production has strongly declined and significant oil remains in the subsurface (RF 26%). The primary objective of this study was to quantify remaining opportunities and obtain an optimized development plan, justifying further investment in this old field. Facies associations coming from core and outcrop analyses interpreted the Barrancas Formation as a North-South prograding alluvial-ephemeral system. Changes between progradational and retrogradational periods were used as chronostratigraphic correlation surfaces. Areal trends in reservoir quality, resulting from this stratigraphic model, were clearly reflected in uneven production distribution across the field, but were not as clearly shown in the outdated and contradictory electric logs responses. Log data was in fact found to be inconsistent, due to low resolution Spontaneous Potential profiles and volcanic-affected Gamma Ray logs. Since production history was the most consistent reservoir response, it was decided to use dynamic data upfront, as the main constrain for reservoir characterization and modelling. By doing so, different geological scenarios were tested and compared, letting dynamic data guide the appropriate hierarchy, porosity, and connectivity of reservoir bodies. To aid integration and guarantee consistency between static and dynamic models, the geological model was deliberately built at a scale that could be simulated. Dynamic models built this way managed to overturn existing preconceptions about the field (reservoir quality distribution, distinct OWCs, aquifer impact) and to successfully predict the existence of unexploited flank oil and unswept central zones. Even when the field was supposed to be mature, the study proved existence of enough opportunities to support additional investments.

Reference Cited

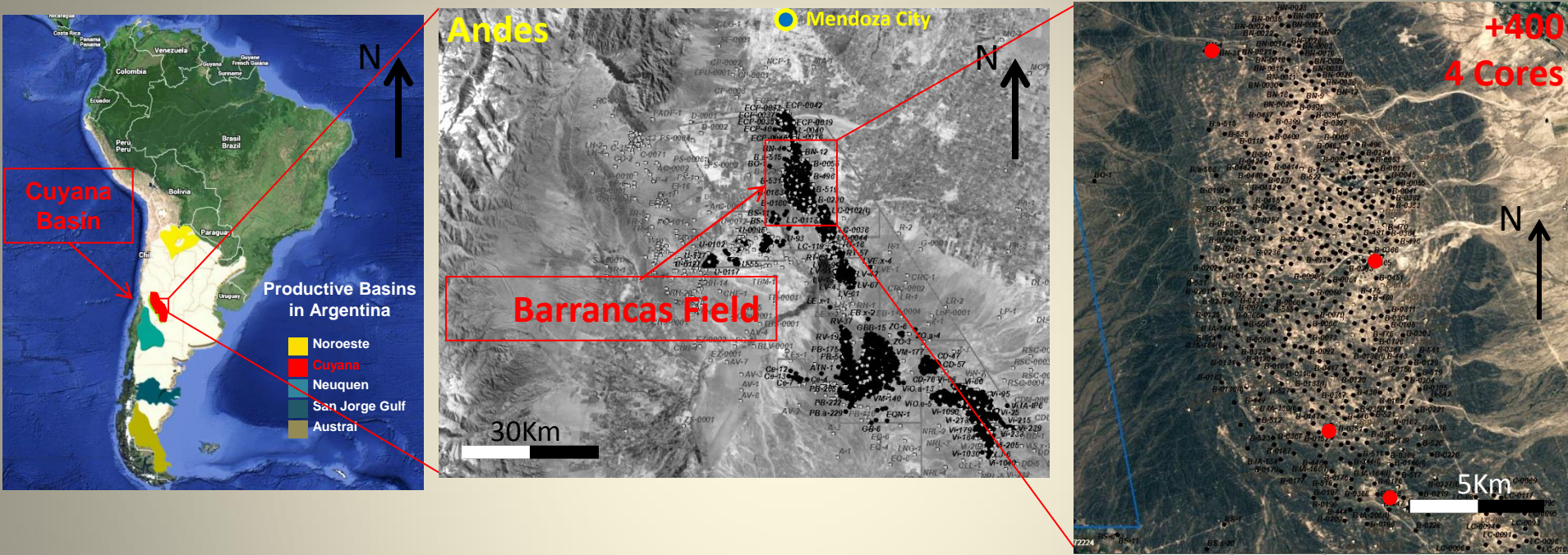
Galloway, W.E., and D.K. Hodbay, 1996, Terrigenous Clastic Depositional Systems: Applications to Fossil Fuel and Groundwater Resources: Springer-Verlag, Berlin, Germany, 489 p.



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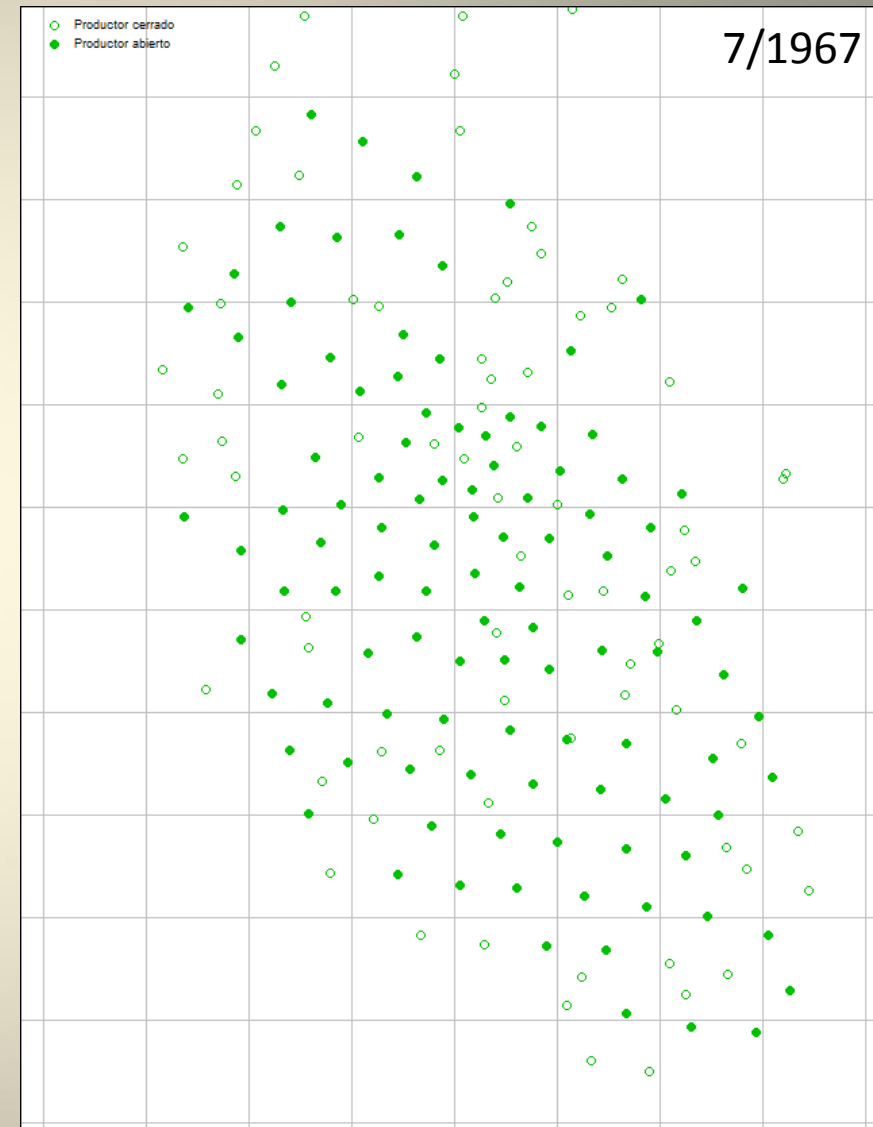
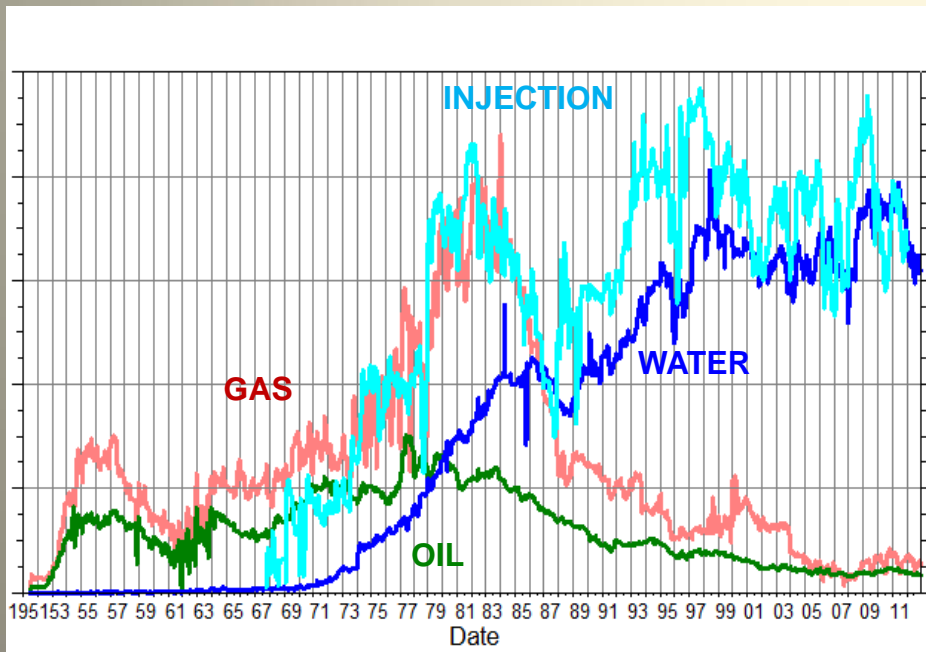
Héctor Campos, Fabian Dandrea, Silvana Gandi, Gaston Manestar, Elena Morettini, Fabricio Nissero, Jazmin Propato, Alejandro Saccomano, Anthony Thompson.



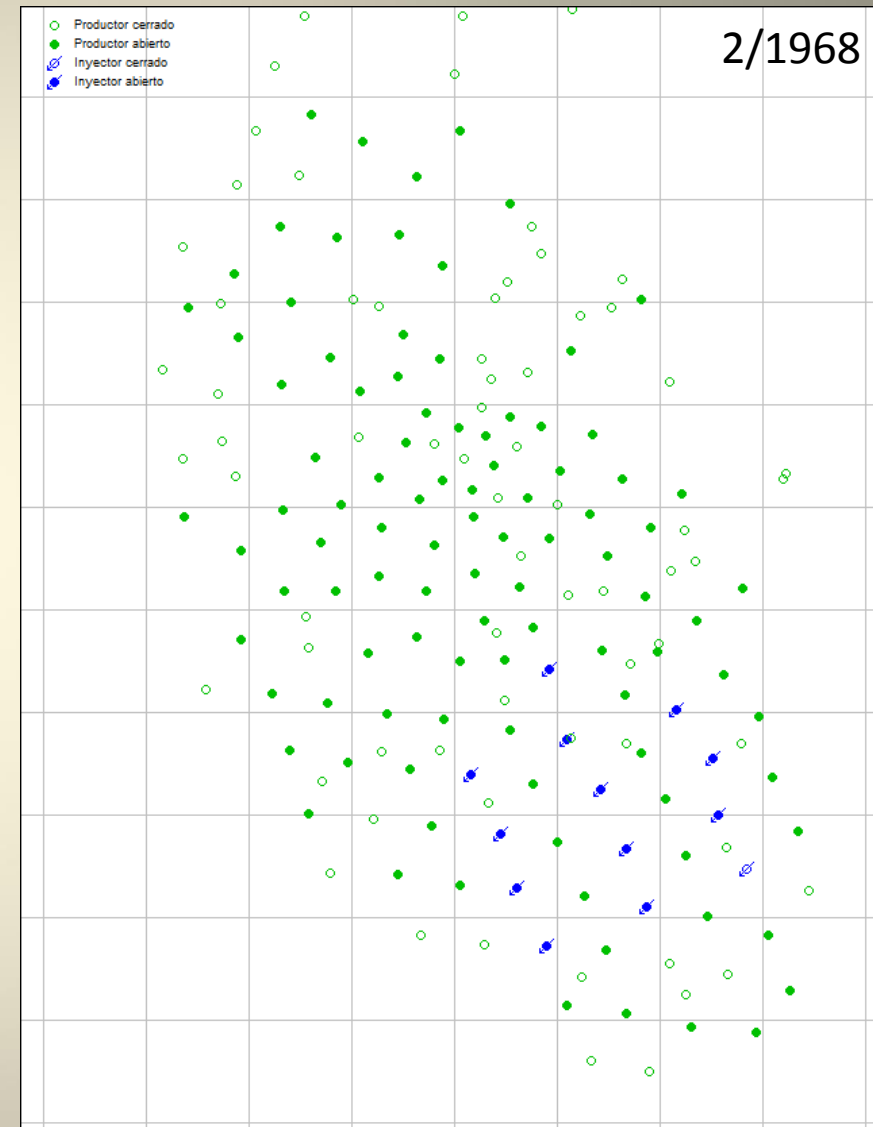
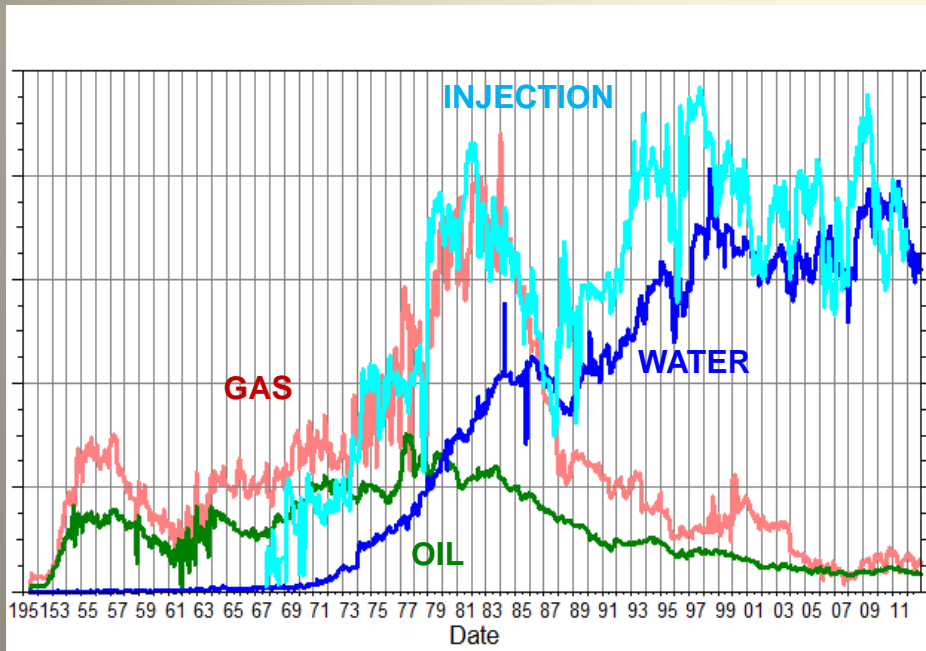


- Large Field (+400 Wells)
- Most productive field of the basin
- Long production history (+50 years)
- Limited data set (4 cores, limited well logs set, low seismic resolution)

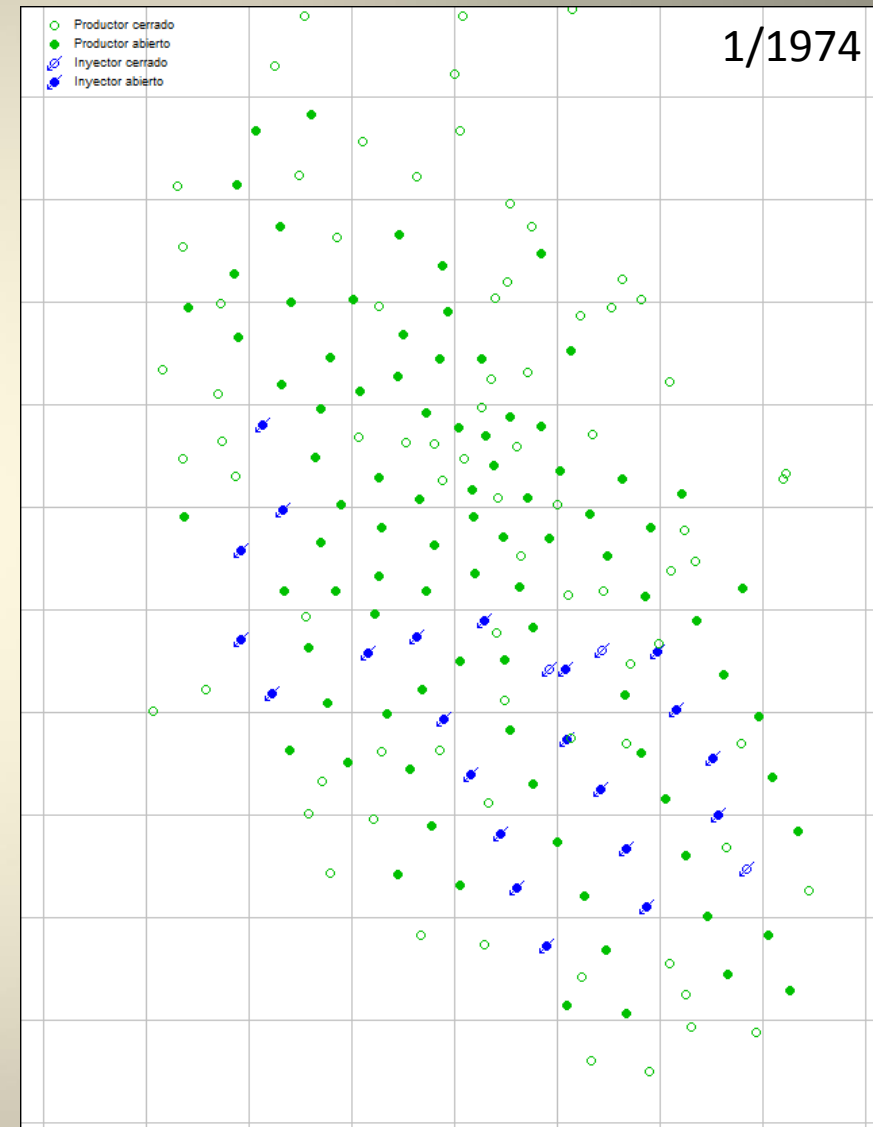
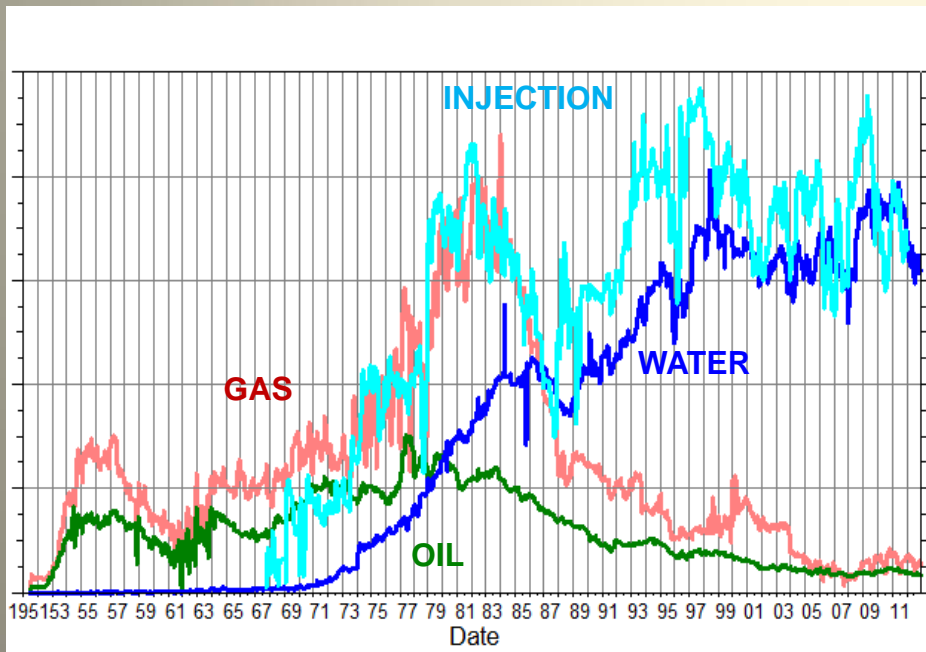
- *Good Water Injection Response*
- *Problems with Water Injection Distribution (lack of selective injection, poor water quality, random pattern design, etc.)*
- *Surface problems override subsurface optimization*



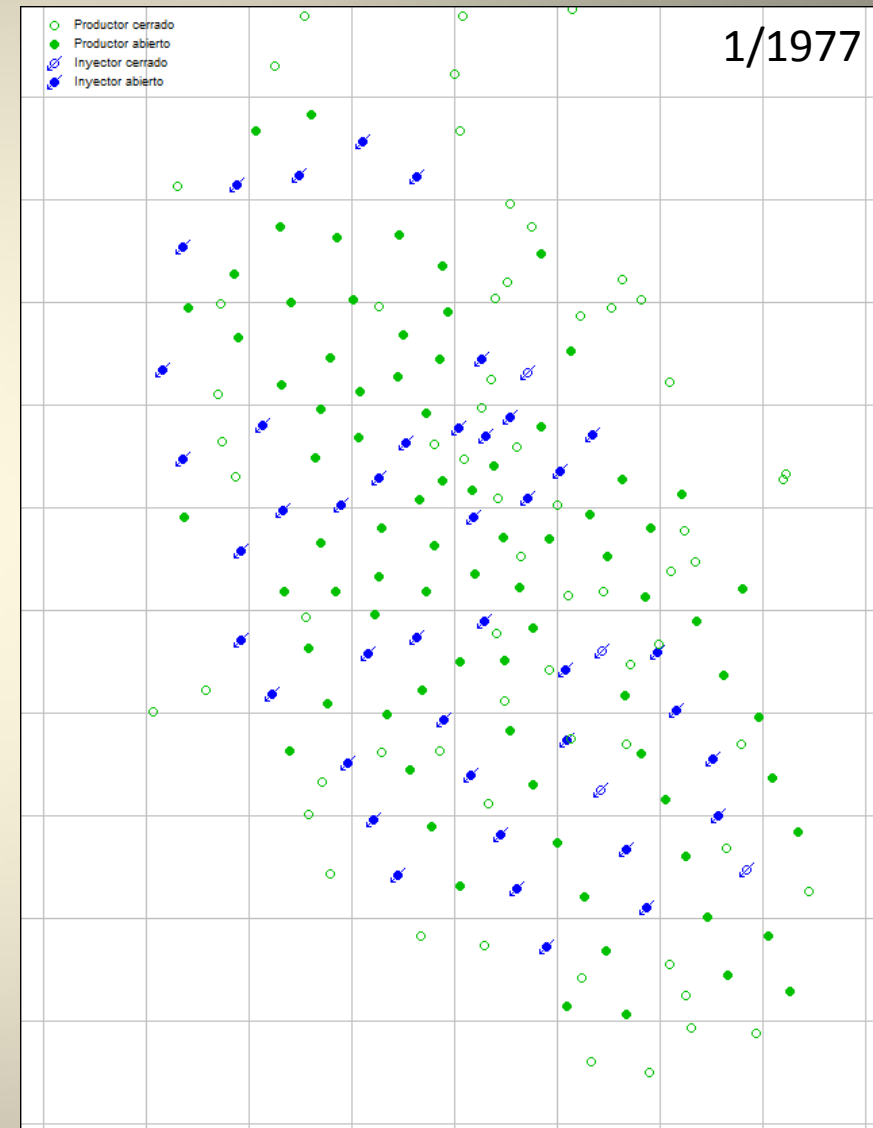
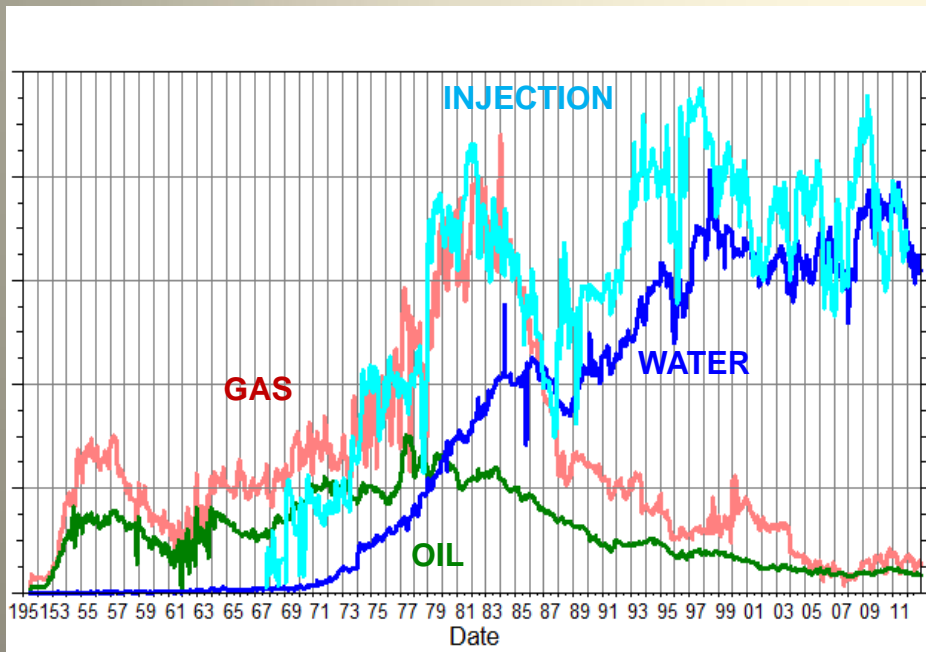
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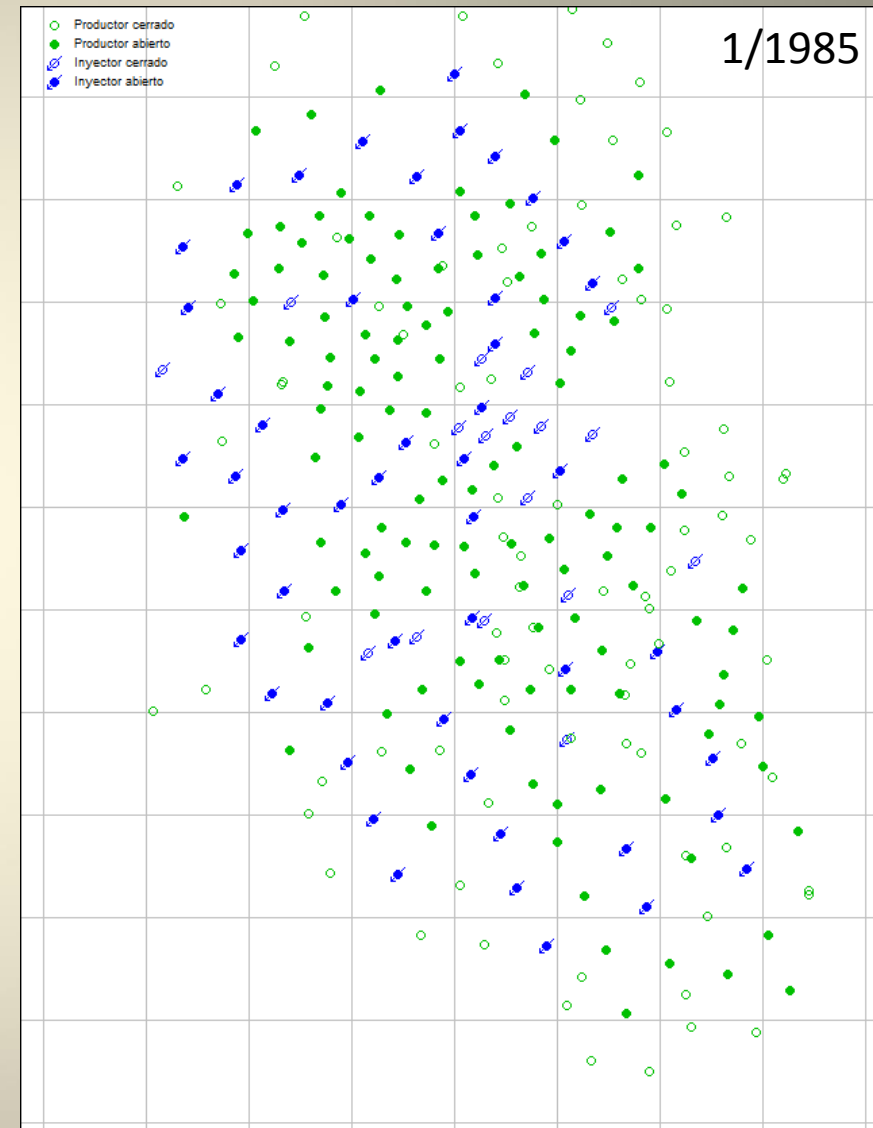
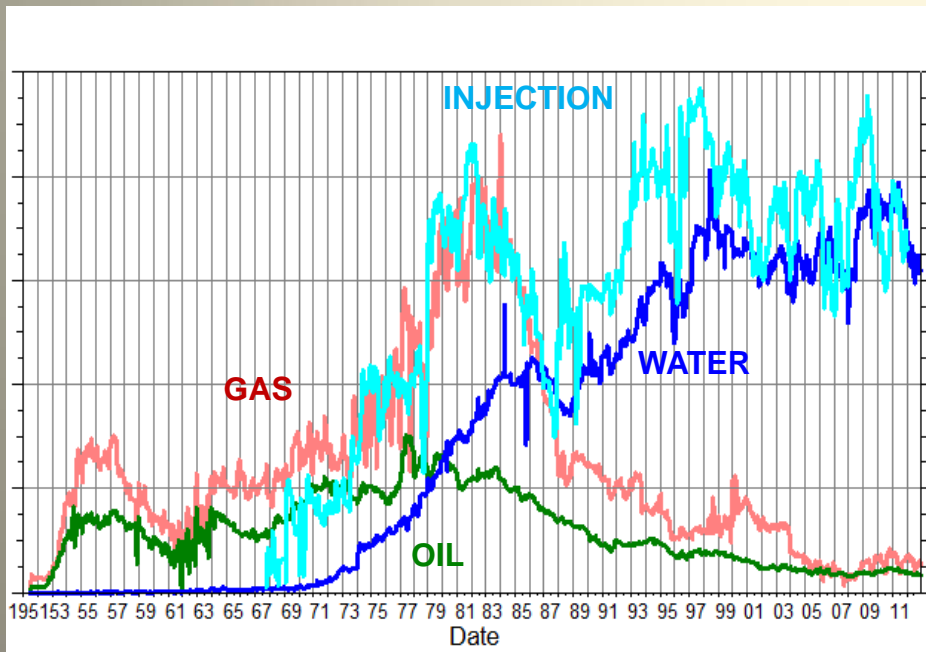
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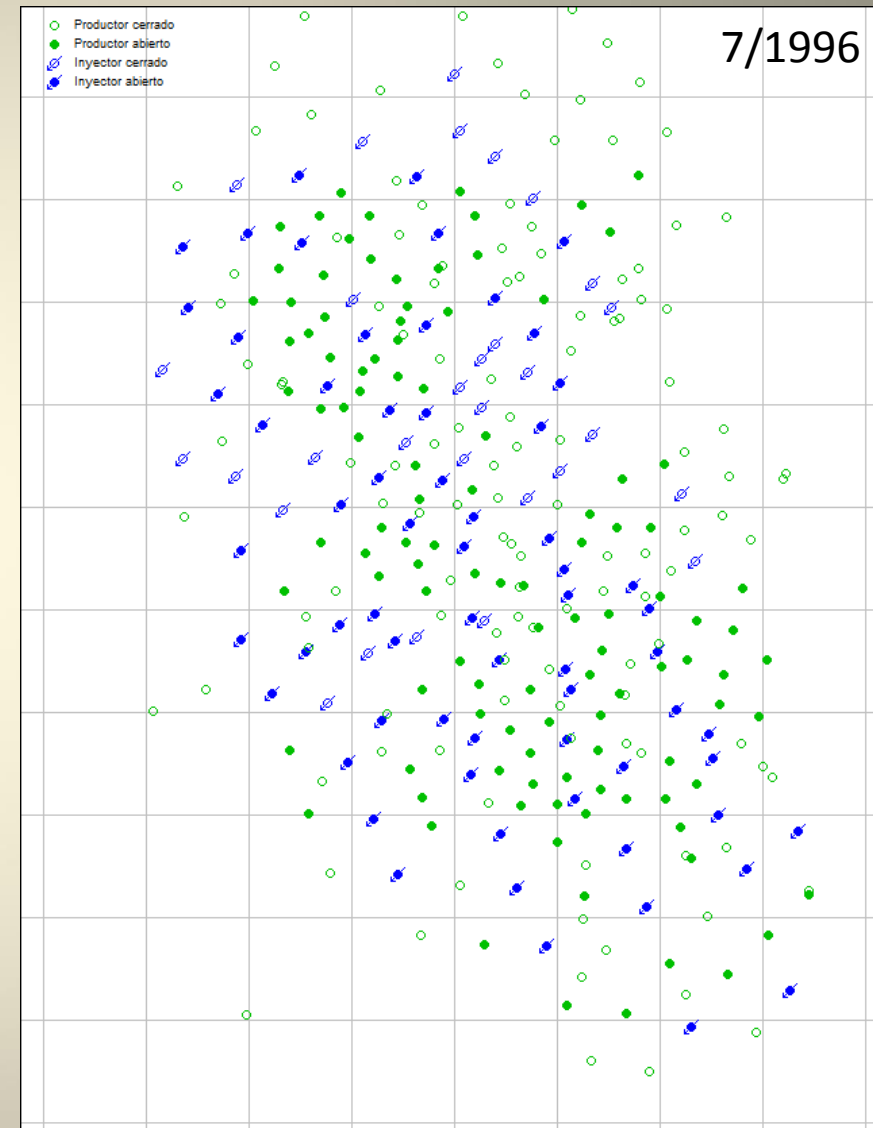
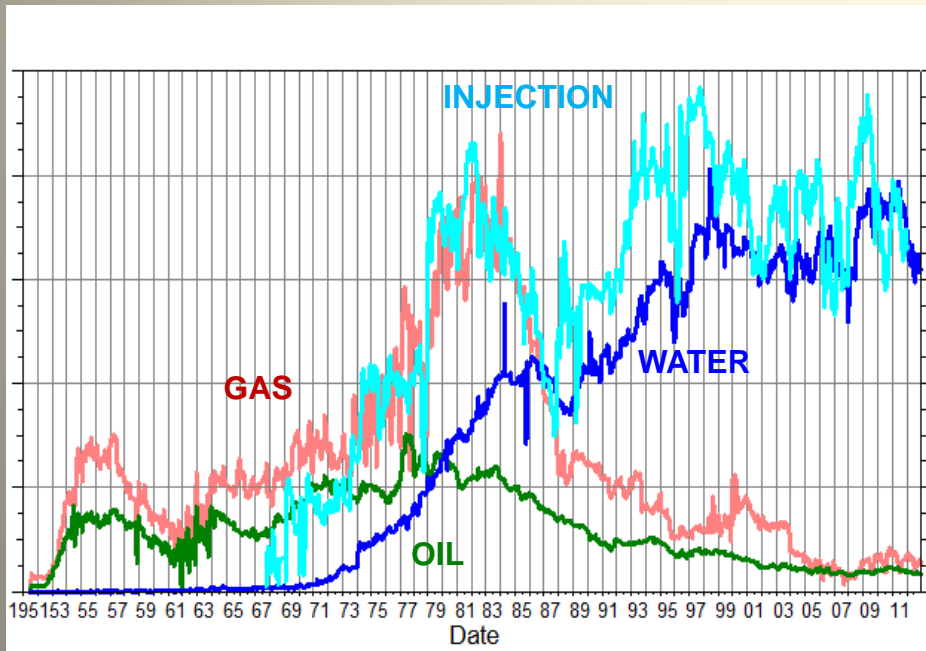
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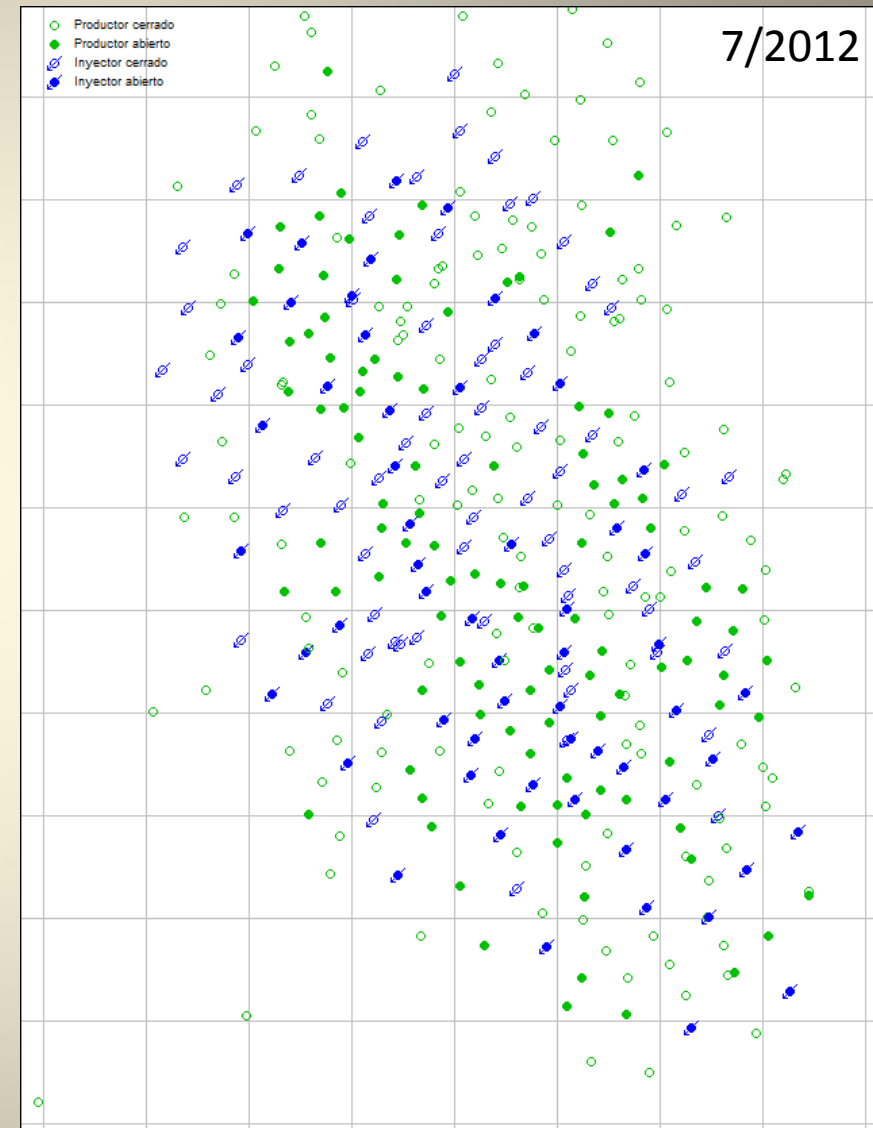
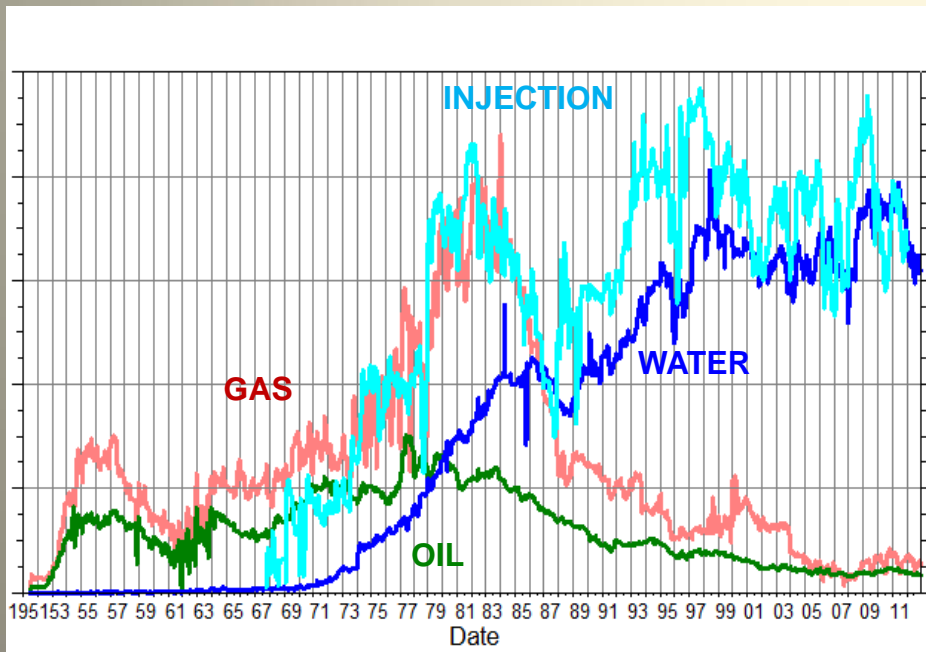
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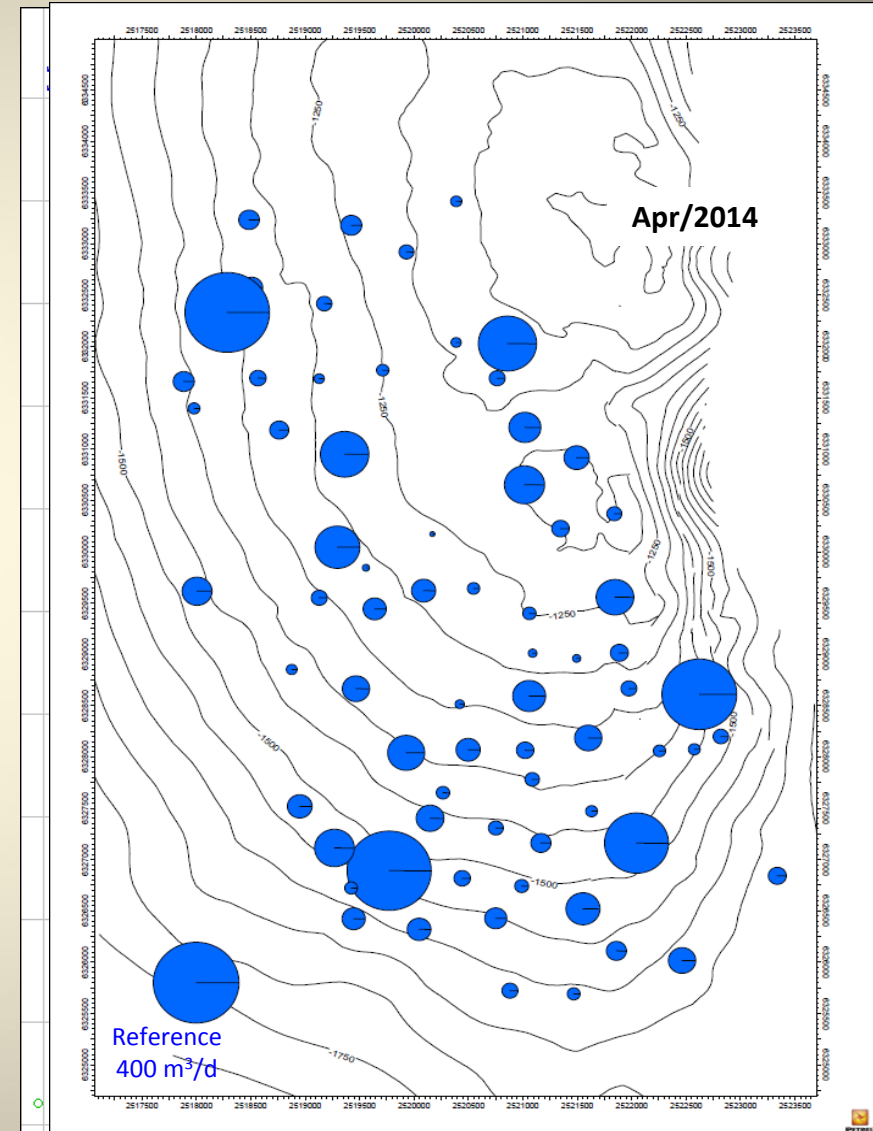
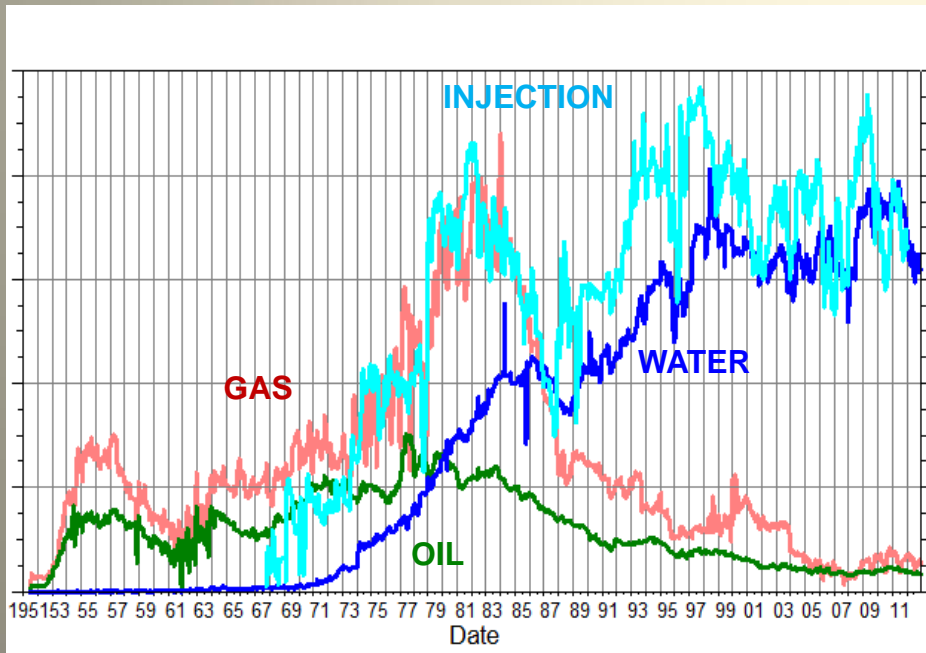
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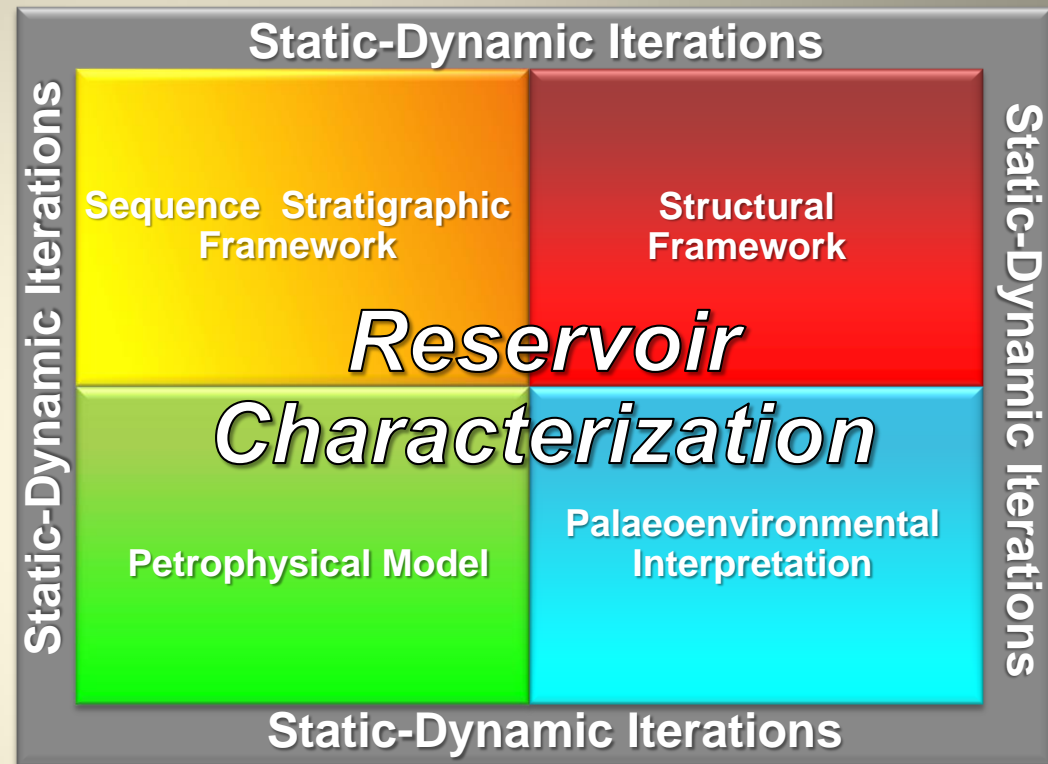
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1. *How much OOIP do we really have?*
2. *How much remaining oil is there? Where?*
3. *How to develop the remaining oil?*

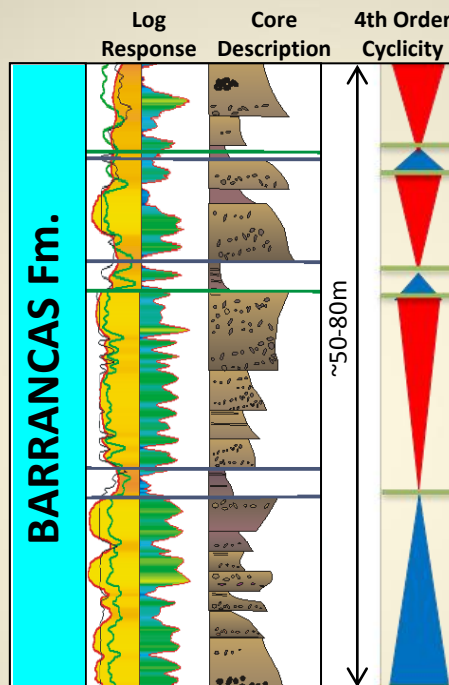


Strong history match constraint

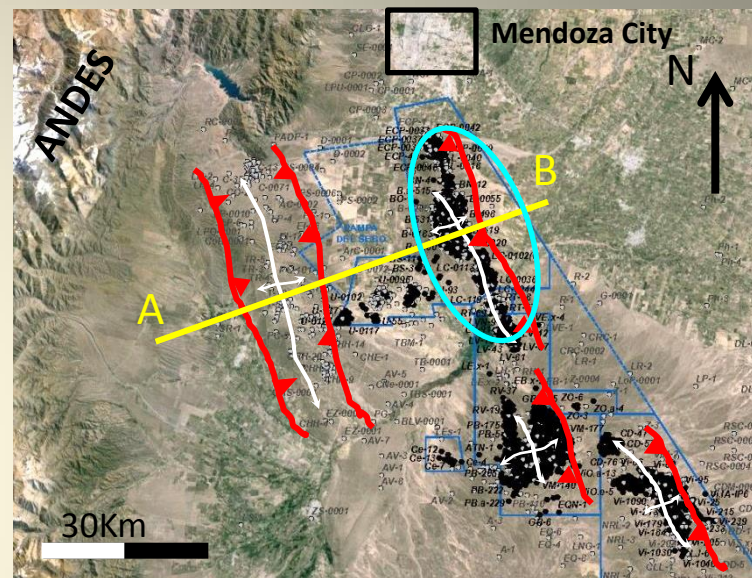
Predictive Static-Dynamic Model

Stratigraphy of Cuyana Basin

AGE	FORMATION	STRATIGRAPHIC COLUMN	BASIN STAGE
TERTIARY	Mogotes		FORELAND
	Tobas Grises Sup		
	La Piona		
	Tobas Grises Inf		
	Mariño		
CRETACEOUS	Panapavos		ABORTED RIFT
	Punta de las Bardas		
JURASSIC	Barrancas		POST RIFT
TRIASSIC	Rio Blanco		SAG
	Cacheuta		SYNRIFT II
	Potrerillos		SYNRIFT I
	Las Cabras		
	Rio Mendoza		
PALEOZOIC	Basement		BASEMENT

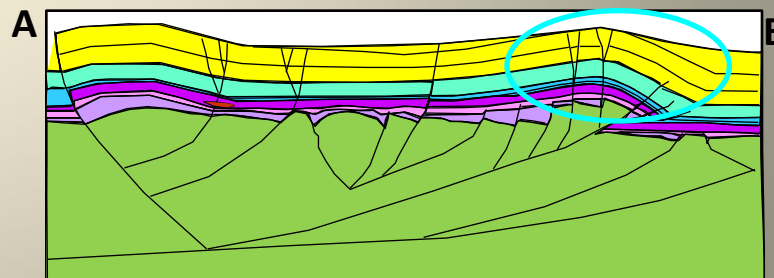


Structural Framework

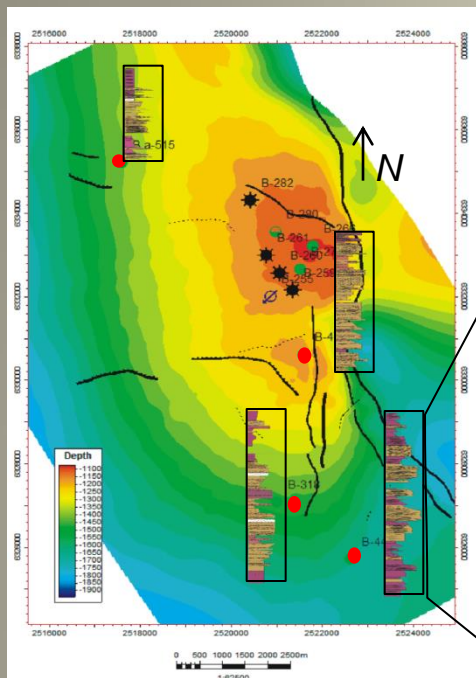


Structural Section

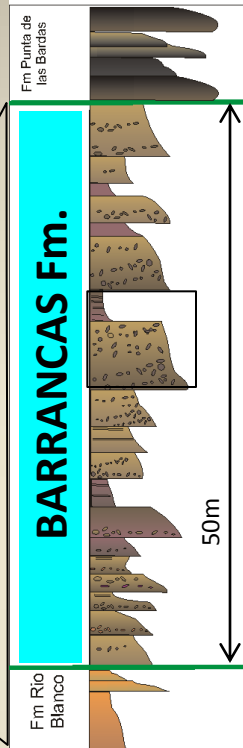
Barrancas Field



Core Locations



Core Description



Gms

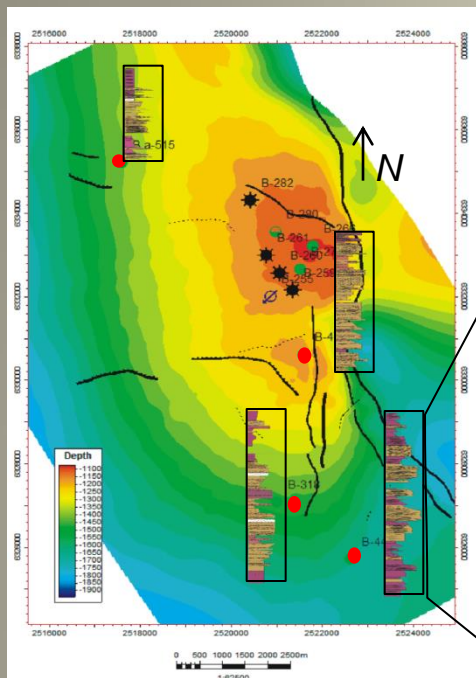
Middle to coarse grained **conglomerates** with clean sandy matrix.

Abundant **volcanics clasts** (up to 8cm diameter).

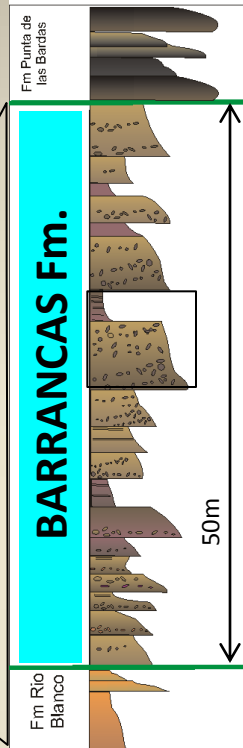
Layers with different sizes of clasts showing cyclicity in a very high frequency. **Planar and trough stratification**.

Base of fining upward sequences.

Core Locations



Core Description



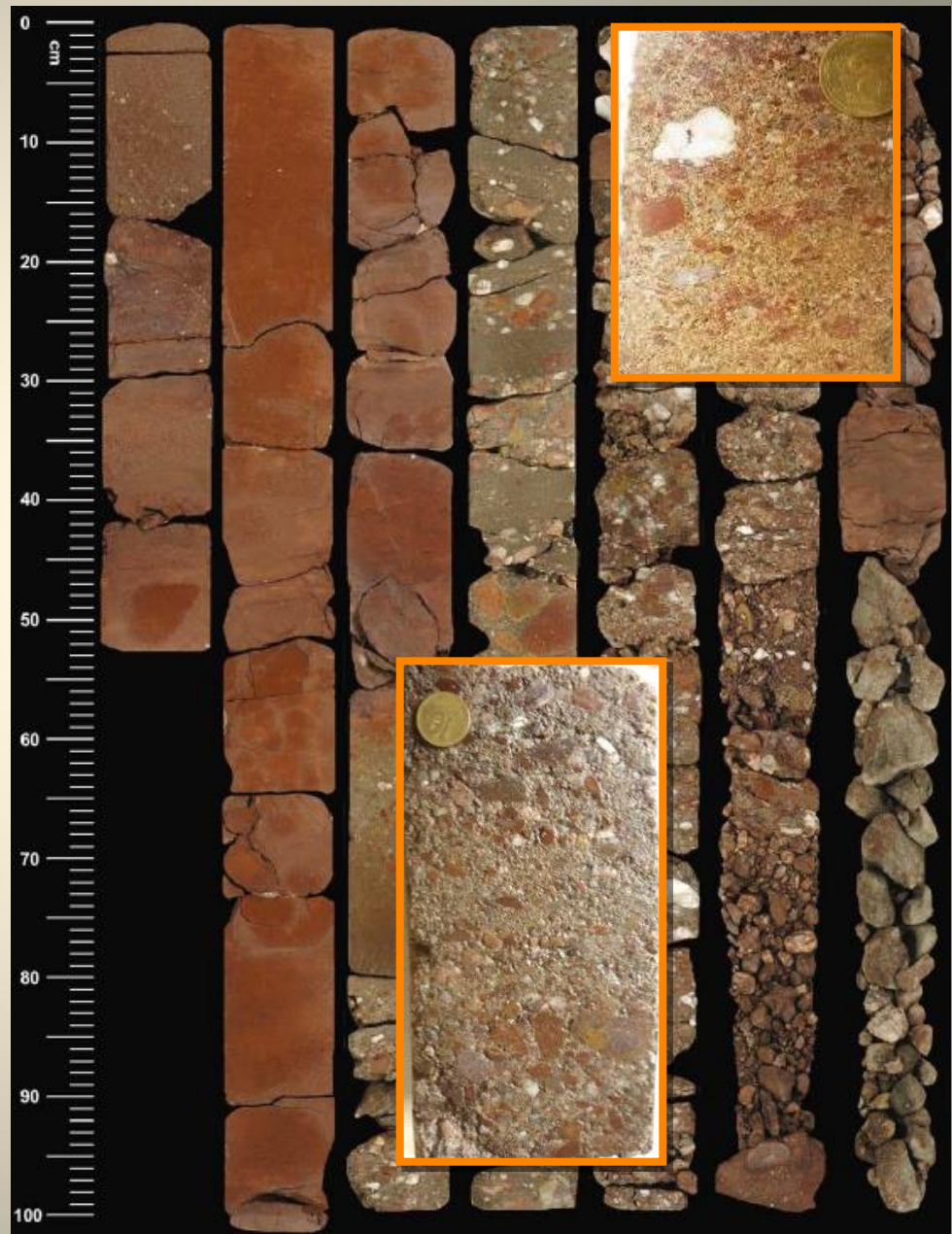
Gms

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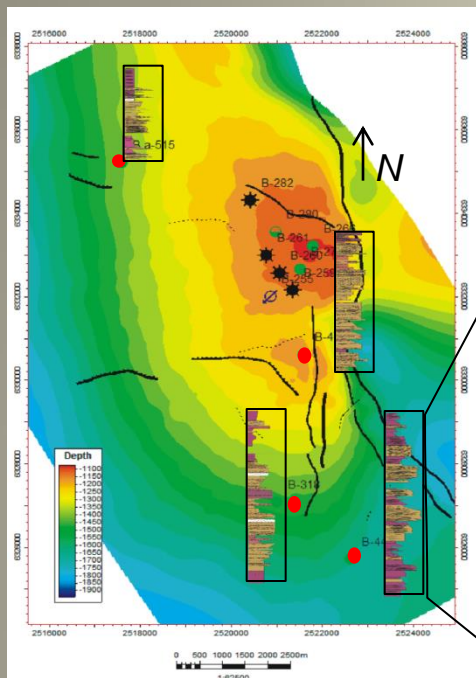
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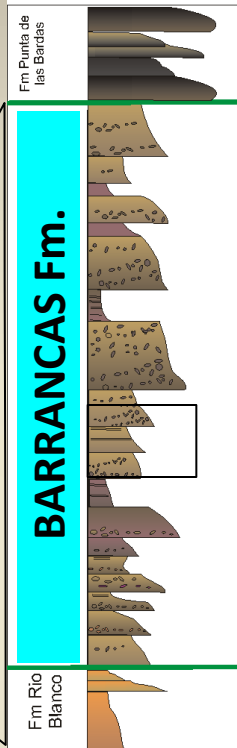
Base of fining upward sequences.



Core Locations



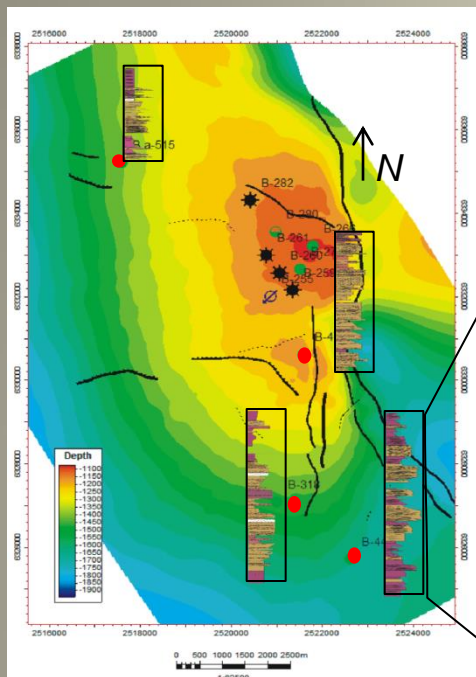
Core Description



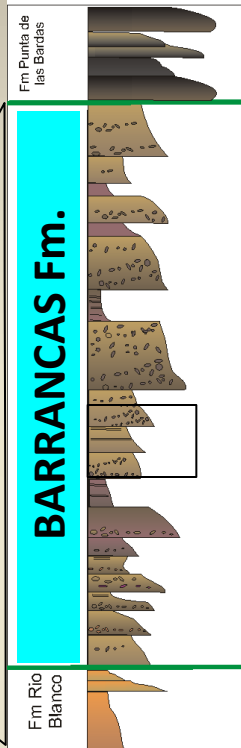
Sp

Medium to coarse clean sandstones.
Strongly bioturbated. Relictic cross stratification.
Associated to the Gms facies.

Core Locations

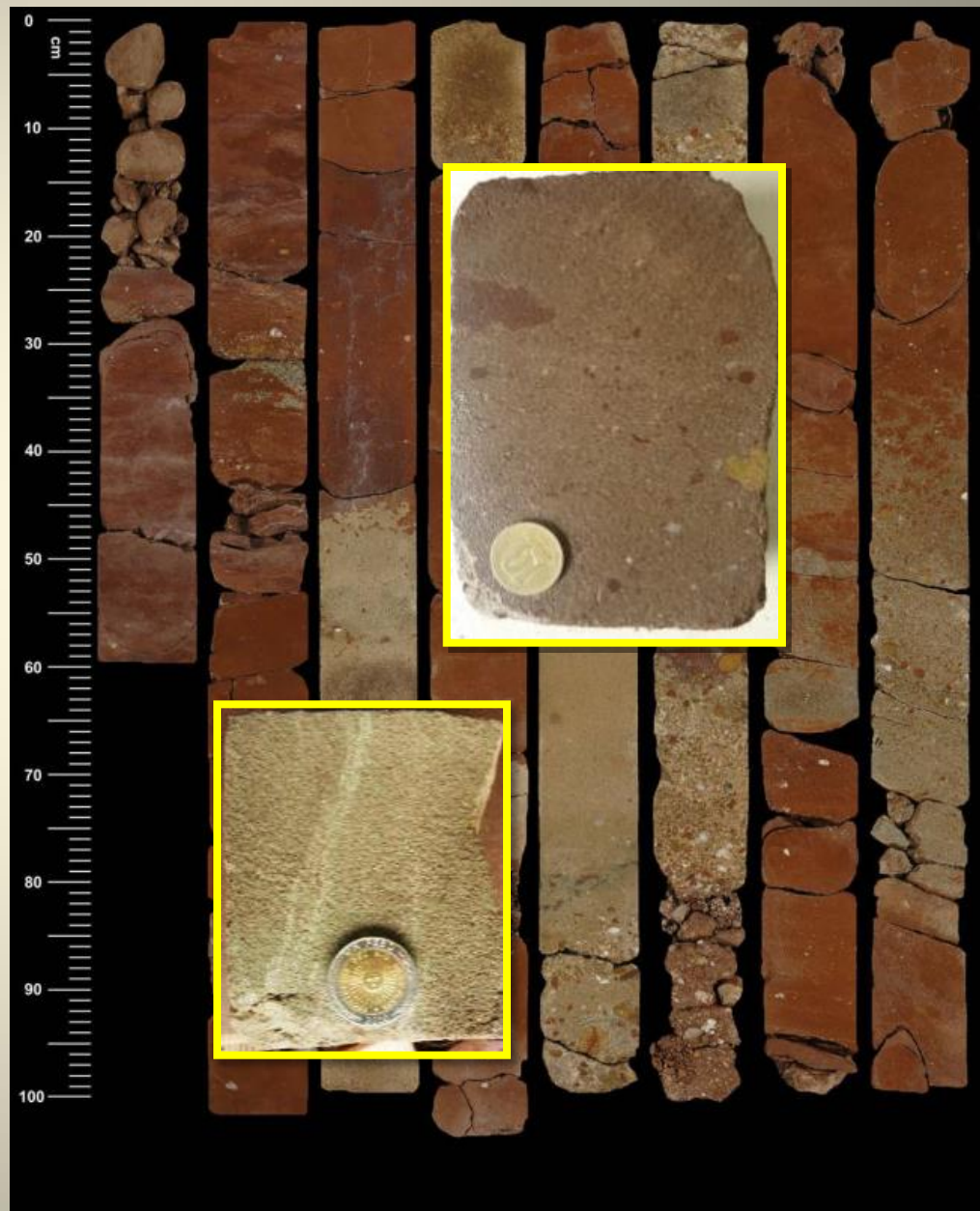


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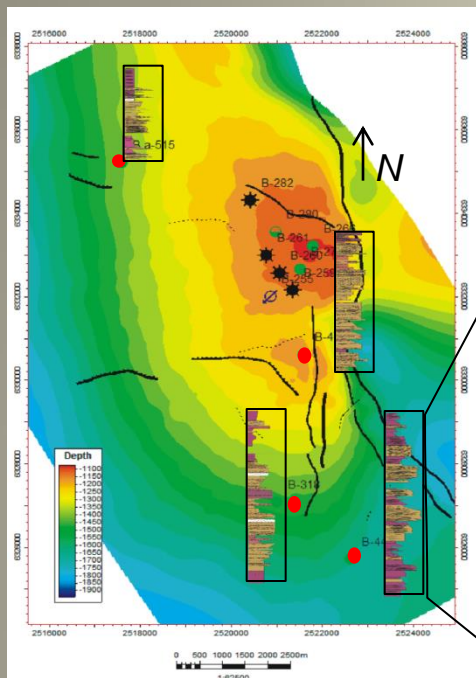


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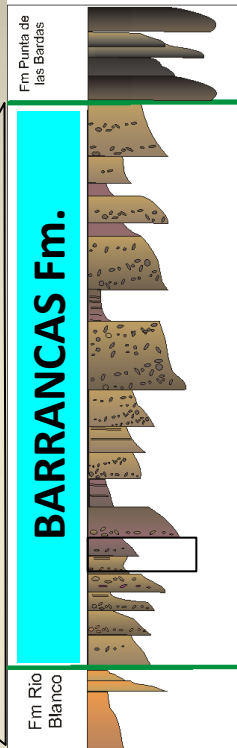
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Core Locations



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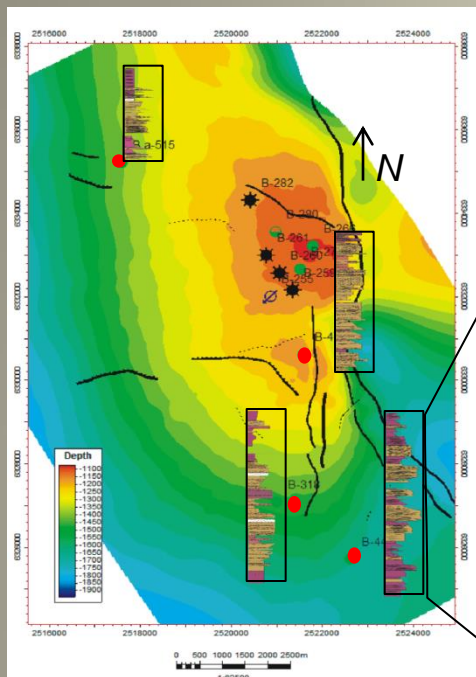
Sm

Coarse to **silty sandstones**. Abundant clasts **chaotic distribution** (up to 3 cm).

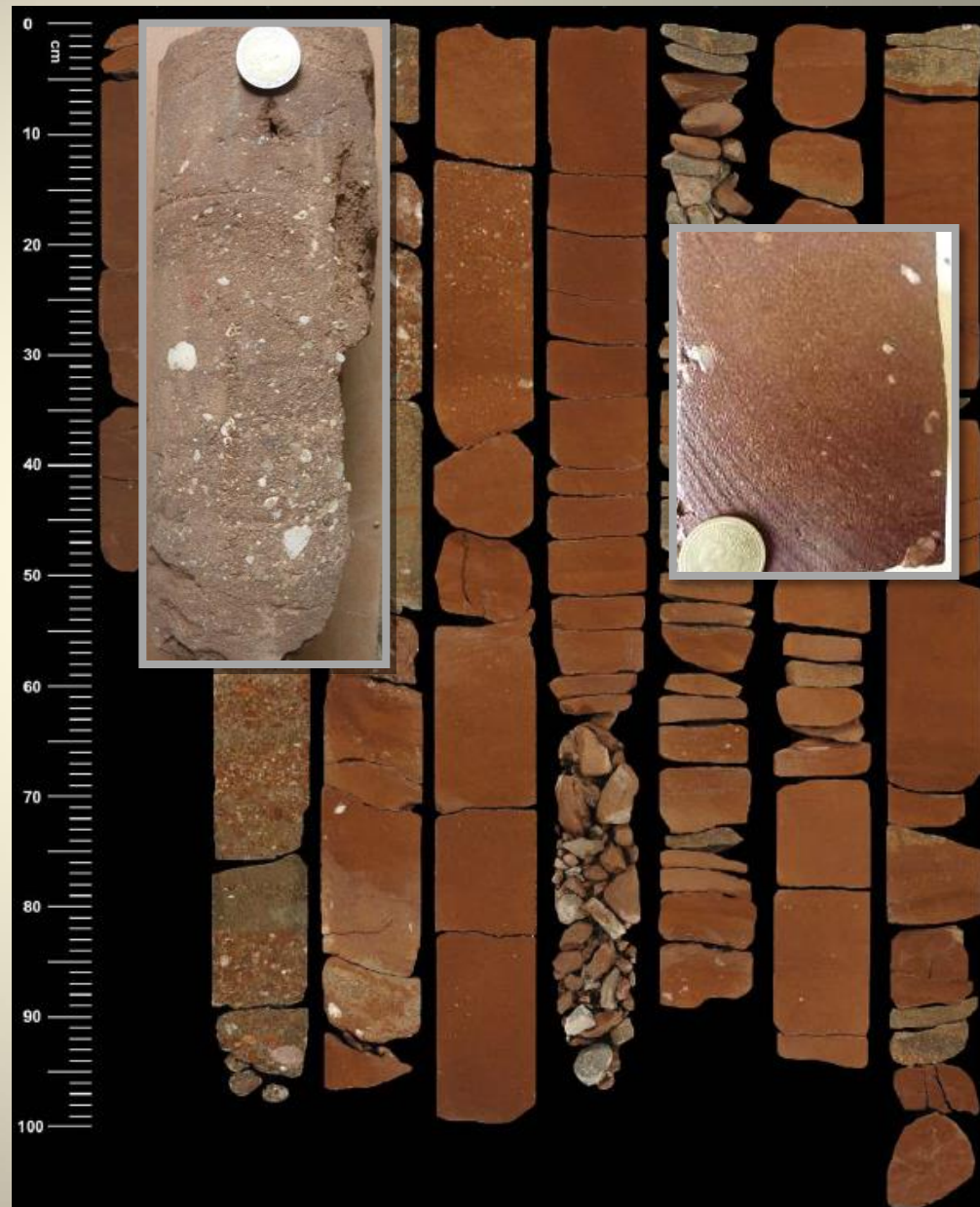
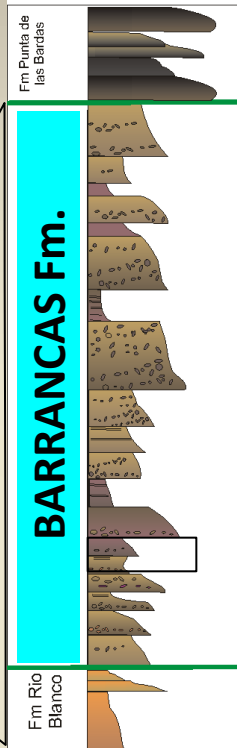
High energy planar stratification regime.

Coarsening upward trend.

Core Locations



Core Description



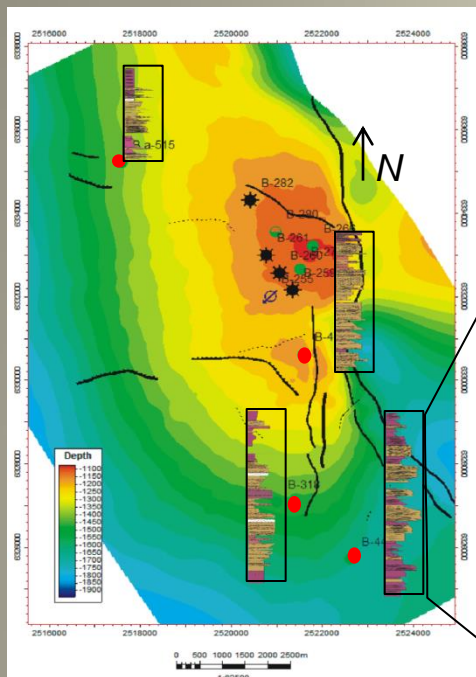
Sm

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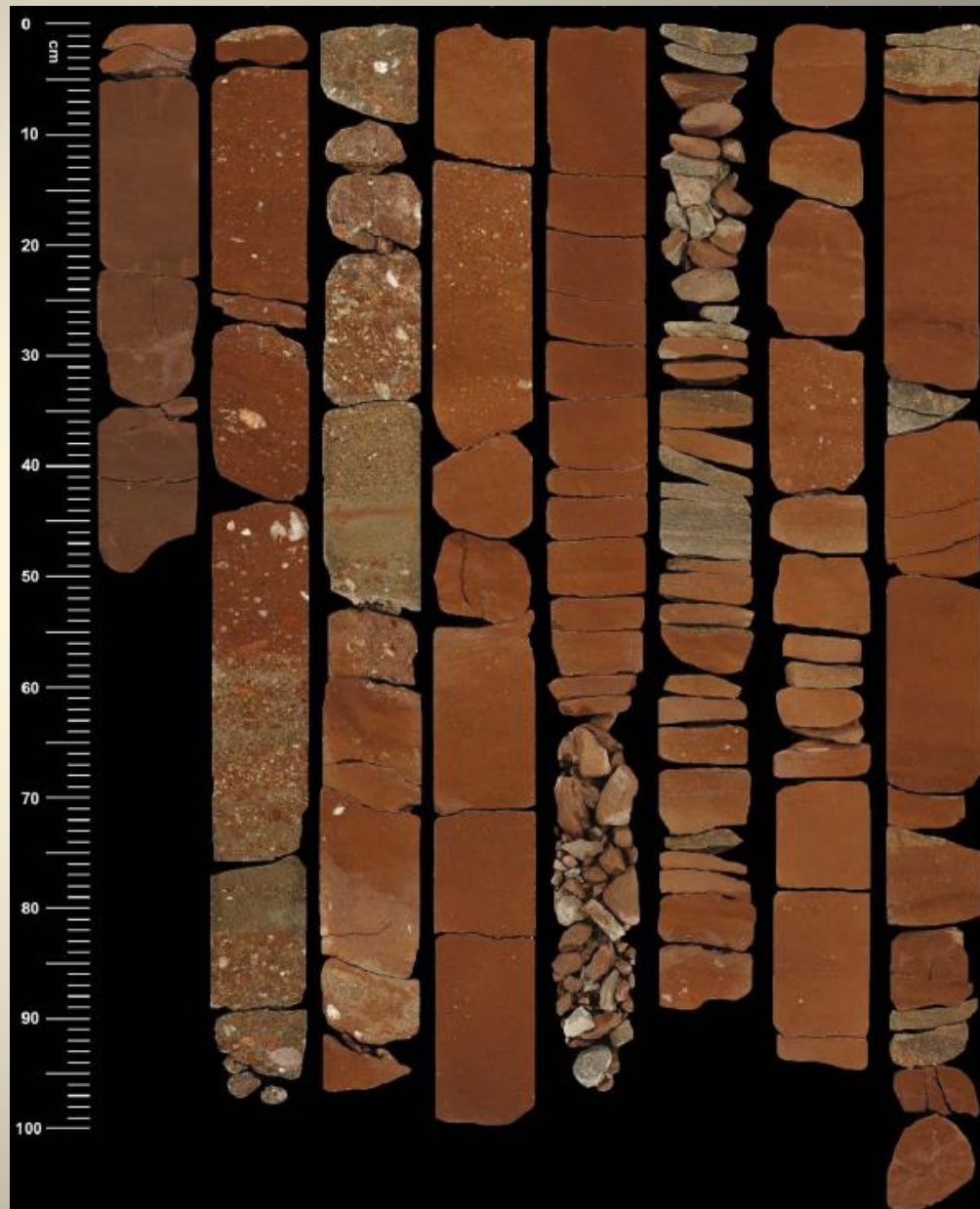
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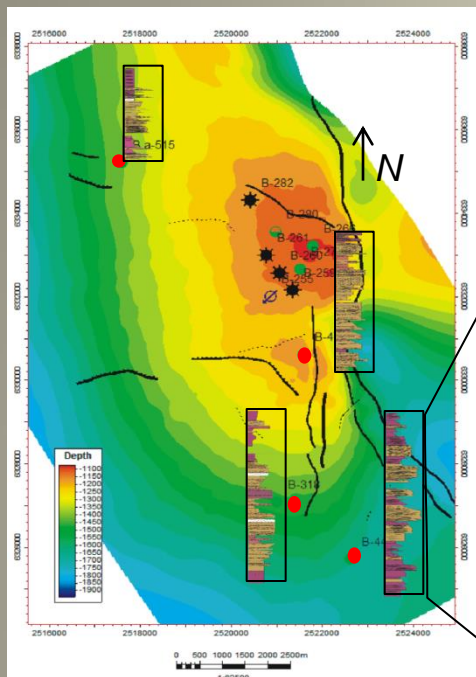
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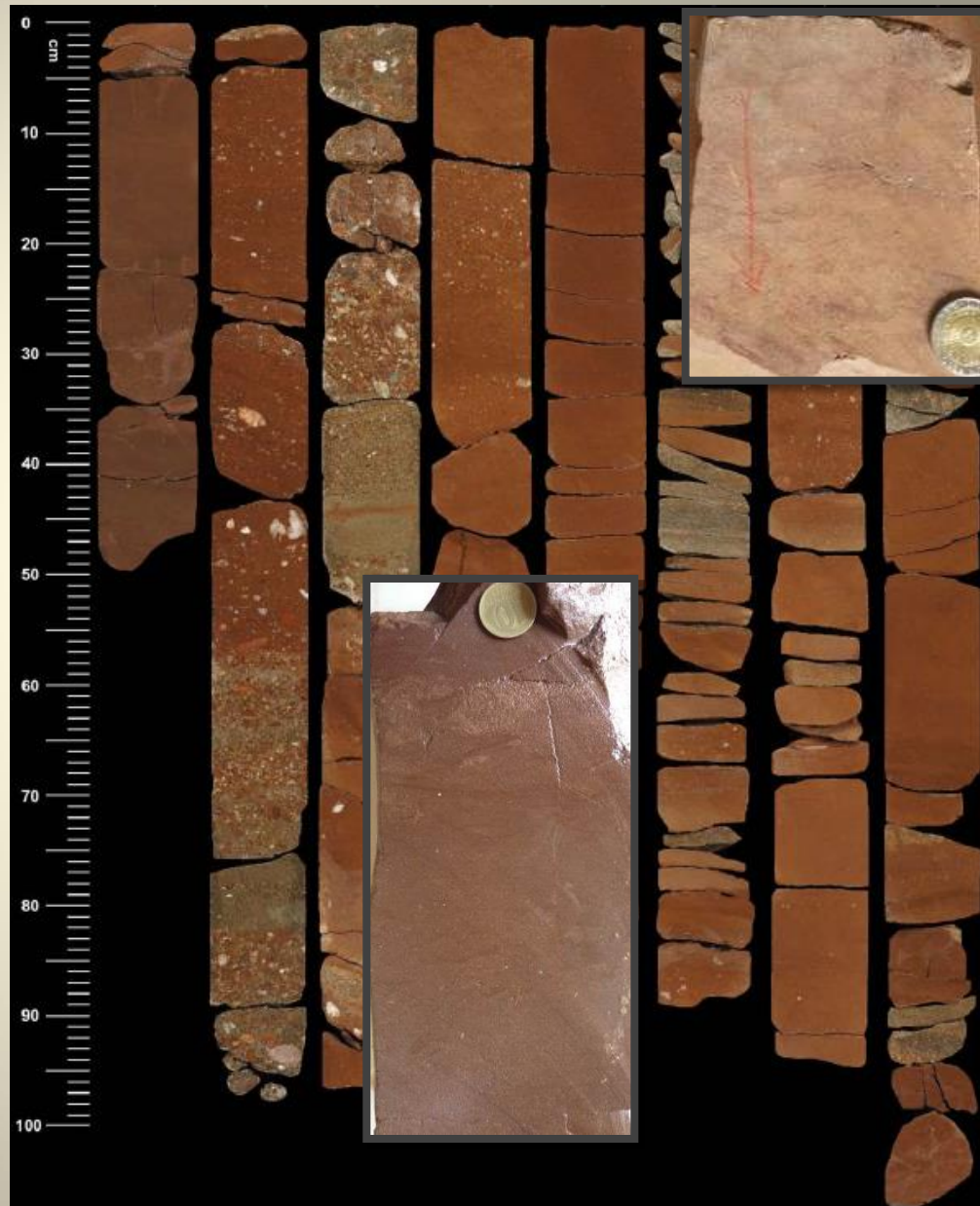
Lm

Silts to very fine sandstone. Climbing ripples.
Slickensides (paleosols), CaCO_3 Nodules,
Dissection cracks, root marks.

Core Locations



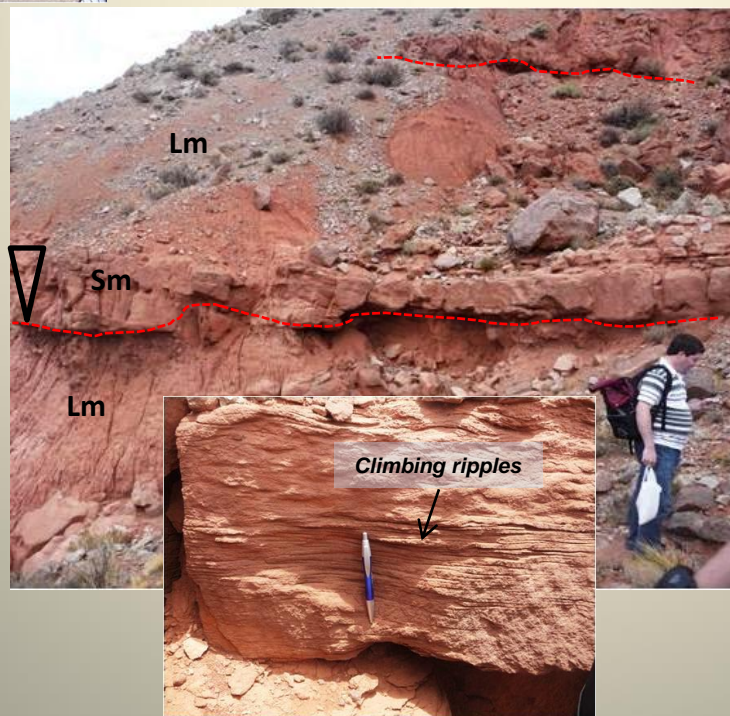
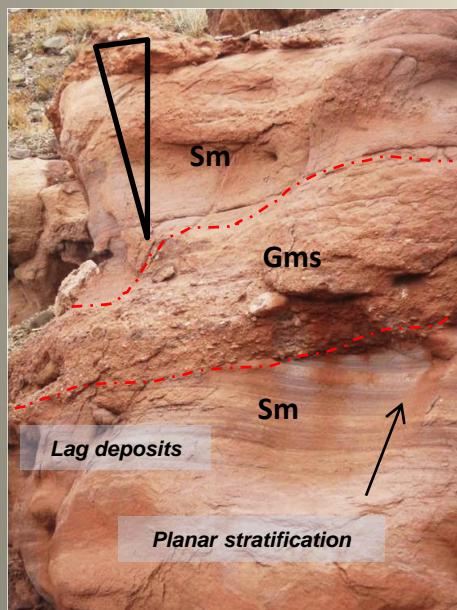
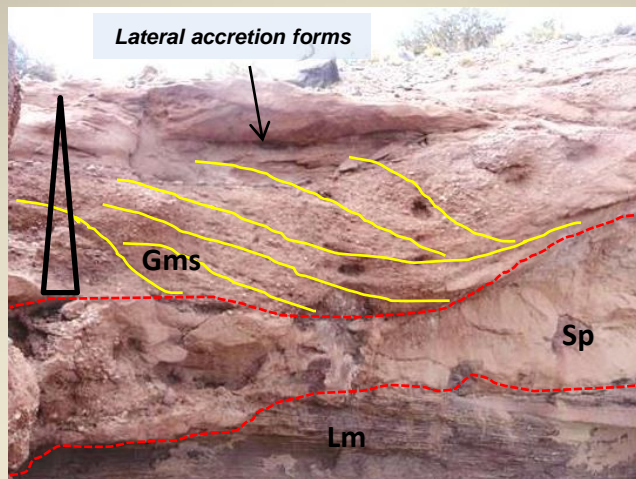
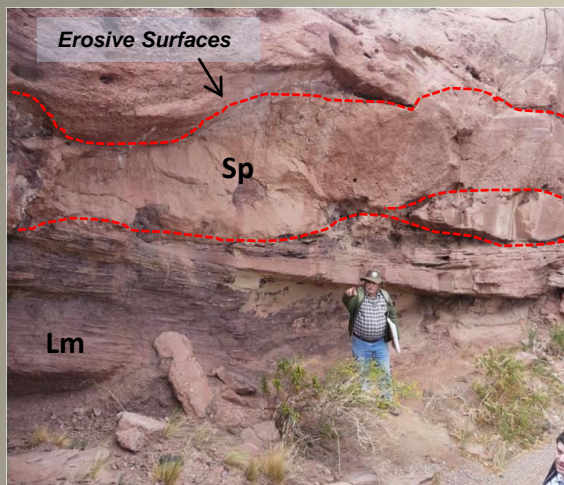
Core Description



Lm

Silts to very fine sandstone. Climbing ripples.
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Dissection cracks, root marks.

RESERVOIR ARCHITECTURE IN OUTCROPS



**Main
Depositional
Process**

**Tractive
Process**
Lateral accretion
forms
Fining upward
sequences
Abundant
erosive surfaces

**Non tractive
Process**
Coarsening upward
sequences.
Abundant
reactivation
surfaces
(lag deposits)

**Suspension
Process**

**Type of
Deposits**

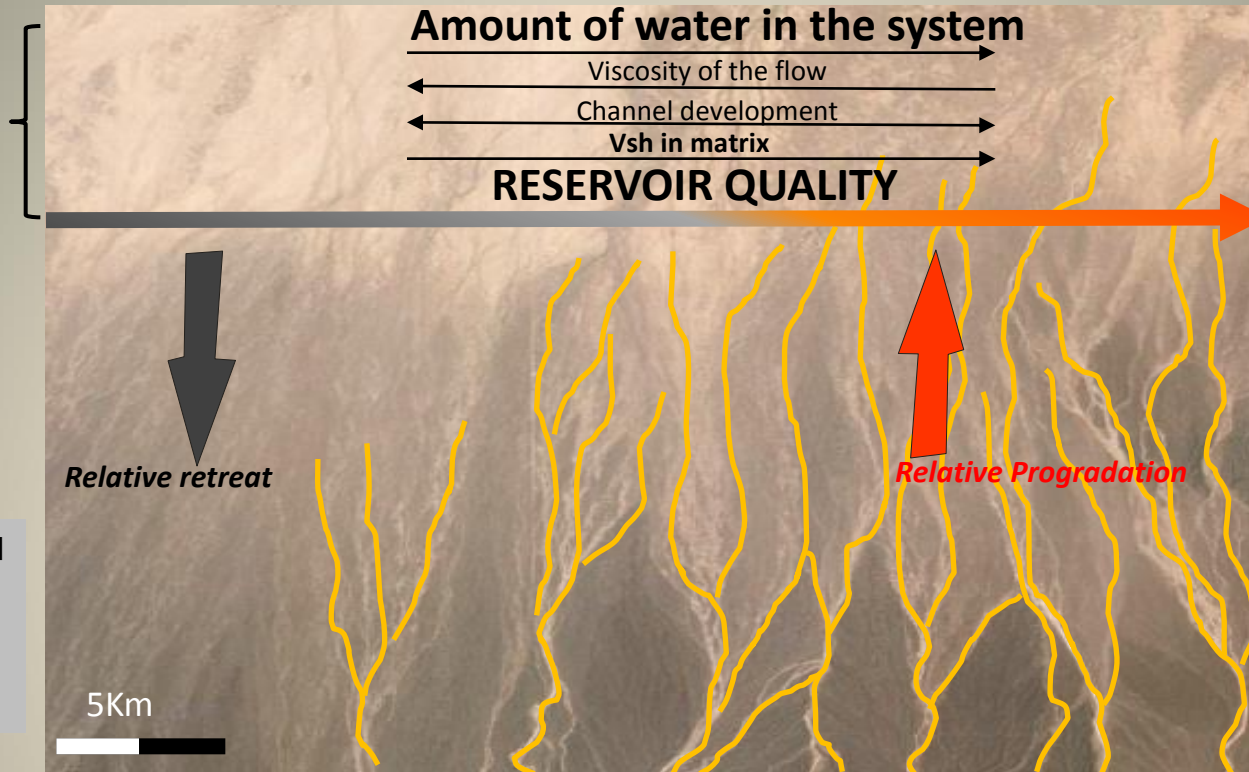
**Channelized
facies
association .
FLUVIAL
TYPE
DEPOSITS**

**Poorly
channelized facies
association
SHEET-TYPE
DEPOSITS**

**PLAYA LAKE
Facies
Association**

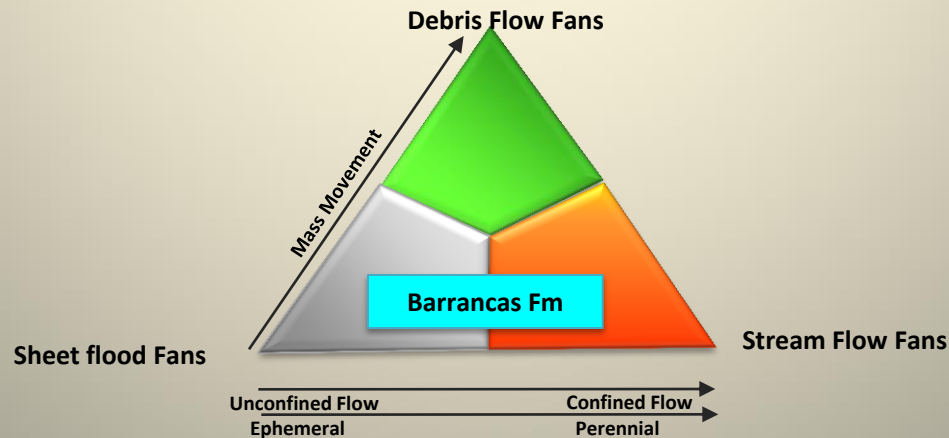
Changes in deposits characteristics depending on the amount of water in the system

Poorly Channelized Facies Association
Sheet-Type Deposits



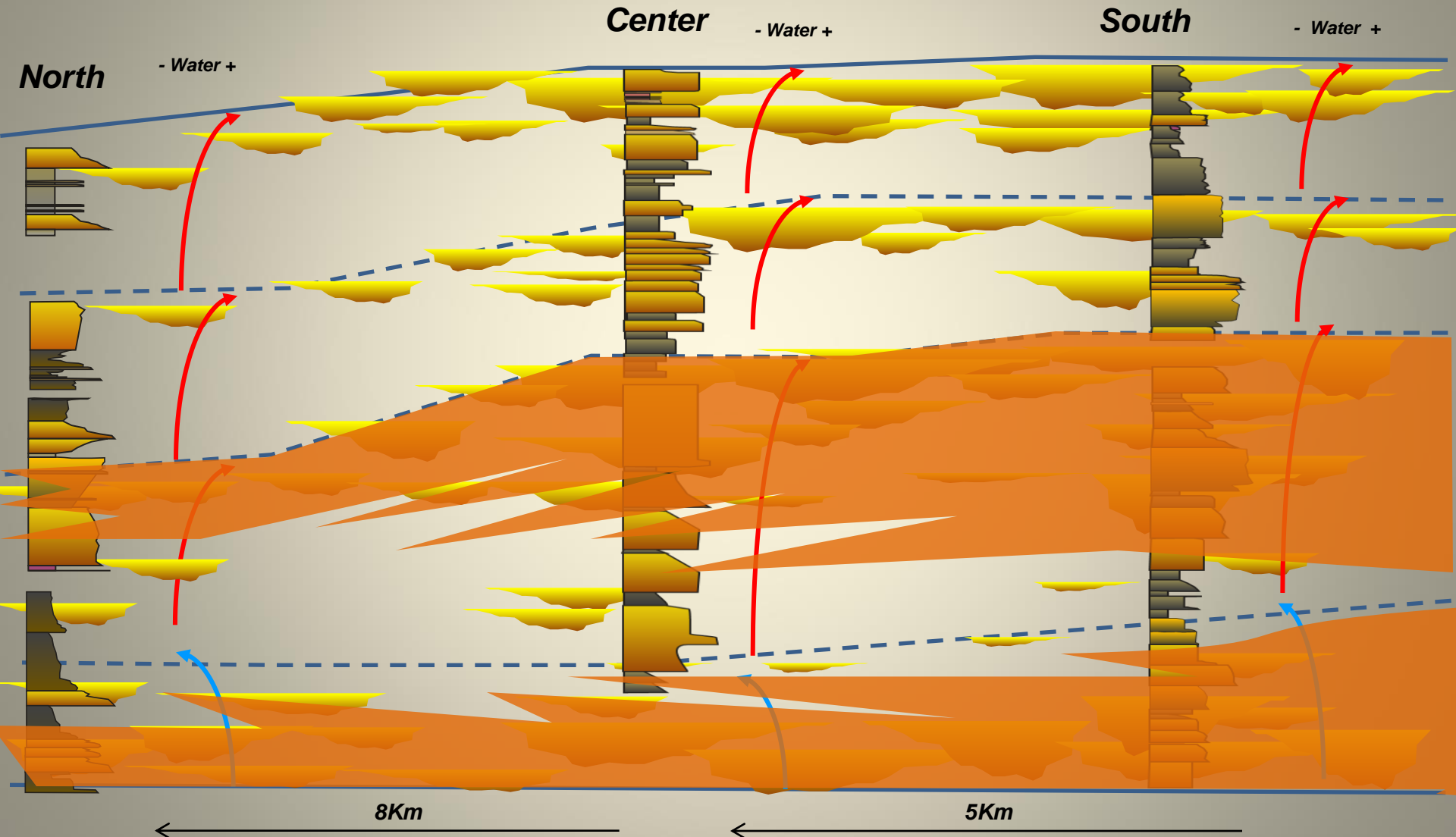
Playa Lake Facies Association
Playa Lake Deposits

Channelized Facies Association
Fluvial Type Deposits

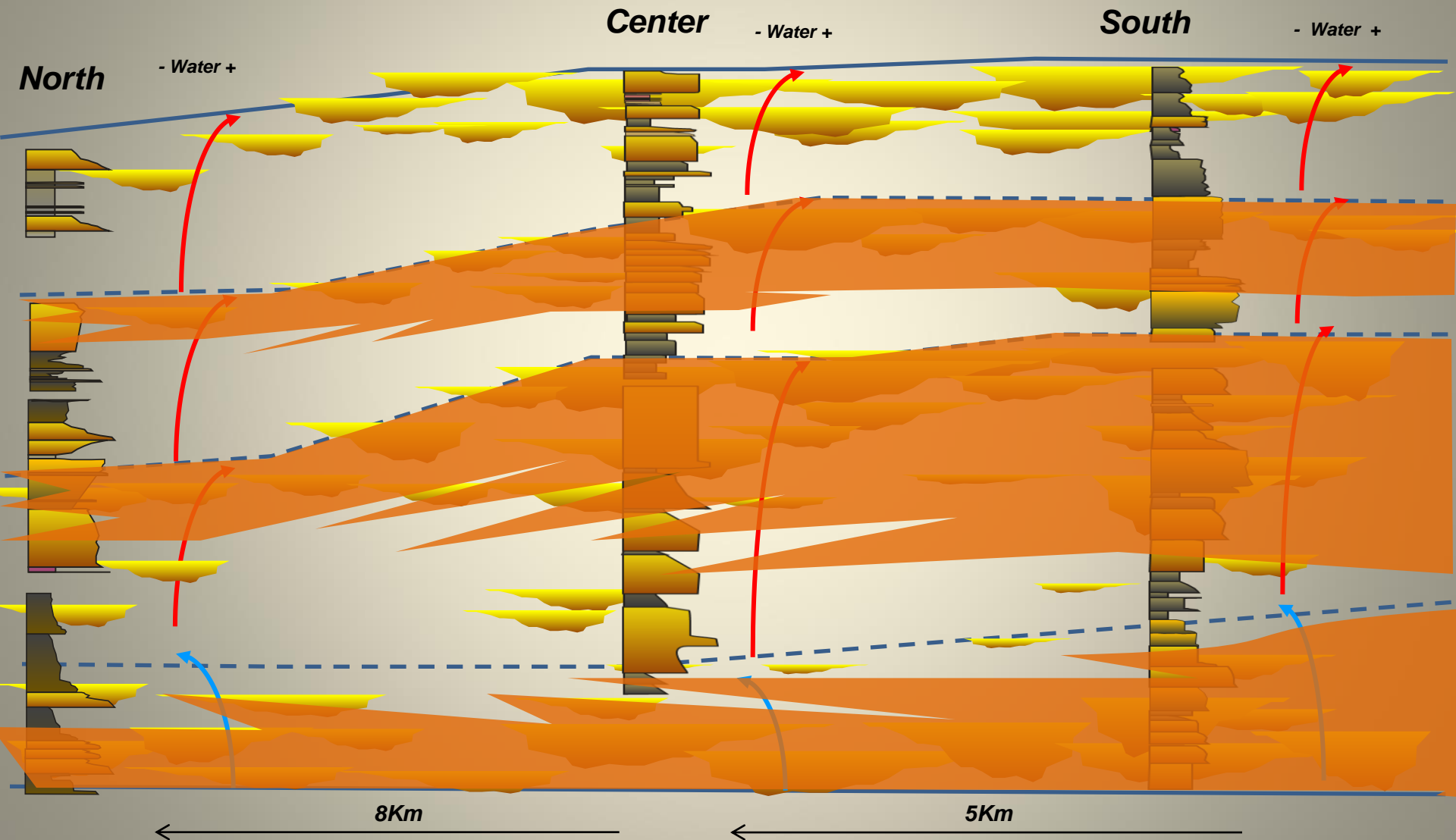


Modified from Galloway y Hobday (1996).

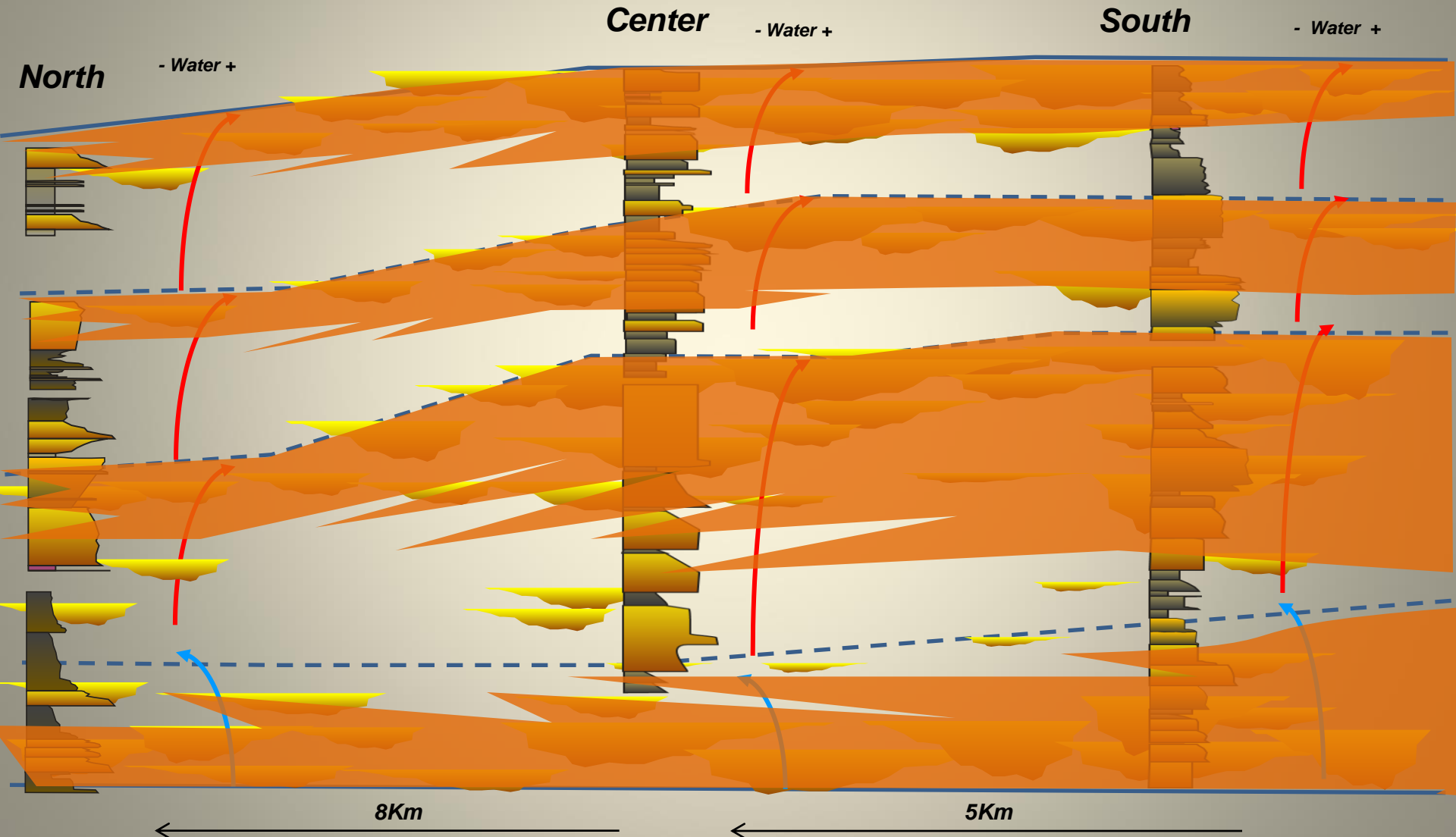
*Conceptual Model showing changes in the vertical facies proportion
Separating surfaces result from changes in the amount of water in the system*



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Separating surfaces result from changes in the amount of water in the system*

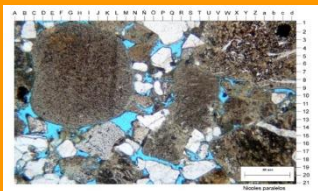


*Conceptual Model showing changes in the vertical facies proportion
Separating surfaces result from changes in the amount of water in the system*



Reservoir Facies

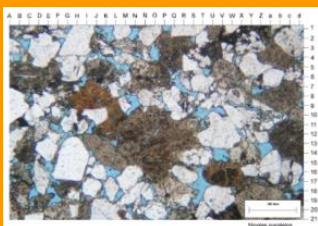
Channelized deposits



ϕ : 17% K: 280 mD



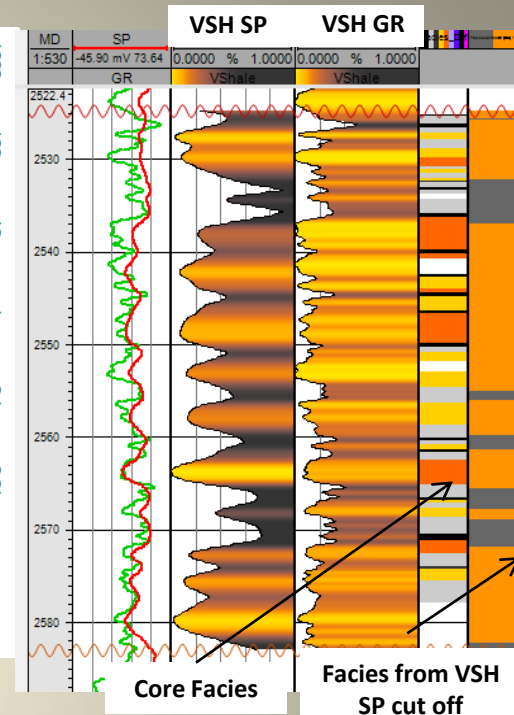
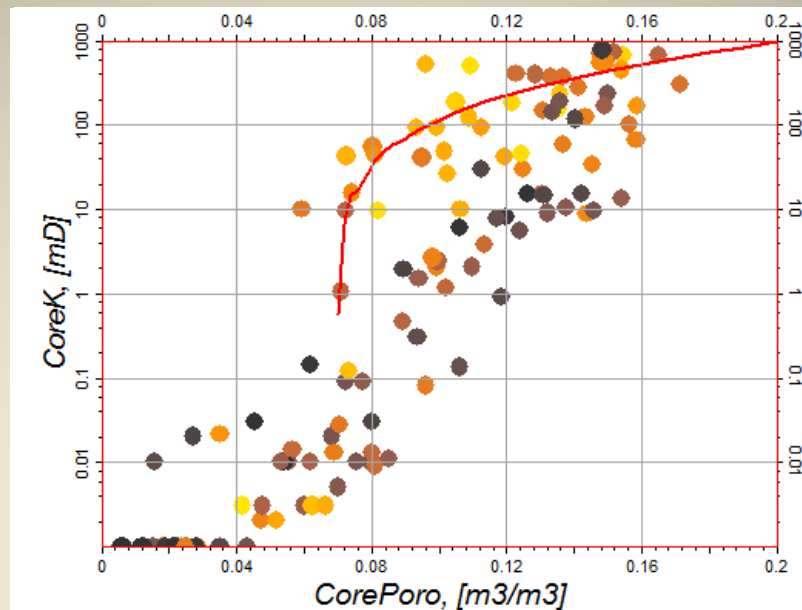
Gms



ϕ : 16% K: 498 mD

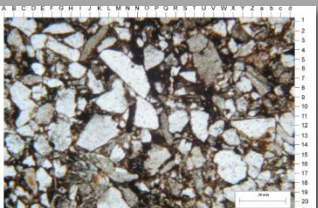


Sp



Non Reservoir Facies

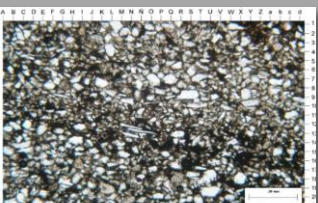
Non Channelized deposits



ϕ : 9% K: 0.322 mD



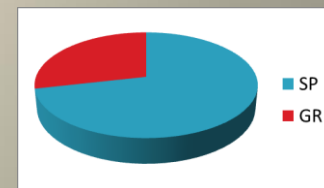
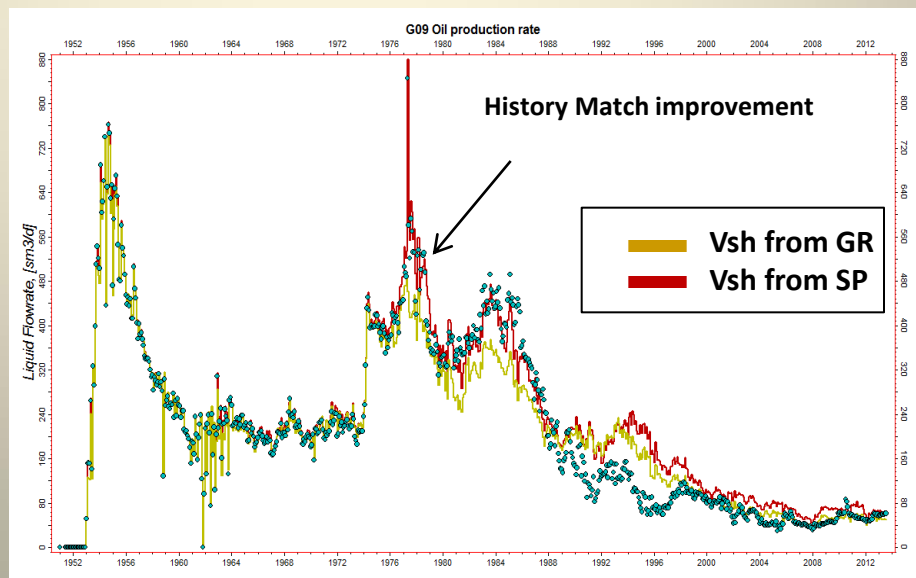
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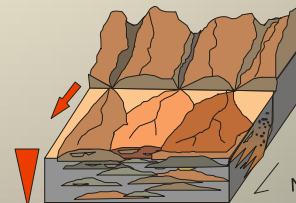
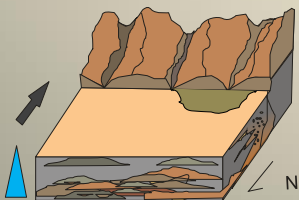
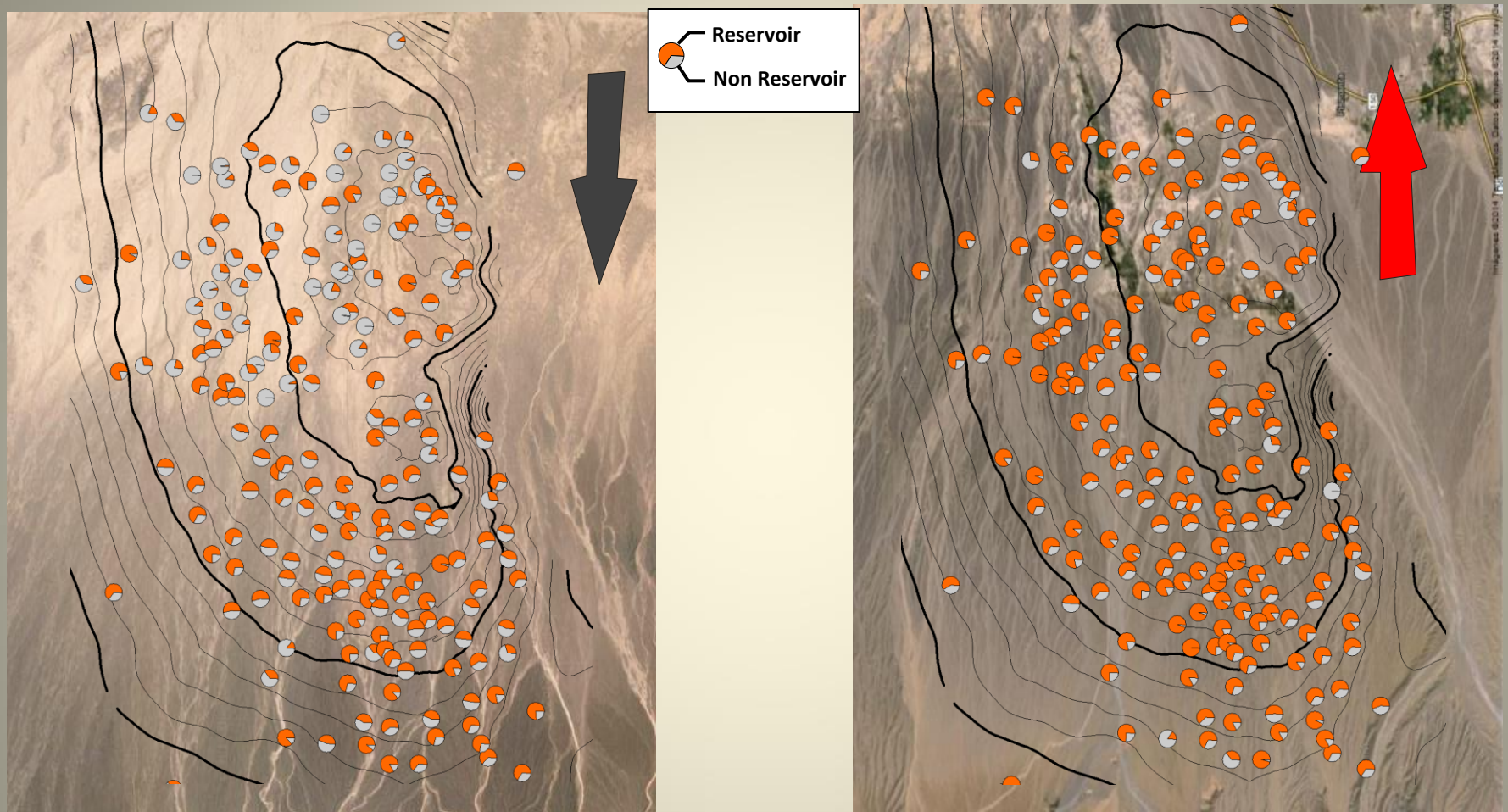
K \approx 0 mD



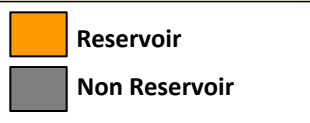
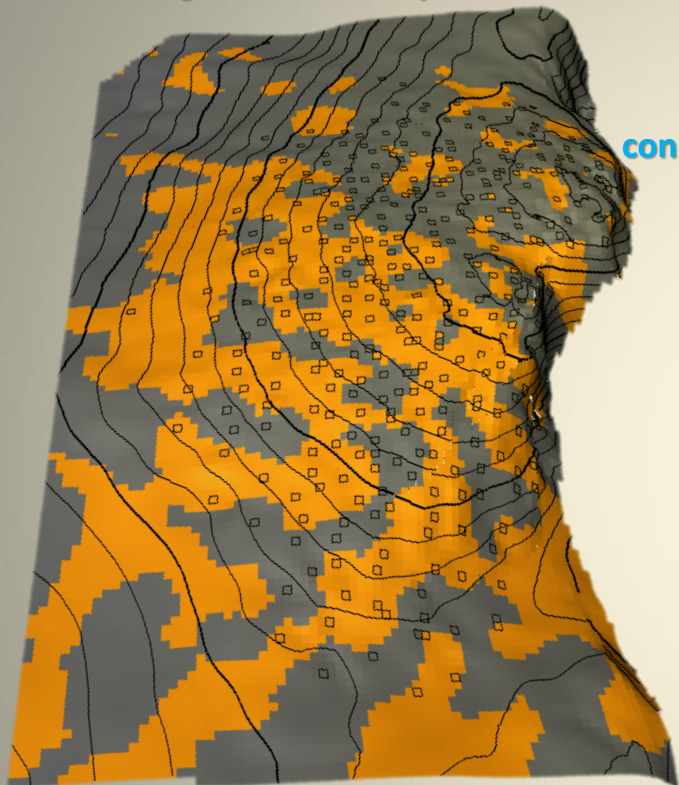
Lm



Facies retreatment or progradation in response to changes in the amount of water



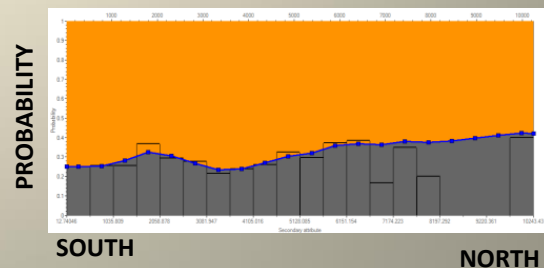
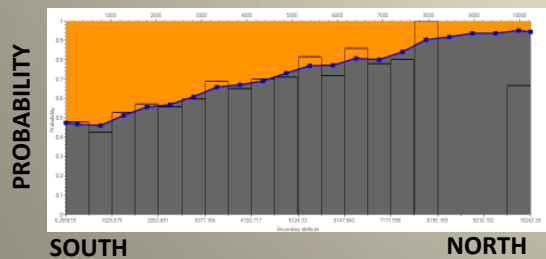
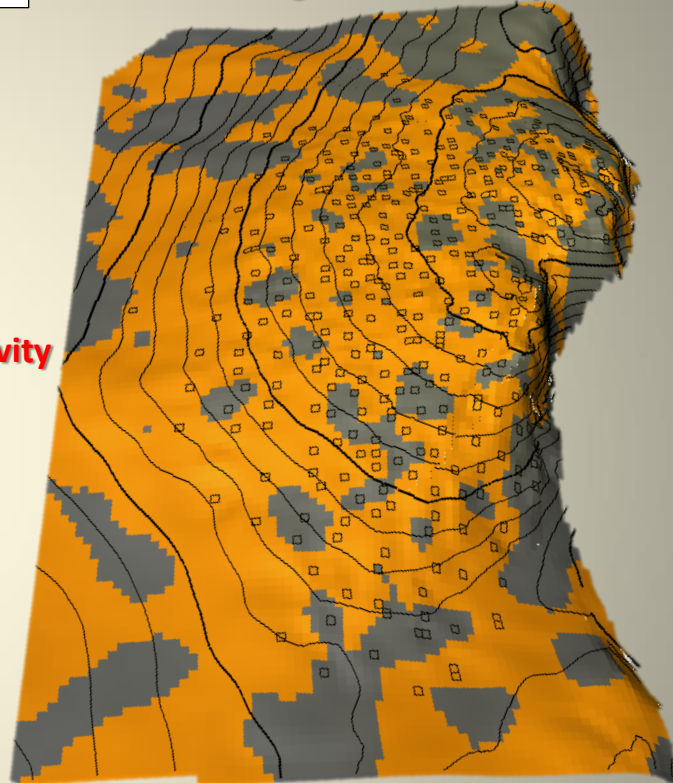
Facies Model for Retrogradational Cycle



Less connectivity

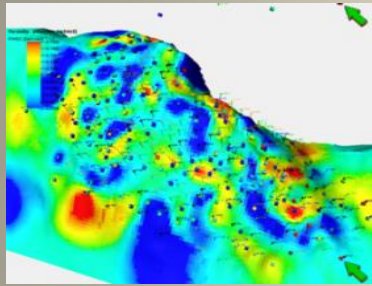
More connectivity

Facies Model for Progradational Cycle

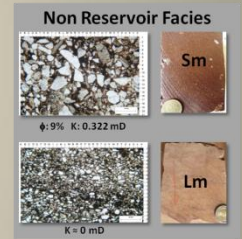
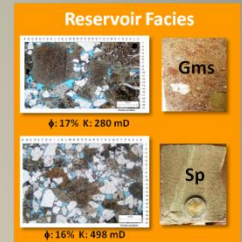
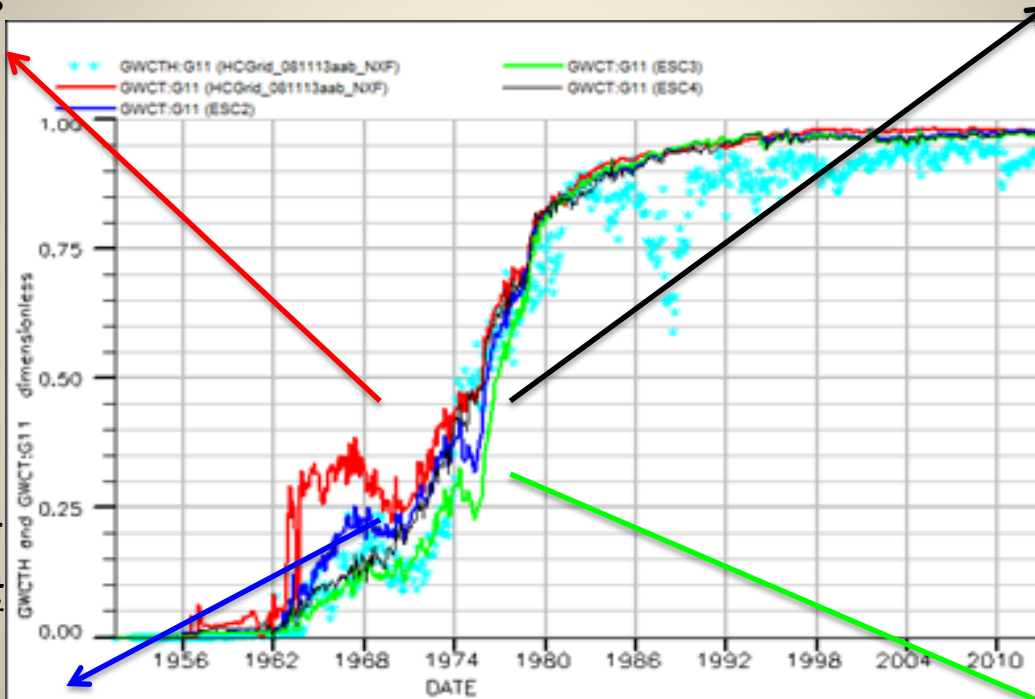


Strong history match constraint

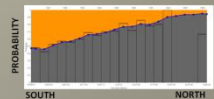
Kriging distribution of Porosity without any correlation scheme



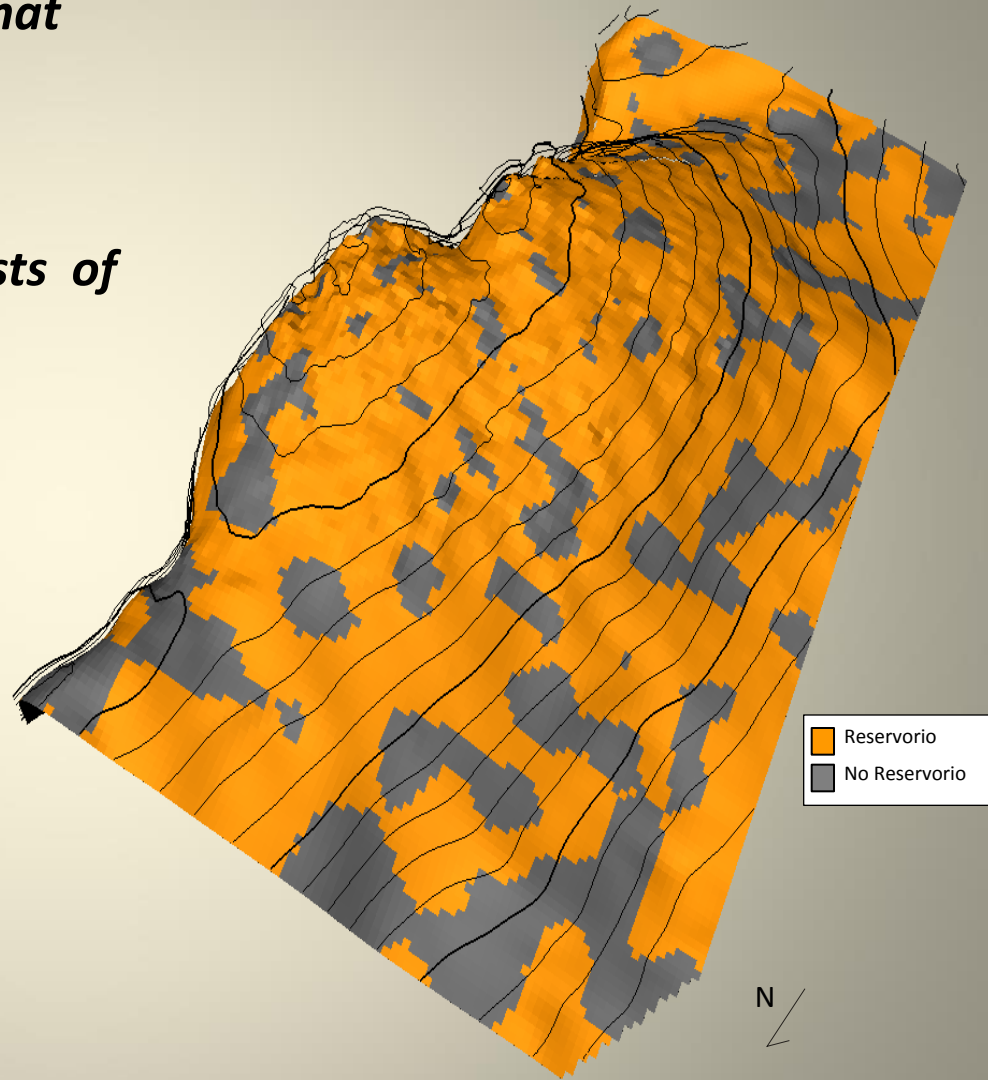
Porosity with seq strat correlation scheme and conditioned to Facies



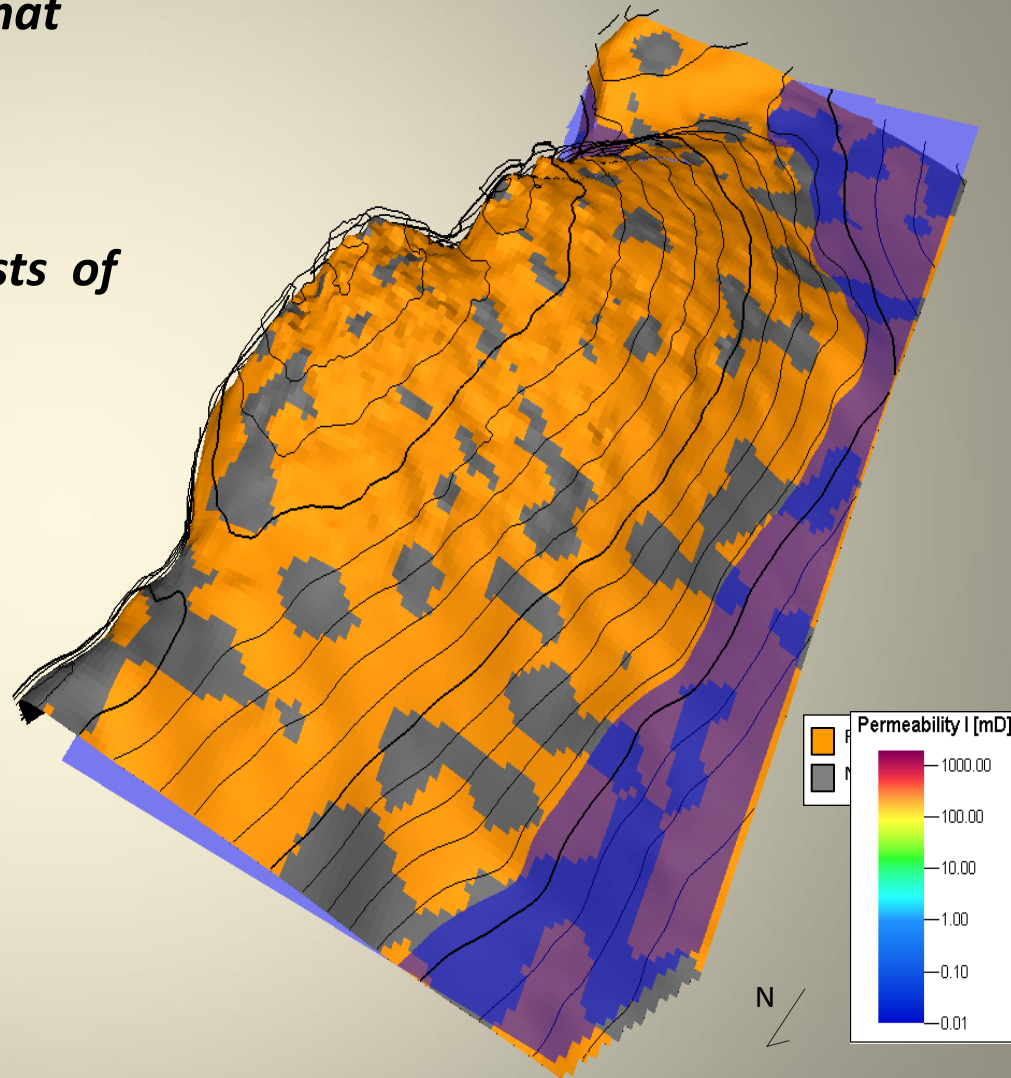
Porosity with seq strat correlation scheme, conditioned to Facies with trends



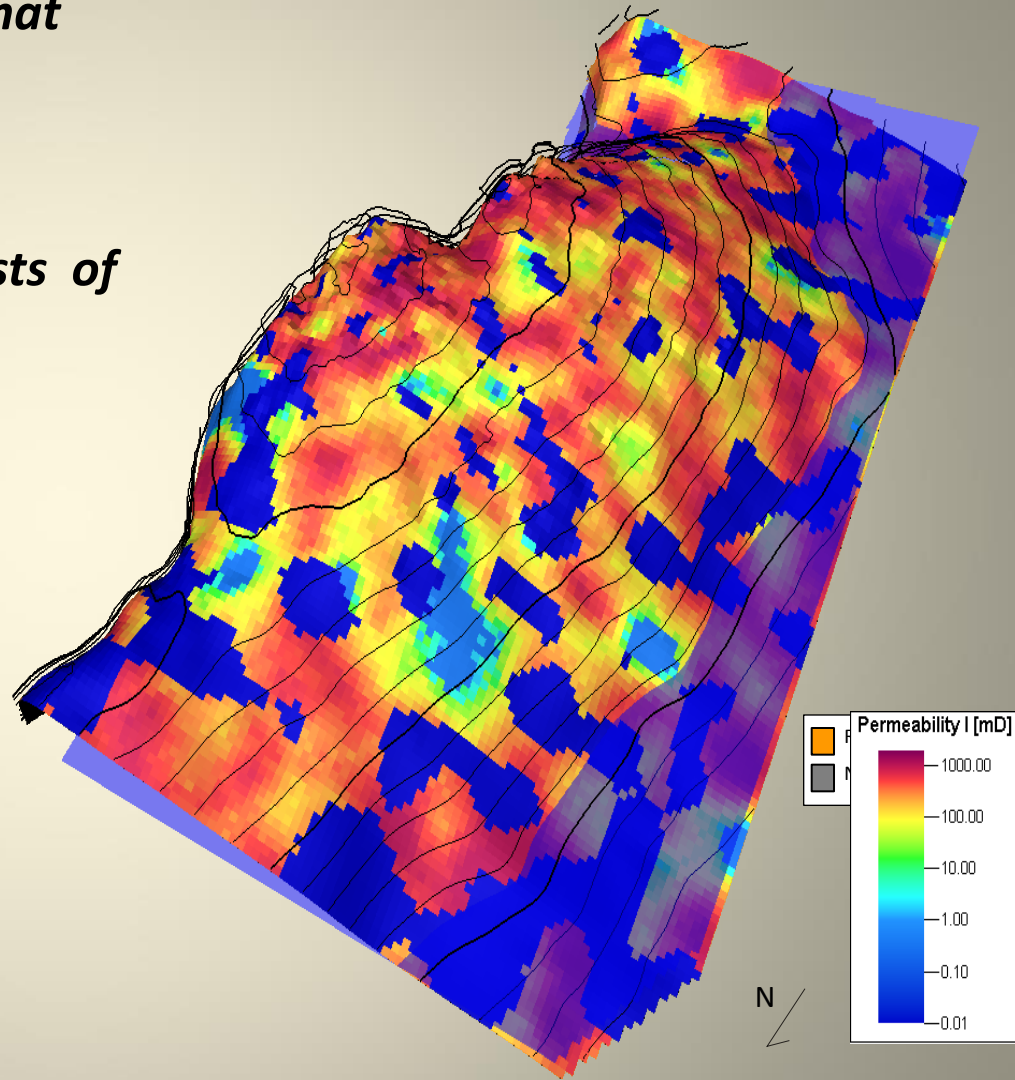
- *Static Model with geological trends that reflects the production data.*
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- *K-PHI law based on core data*
- *Saturation Model with J-Function*
- *Full field model history matched*
- *Identification of areas with remaining oil.*



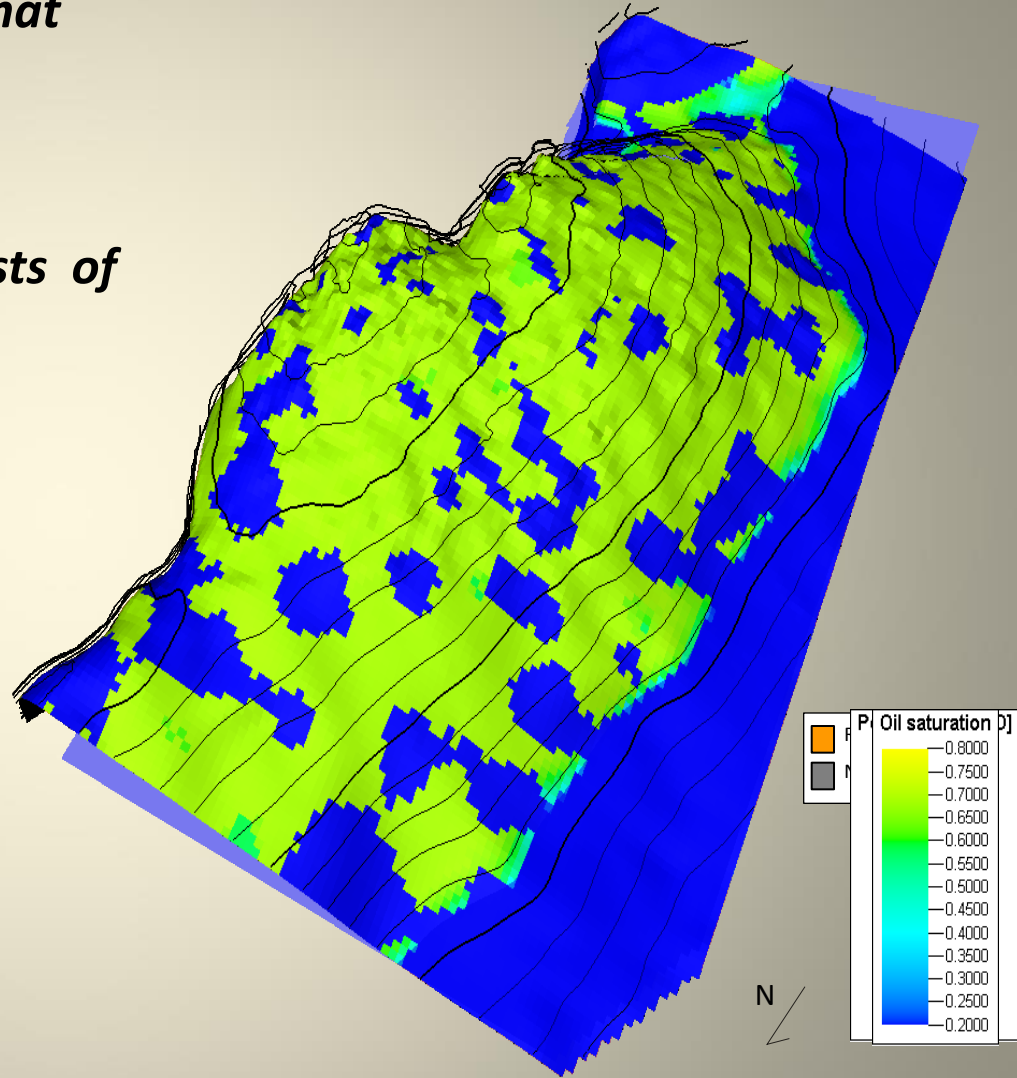
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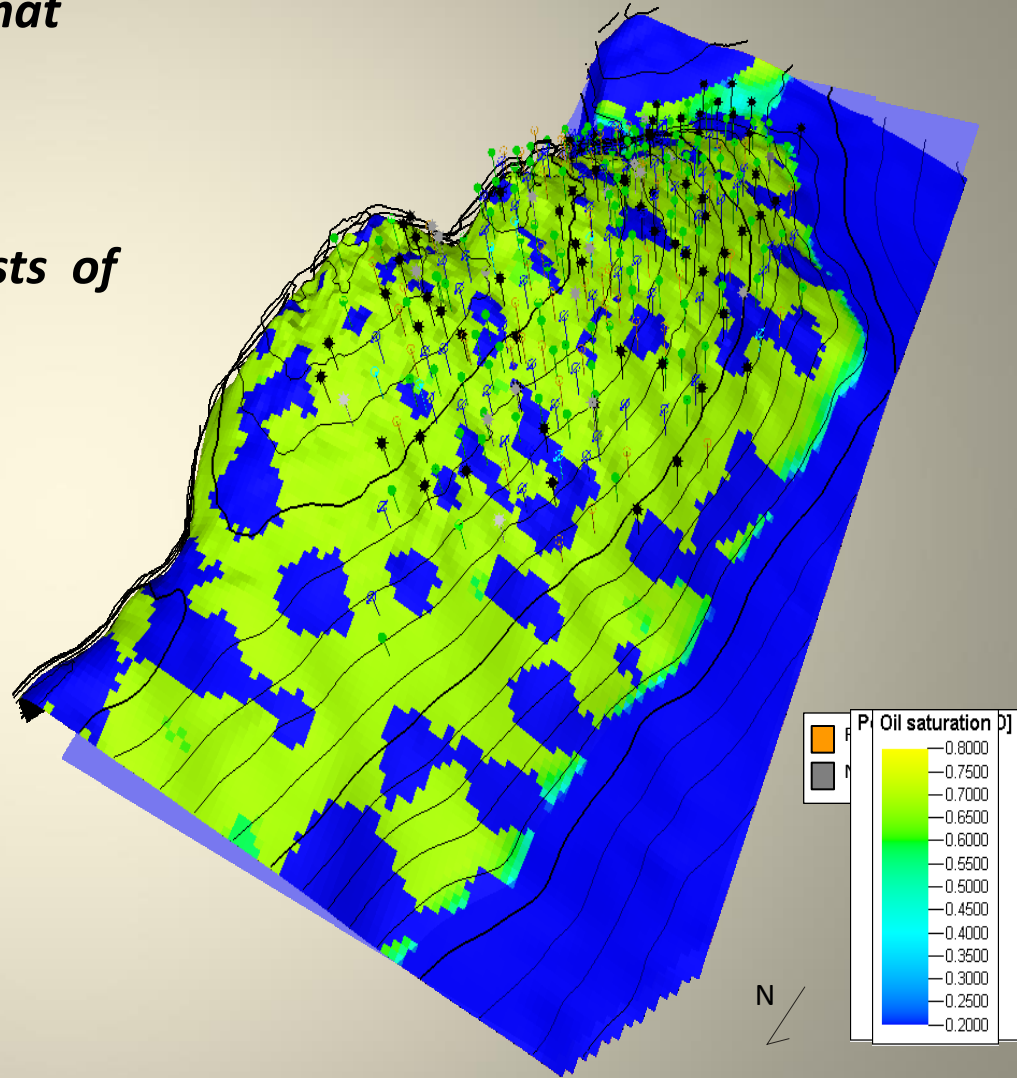
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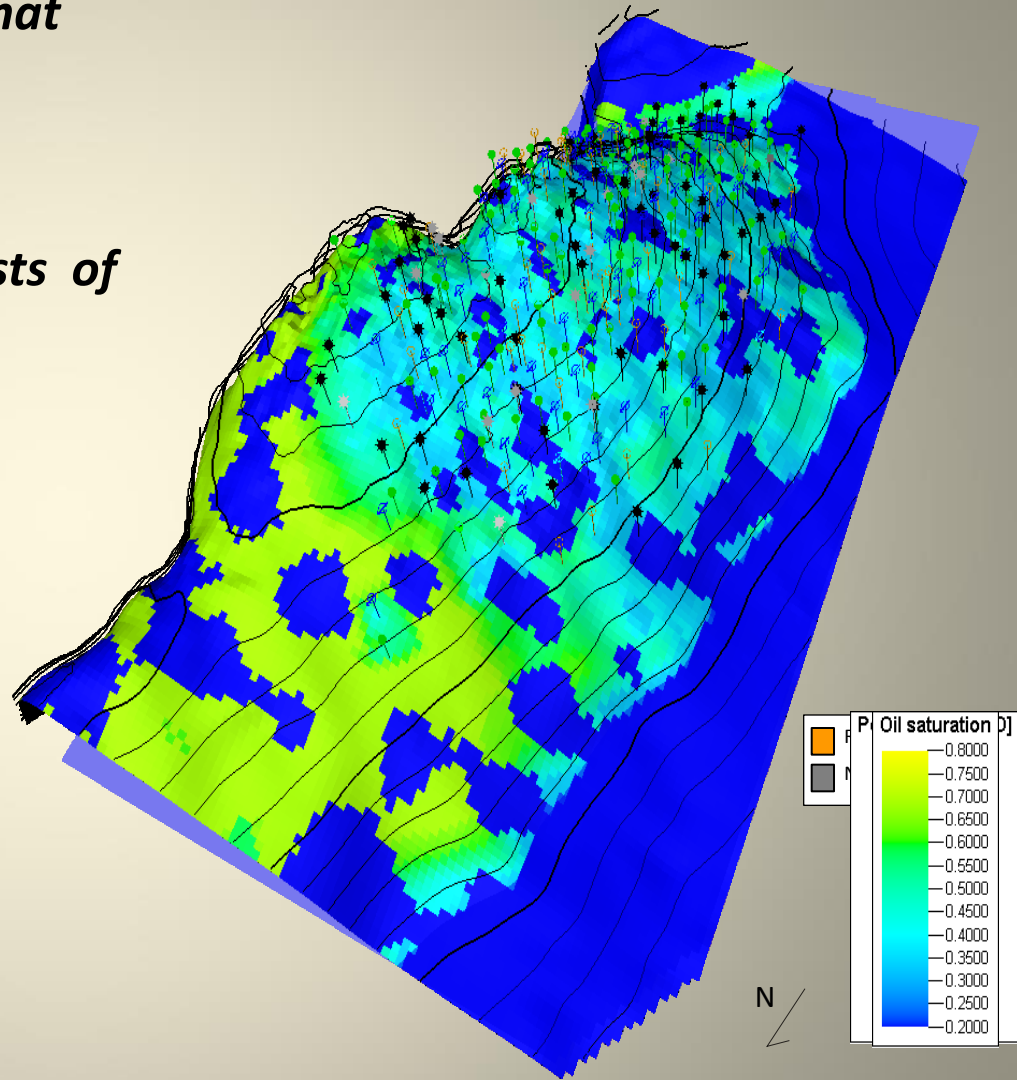
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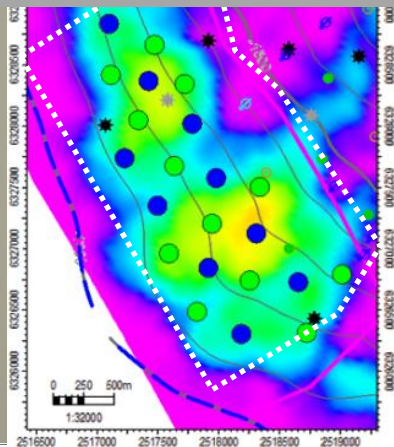


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1. How much OOIP do we really have?
2. How much and where the remaining oil is?
3. How to develop the remaining oil?

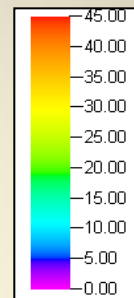
NEW AREAs opportunities



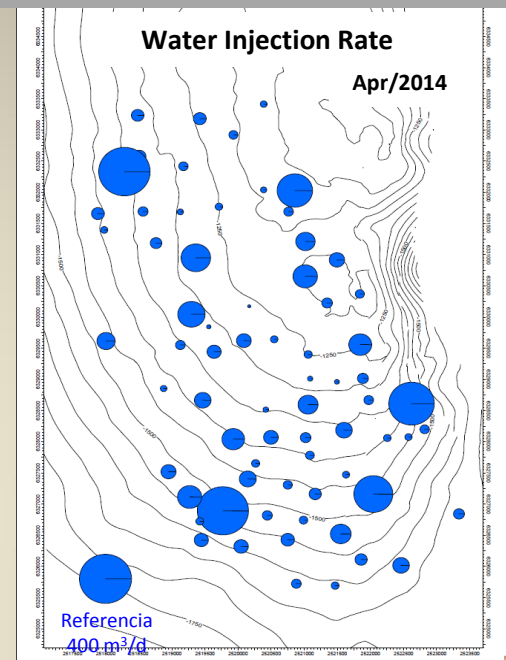
10 Injectors +
12 Producers



Reservoir with
Soil > 0.5
y Kx >
100 mD al
2015

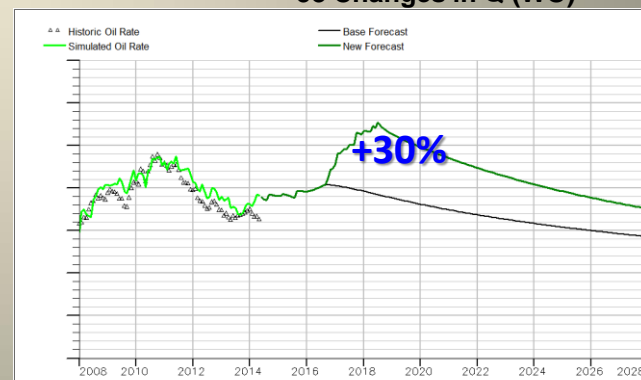


MAIN FIELD opportunities



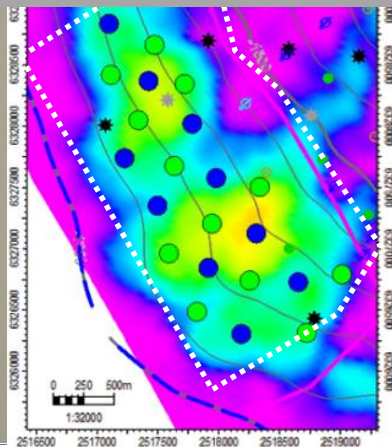
New Patterns and Q>12000 a 15000 m³/d

- 16 Producers
- 15 Injectors
- 5 conversions
- 6 reactivations
- 58 Changes in Q (WO)



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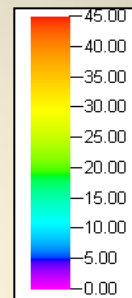
NEW AREAs opportunities



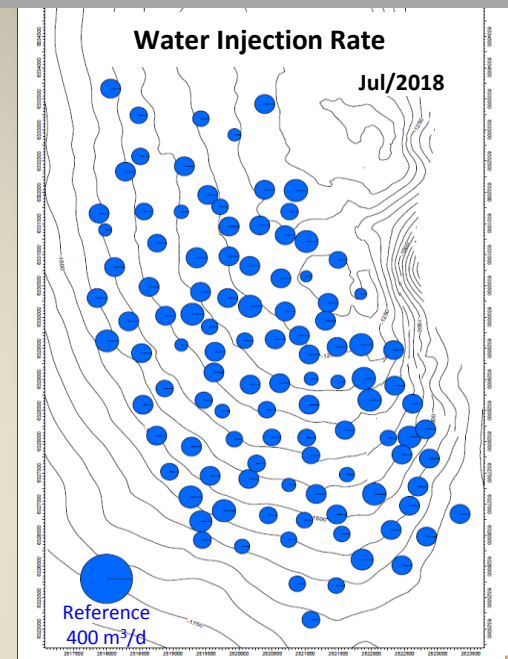
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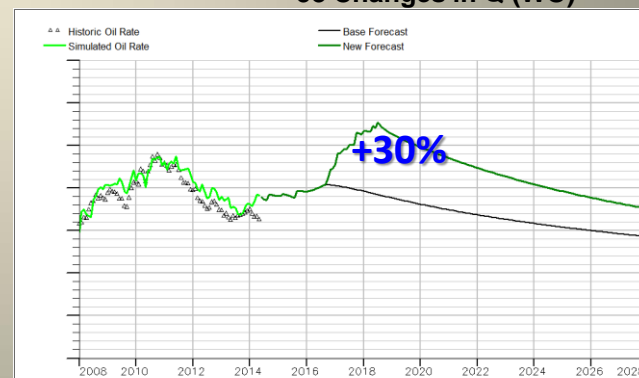


MAIN FIELD opportunities



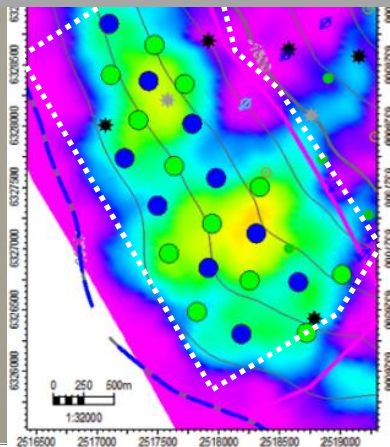
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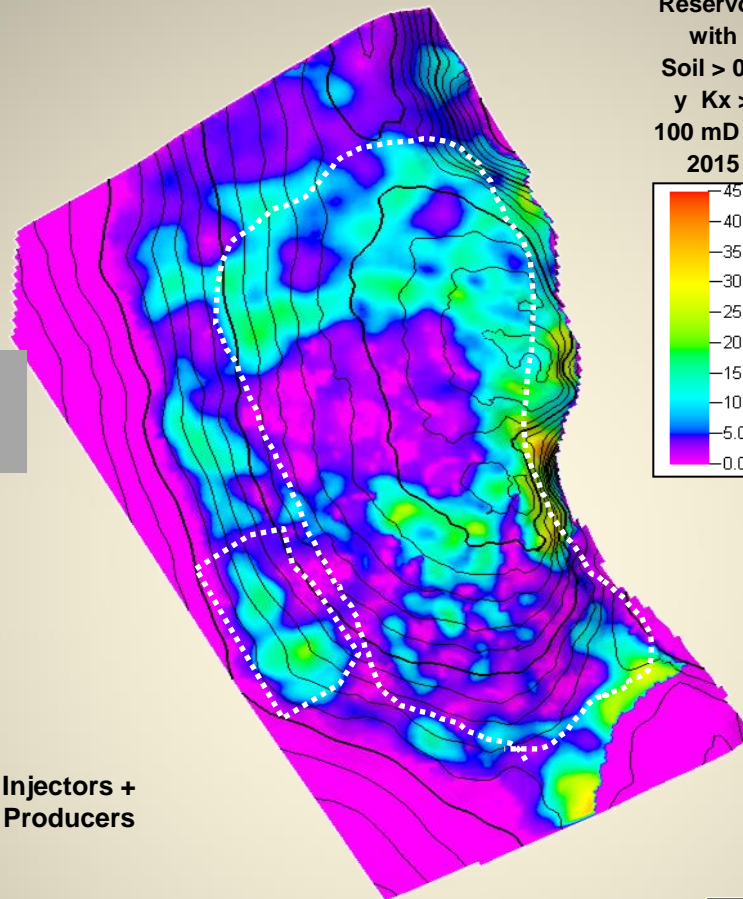


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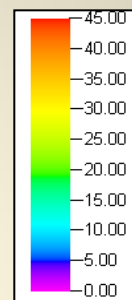
NEW AREAs opportunities



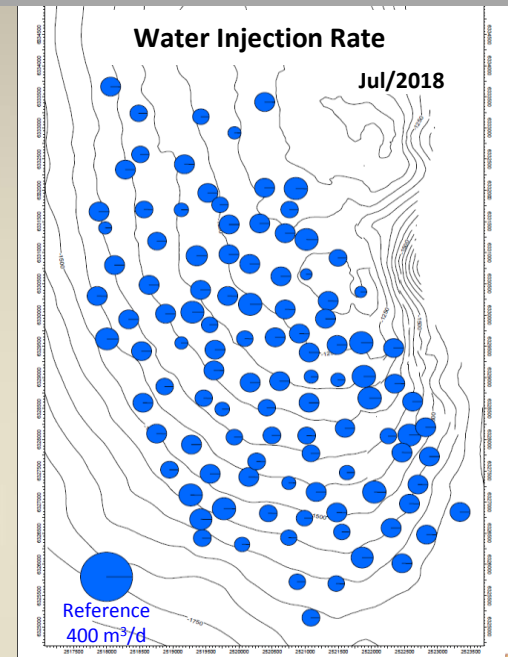
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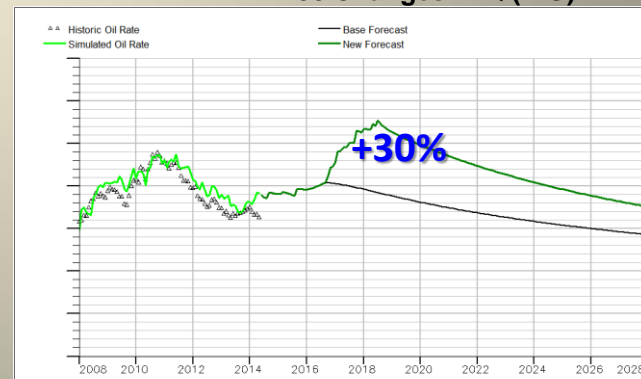
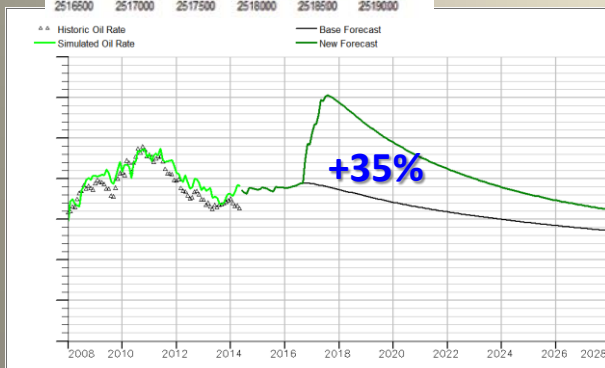


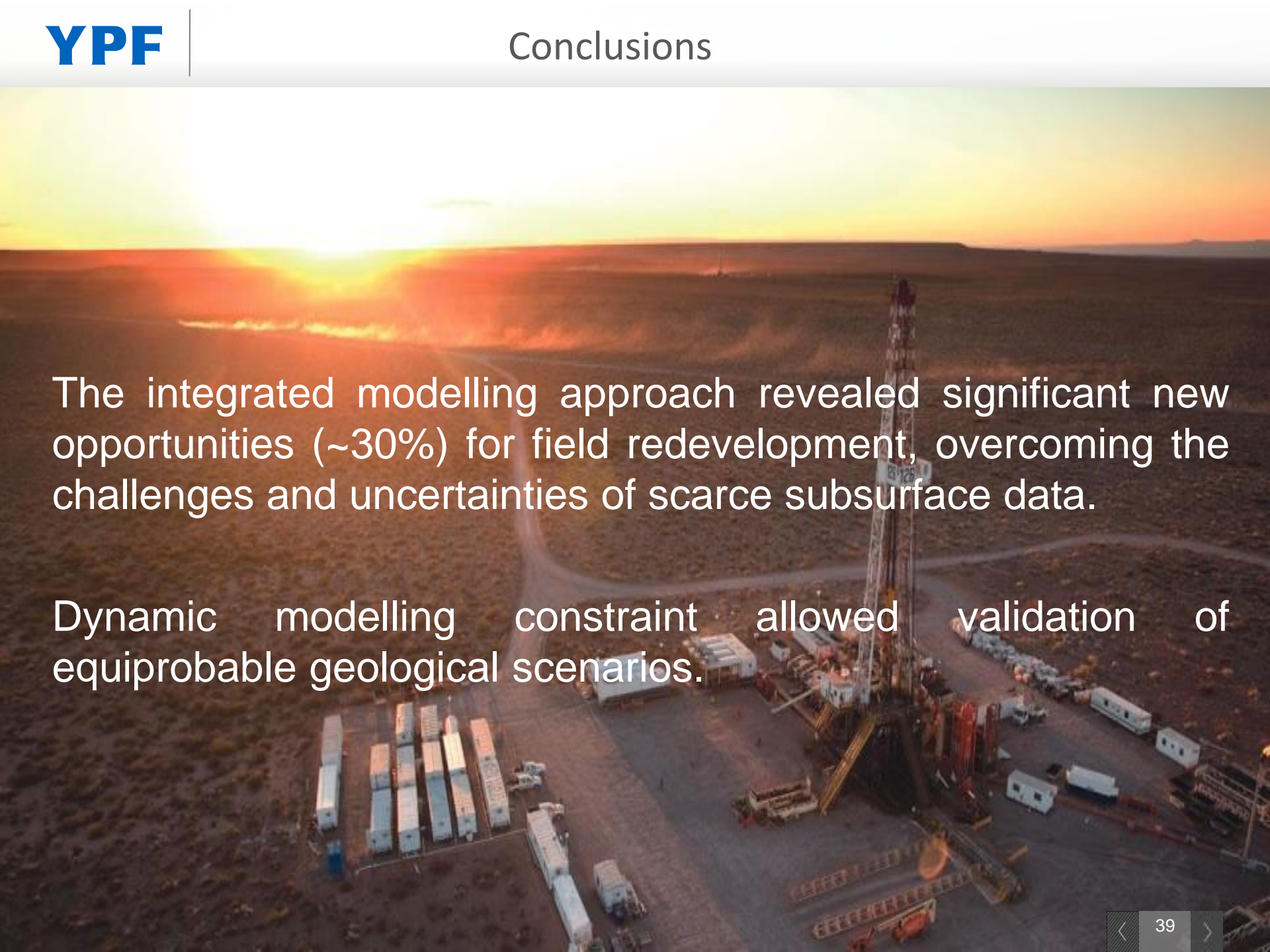
MAIN FIELD opportunities



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An aerial photograph of an oil drilling rig in a desert landscape at sunset. The sun is low on the horizon, casting a warm orange glow over the scene. The rig is a tall, complex structure with various pipes and equipment. In the foreground, there are several white trailers and other smaller structures. The background shows a vast, flat desert under a clear sky.

The integrated modelling approach revealed significant new opportunities (~30%) for field redevelopment, overcoming the challenges and uncertainties of scarce subsurface data.

Dynamic modelling constraint allowed validation of equiprobable geological scenarios.

An aerial photograph of an oil drilling operation in a desert landscape during sunset. A tall drilling rig is the central focus, surrounded by various support vehicles, trailers, and equipment. The sun is low on the horizon, casting a warm, golden glow over the entire scene.

YPF

THANKS!!!

Acknowledgements

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Nayibe Otalora y Ariel Lucero.