

Seismic Architecture and Anatomy of a Basin-Scale Lowstand Wedge (Mulichinco Formation, Argentina): Implications for Tight Reservoirs Exploration*

Sebastián M. Arismendi¹, María E. Pascariello¹, Maria F. Rincón¹, Ernesto Schwarz², and Mariana Olivo²

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¹Gerencia de Estudios de Subsuelo, YPF S.A., Buenos Aires, Argentina (sebastian.arismendi@ypf.com)

²Centro de Investigaciones Geológicas, Universidad Nacional de La Plata - CONICET, La Plata, Argentina

Abstract

The Valanginian Mulichinco Formation is a hydrocarbon productive unit of the Neuquén Basin in Argentina, in which potential recoverable resources associated with tight sandstones are estimated as 5 tcf. Although the unit has been extensively studied in outcrops, its extension, internal anatomy, and sand distribution in the adjacent subsurface region is still poorly understood. The aim of this contribution is to present a basin-scale characterization of the unit, integrating a vast 3D seismic coverage plus hundreds of wells, together with a refined facies and sequence-stratigraphic framework, in order to identify new leads and prospects in underexplored areas. The Mulichinco Formation comprises continental, transitional, and marine deposits that accumulated on a previous marine ramp setting after a major sea-level fall. It, therefore, represents an exceptional example of a lowstand wedge whose sequence boundary (SB) is named the Intra-Valanginian unconformity. The basinal-scale study encompasses an area of 56,000 km² (about half the extent of the basin), from which 36,000 km² are covered with 3D seismic data of variable quality acquired during the last three decades. Gaps within 3D data are filled with 2D seismic. Moreover, 1600 wells with sonic, density and gamma-ray logs and 56 wells with core data are available. Standard facies and sequence-stratigraphic analysis were carried out of the cores. The results of this study are presented in up to fourteen dip-oriented regional seismic sections passing through calibration wells from the basin margin to the outcrops in the fold and thrust belt. In all sections the lowstand wedge morphology is clearly identified, using consistent markers for its top and base. It thickens gradually from a few meters in the basin borders up to 300 m in the distal portions, having an average length of 150 km. From seismic interpretation, key reflectors are identified. The basal SB and the master transgressive surface at the top are represented by well

defined reflectors. Internally, both reflectors and strata representing different depositional systems show some variability from south to north, and, therefore, seismic stratigraphy is the key to understand the lateral and temporal relationships between different stratigraphic intervals. This integrated study allowed prediction and identification of new tight sandstone plays within this lowstand wedge and provided a new basin-scale exploration model for this prolific hydrocarbon unit.

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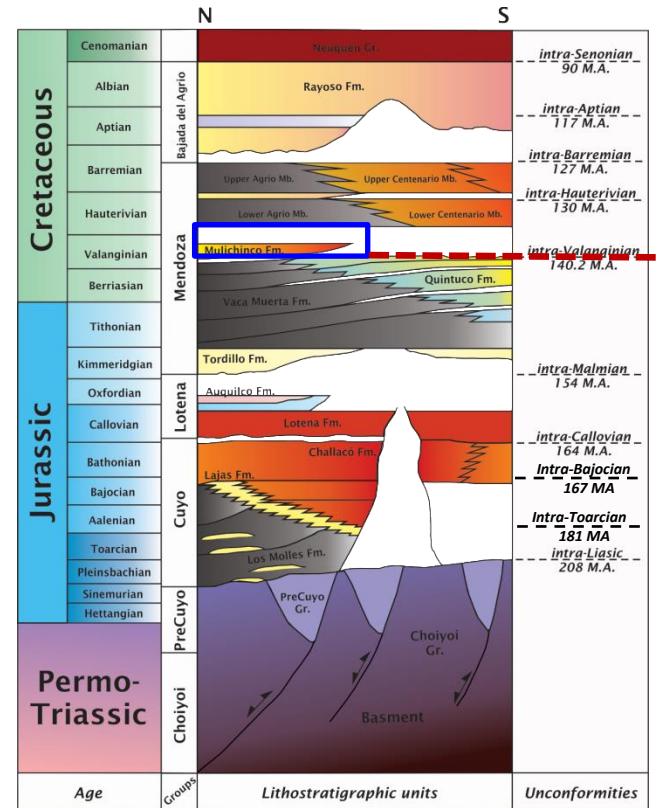
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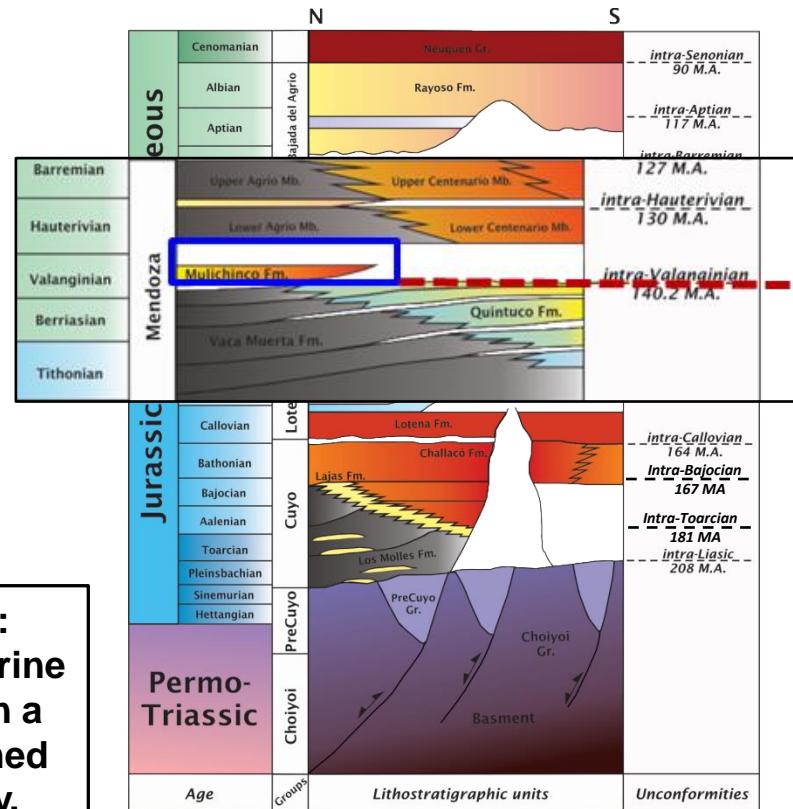
Seismic Architecture and Anatomy of a Basin-Scale Lowstand Wedge (Mulichinco Fm, Argentina): Implications for Tight Reservoirs Exploration.

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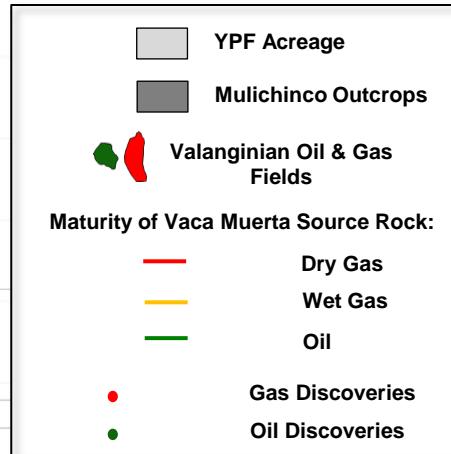
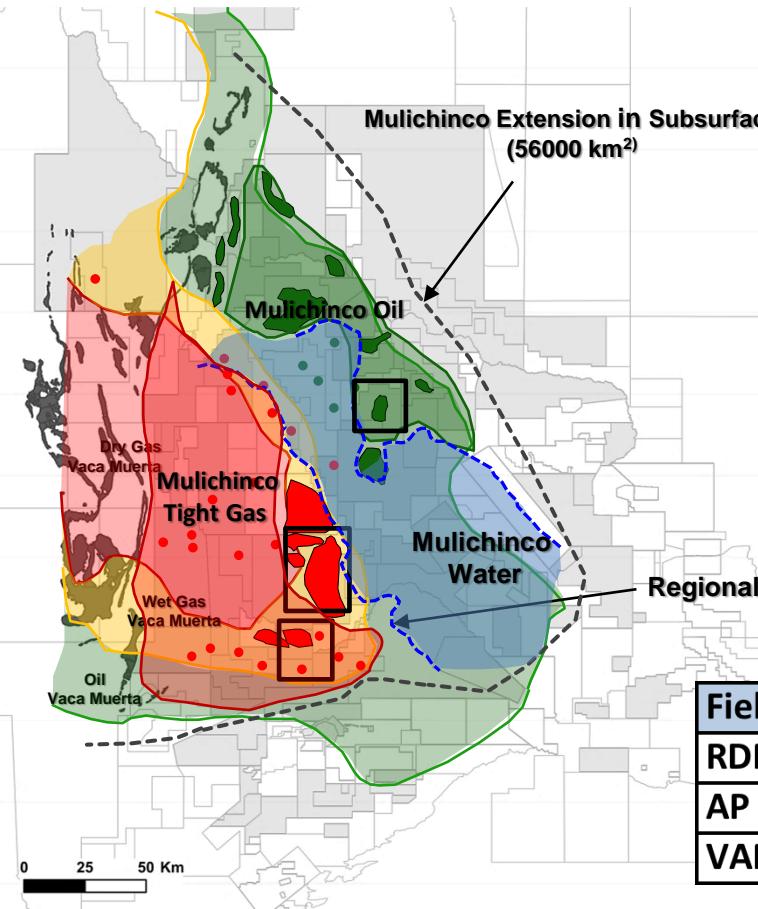
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General Location**Tectonic Setting****General Stratigraphy**

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Mulichinco Lowstand Wedge:
Continental, transitional and marine
sedimentary rocks deposited in a
ramp setting above the SB named
IntraValanginian unconformity.

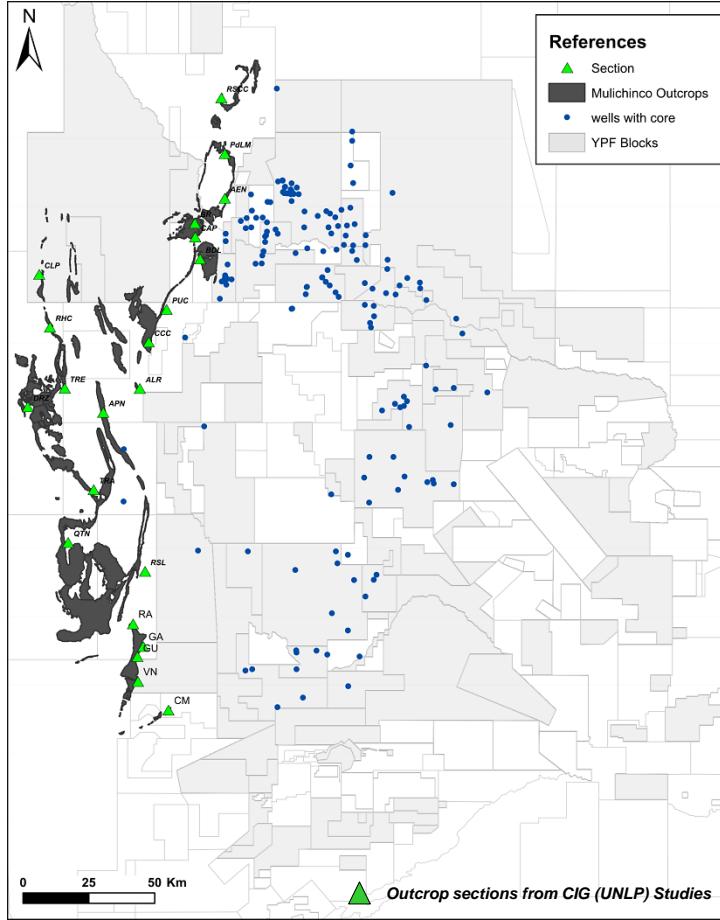


“..several formations with tight gas potential.. found at different depths and ..different geological ages. Lajas and **Mulichinco** formations accounted for close to 80% of tight gas production in Neuquén Province in 2014.”

From WoodMackenzie Report “Neuquén Basin Tight Gas Unconventional Play”, July 2015

Average Field Petrophysical Parameters

Field	Net/Gross	Porosity (%)	Permeability (mD)	Fluid
RDM	0,50	12,00	0,1	GAS
AP	0,70	14,00	1,0	GAS
VAM	0,80	16,00	100,0	OIL



Outcrop Location Sections (21)

Mulichinco Core Data (98 Wells & more tan 2000 m)

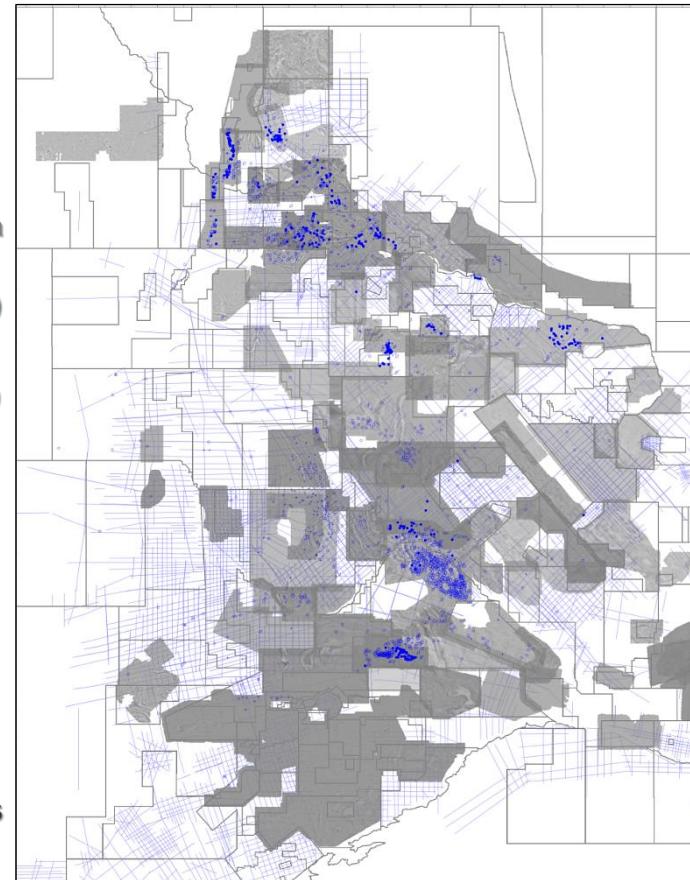
3D Seismic (36000 km²)

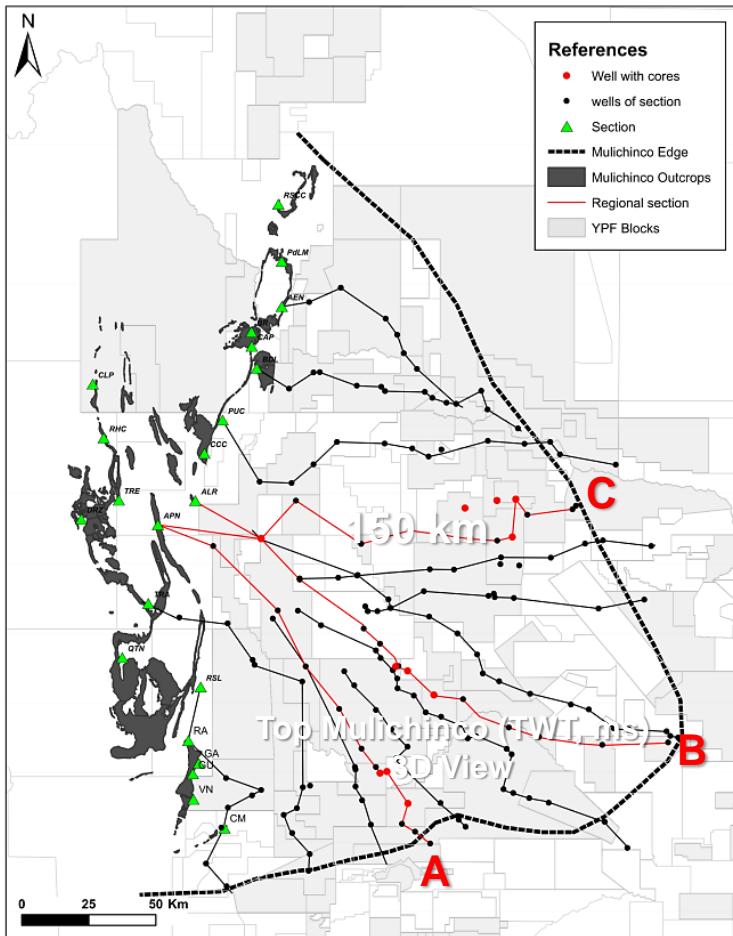
More than 60% of the study area

2D Seismic (Filling Gaps)

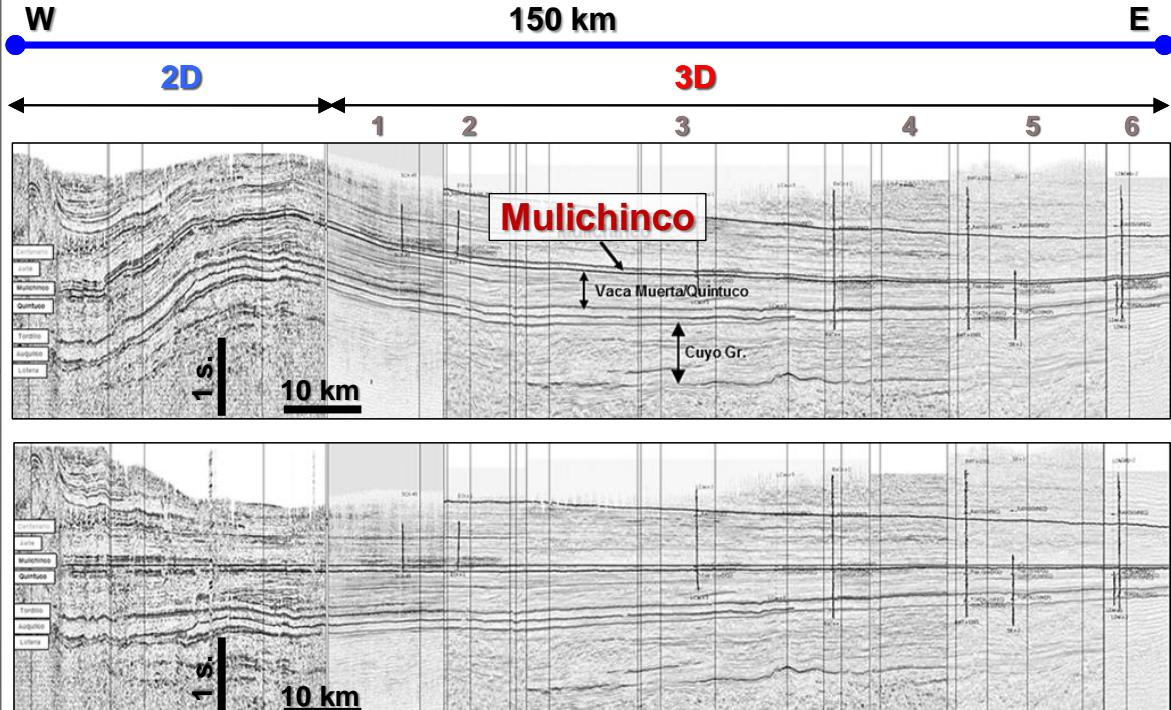
1600 Wells (Sonic and Density)

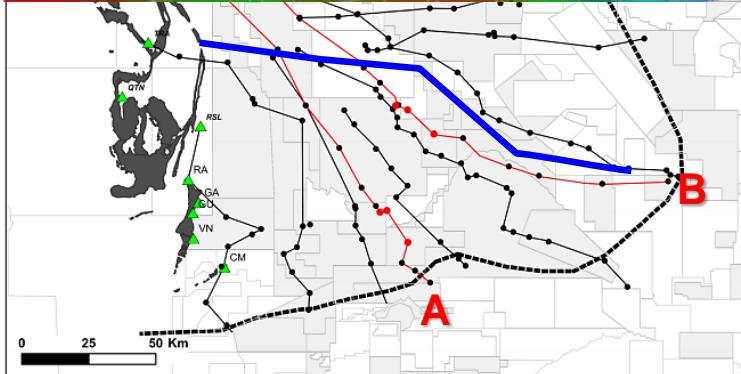
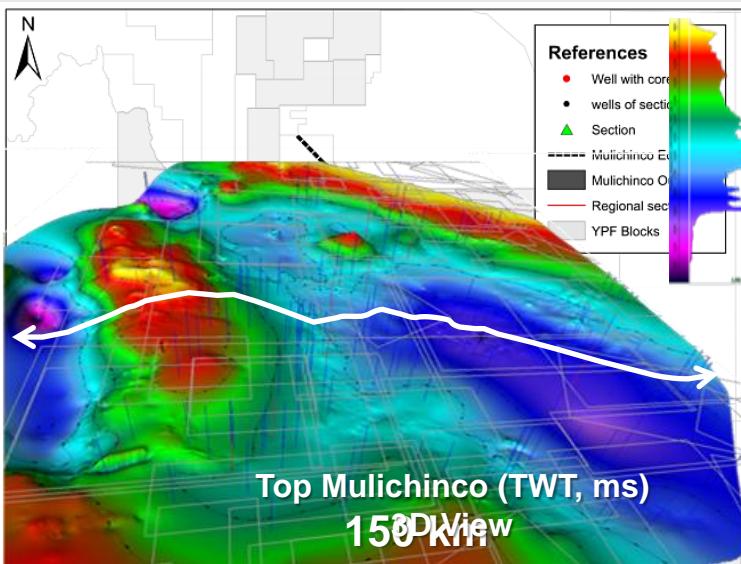
- **Regional Synthesis**
- **Exploration Opportunities**
- **Development Opportunities**



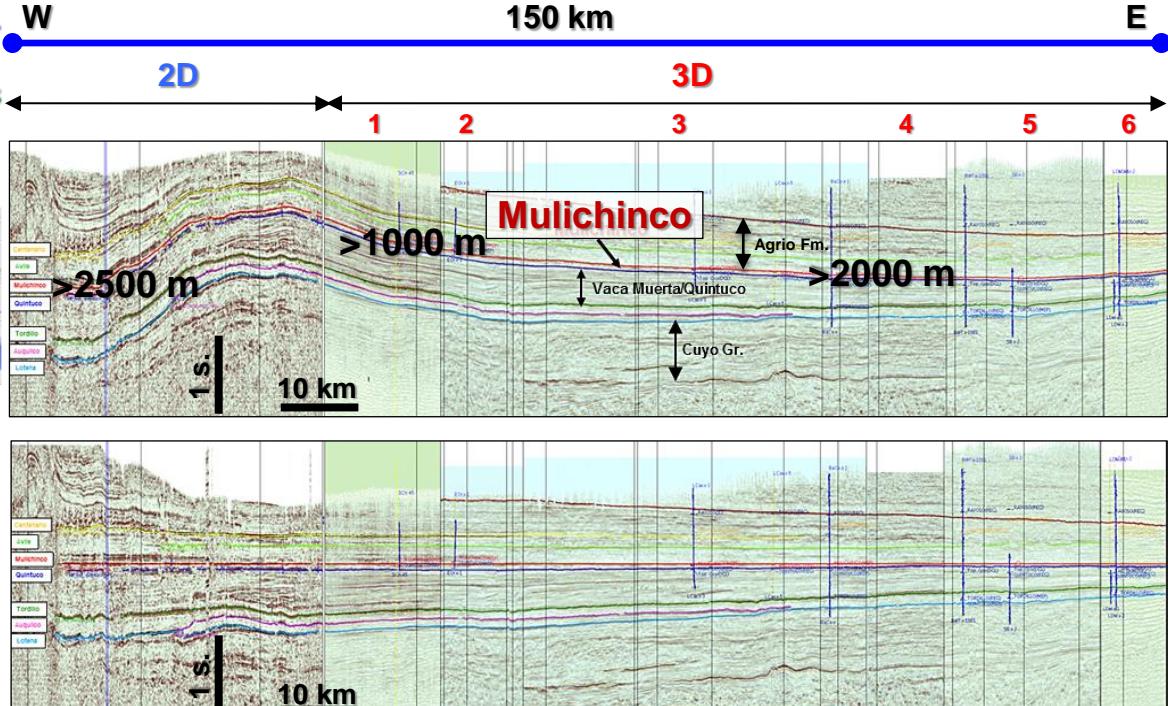


- 14 Dip Regional Sections (to main Depositional Systems)
- Calibrated with Wells (logs, cores, cuttings) and Outcrops
- 3 of them will be shown in this presentation (A, B & C)





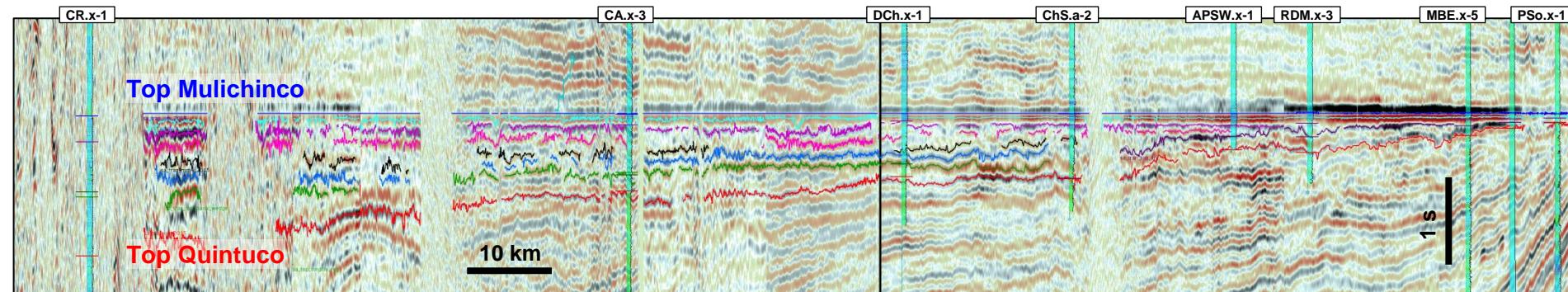
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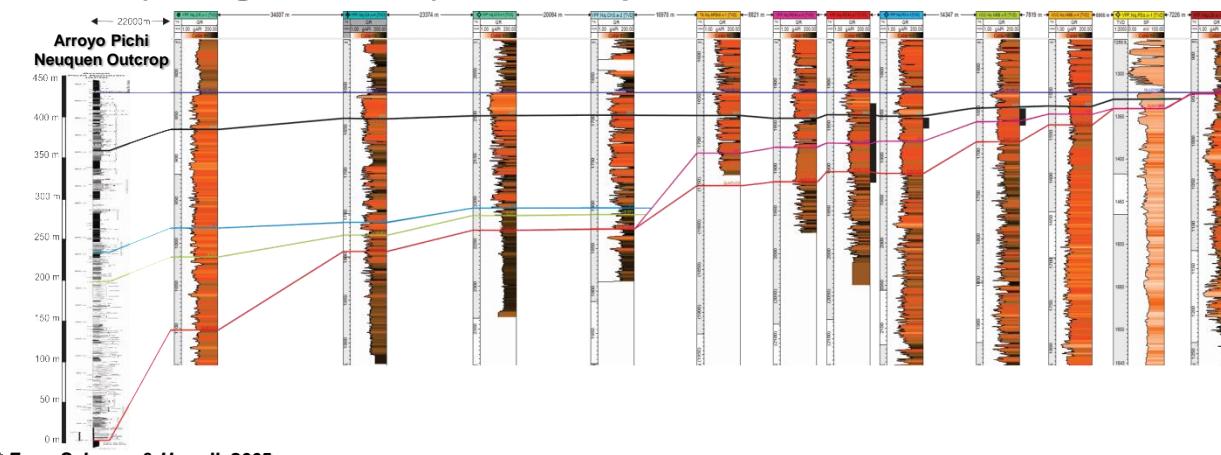
Different Depths of Tight Reservoirs

NW

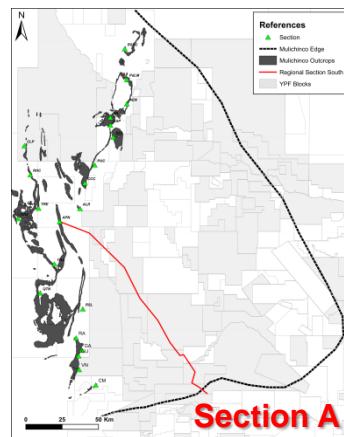
- Seismic Section (and sonic logs) & Horizon Interpretation



- Wells (GR logs and cores) and Outcrop Section



* From Schwarz & Howell, 2005



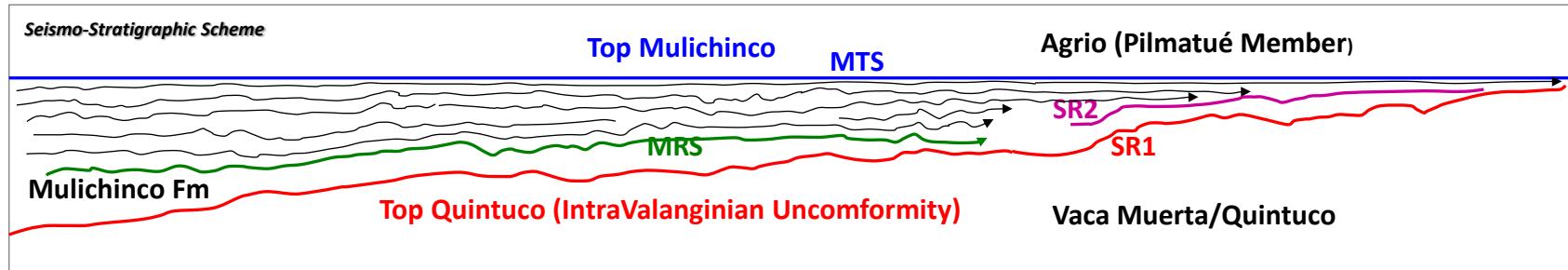
Section A

* YPF-CIG(UNLP) Consortium Work

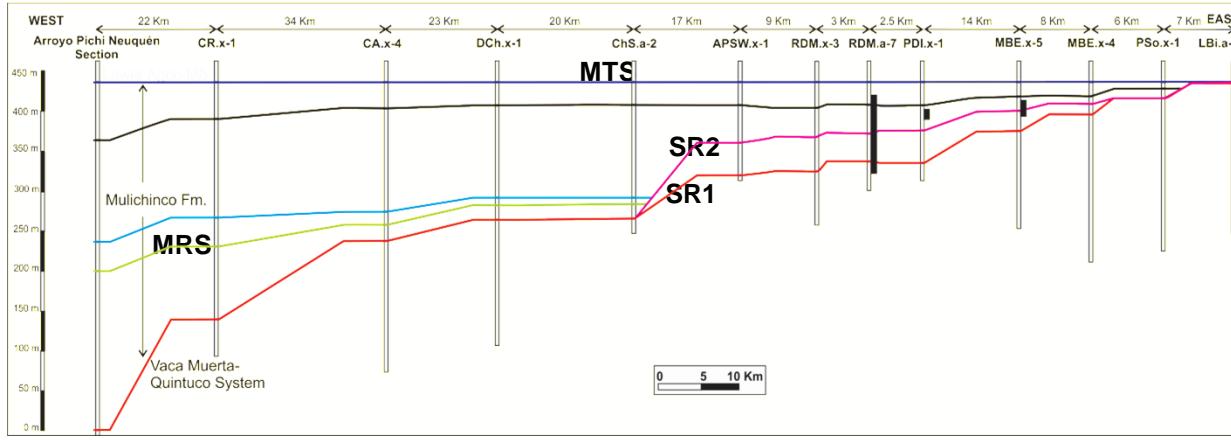
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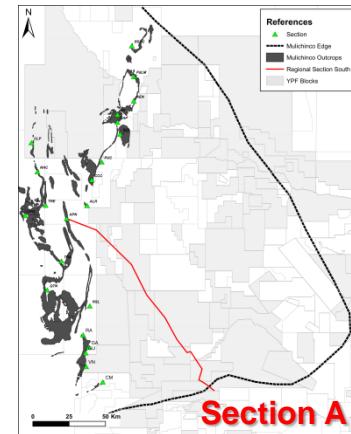
- Seismic Section (and sonic logs) & Horizon Interpretation



- Wells (GR logs and cores) and Outcrop Section



* From Schwarz & Howell, 2005

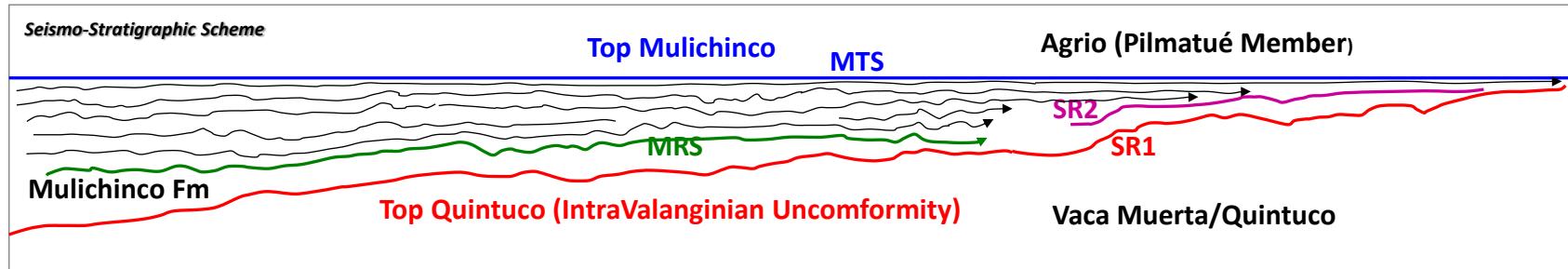


* YPF-CIG(UNLP) Consortium Work

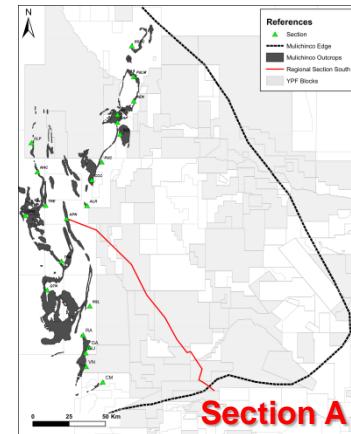
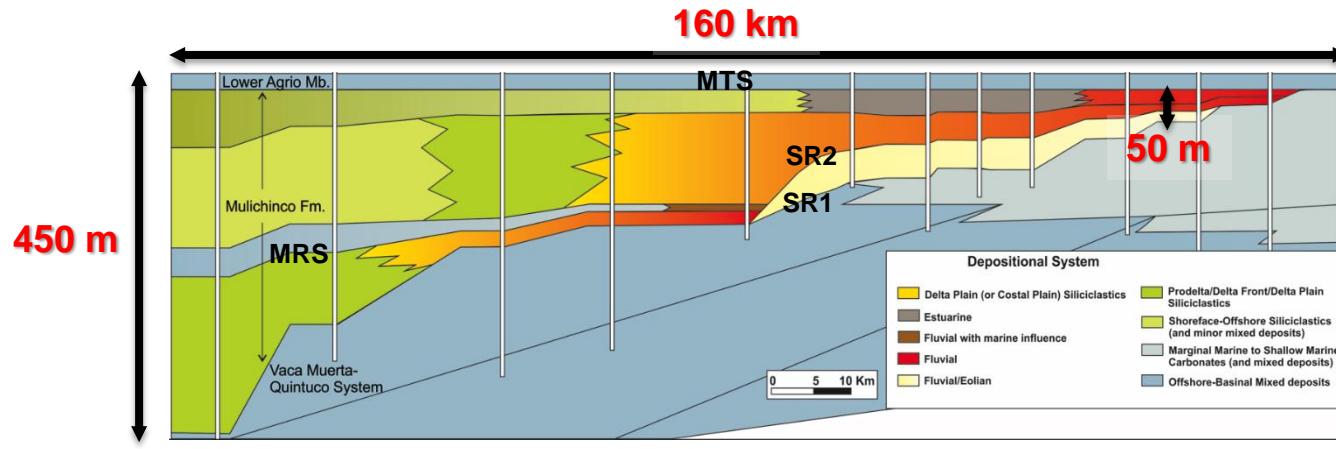
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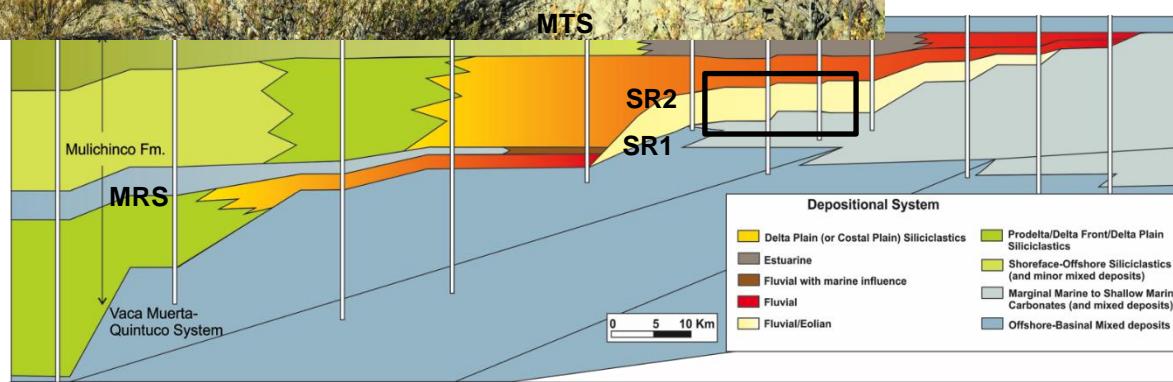
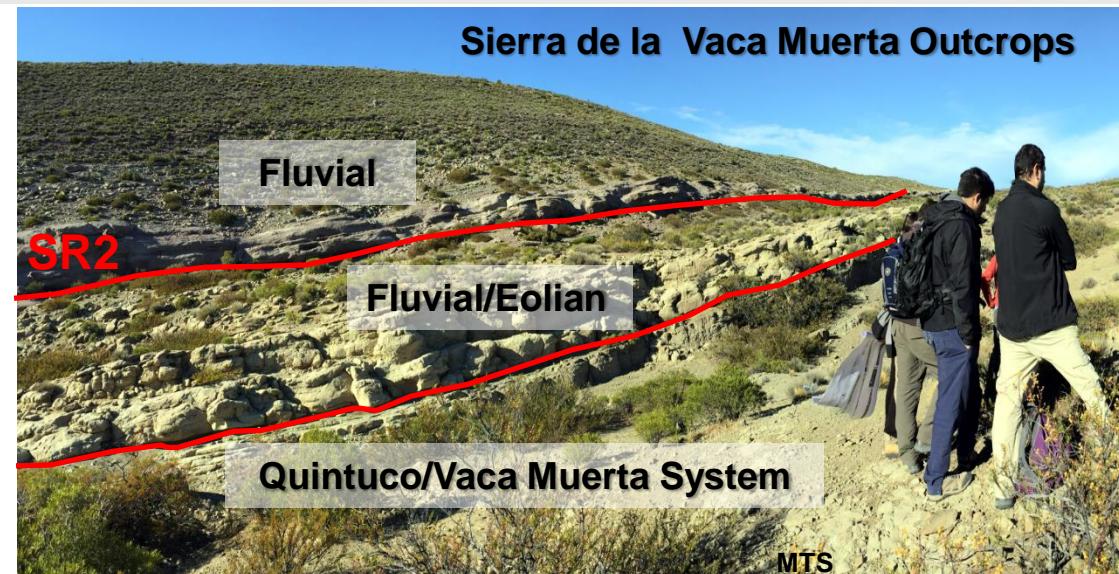
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- Seismic Section (and sonic logs) & Horizon Interpretation

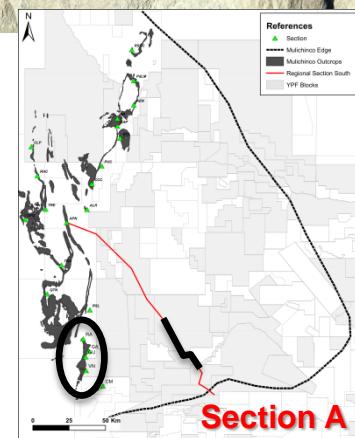


- Wells (GR logs and cores) and Outcrop Section





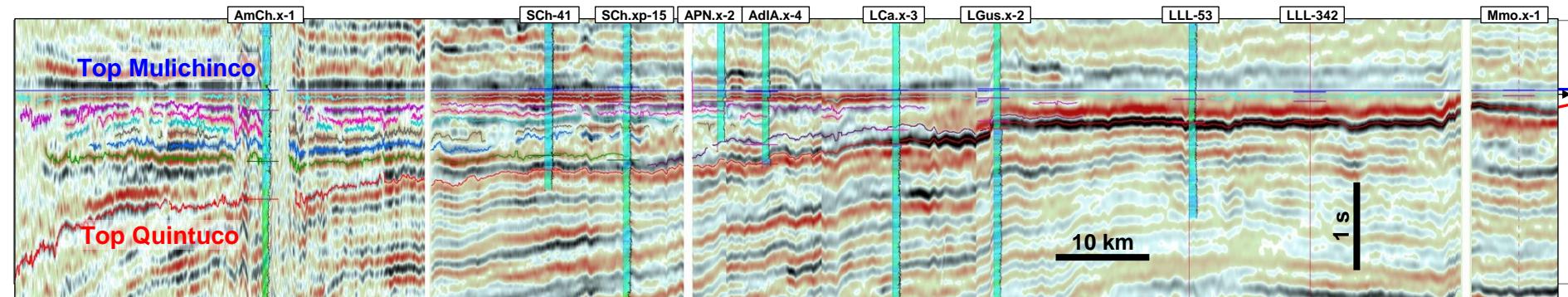
* From Schwarz & Howell, 2005



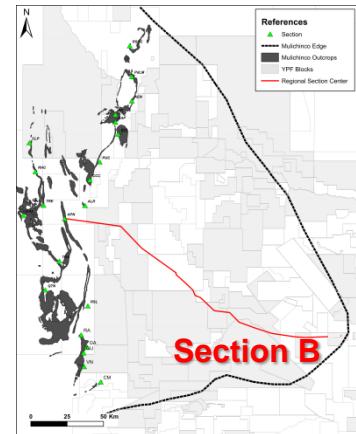
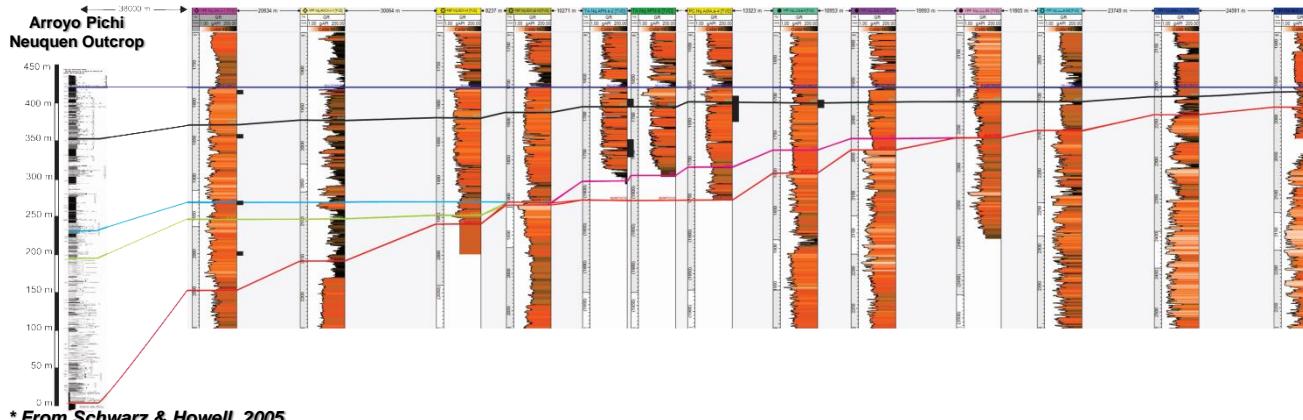
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- Seismic Section (and sonic logs) & Horizon Interpretation



- ## • Wells (GR logs and cores) and Outcrop Section



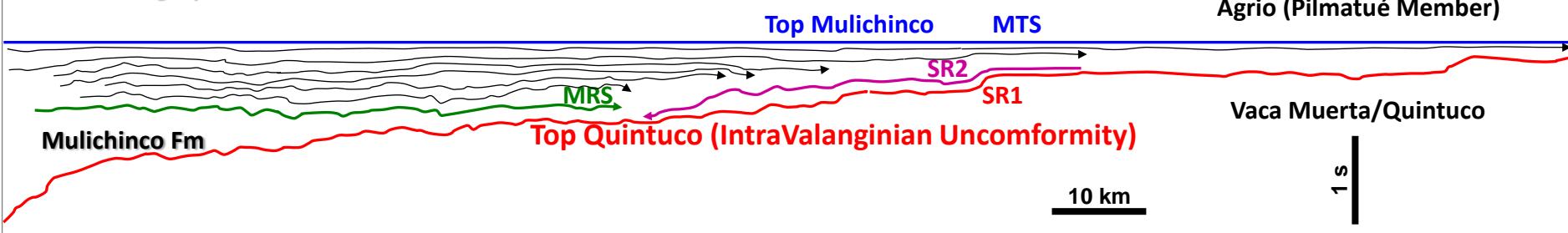
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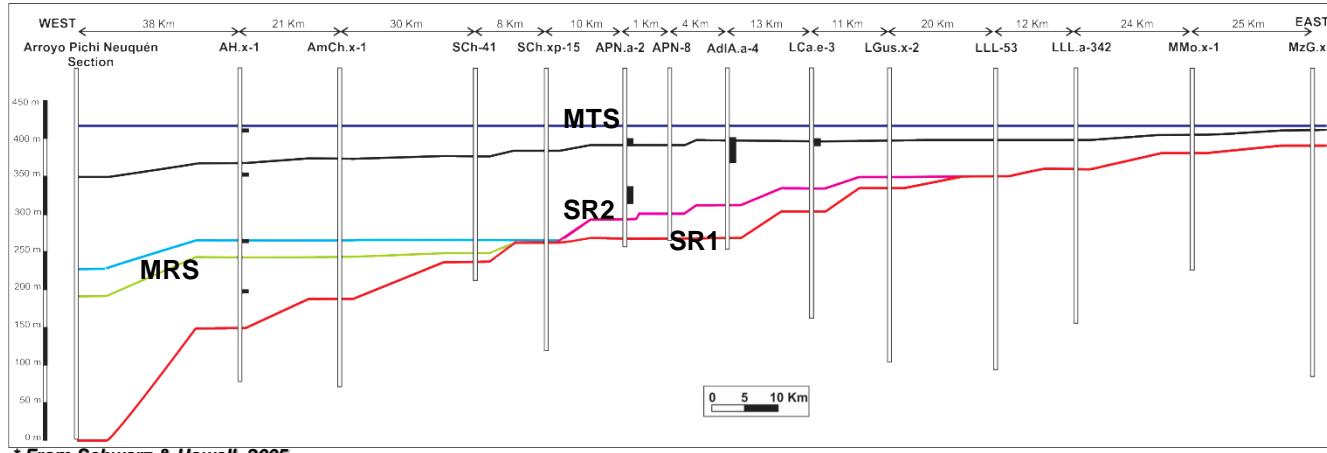
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- Seismic Section (and sonic logs) & Horizon Interpretation

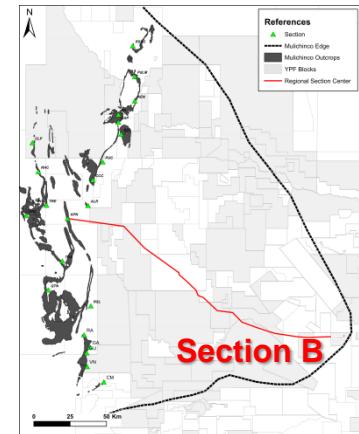
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Seismo-Stratigraphic Scheme

- Wells (GR logs and cores) and Outcrop Section



* From Schwarz & Howell, 2005

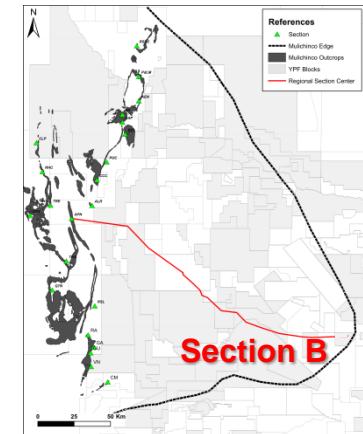
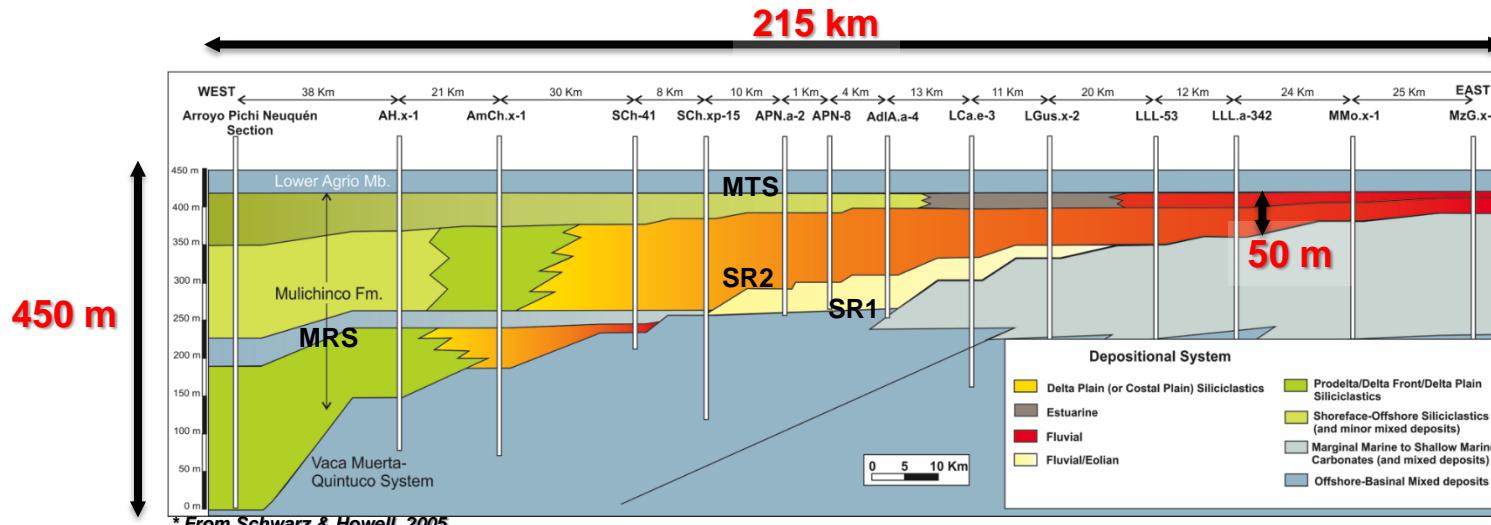
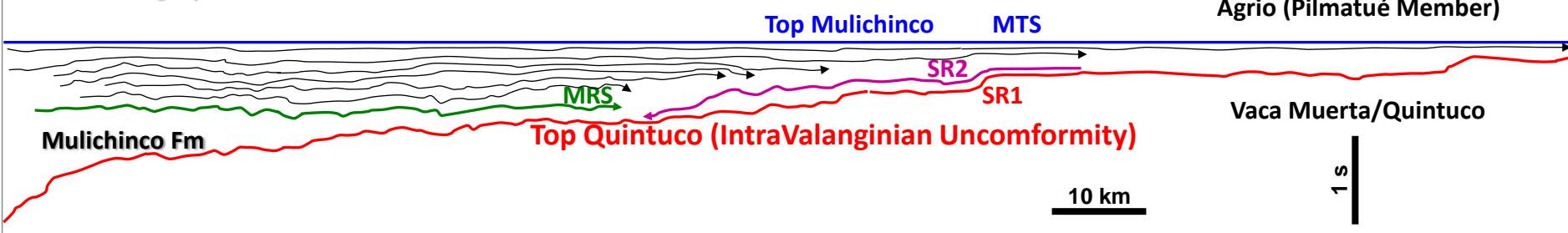


* YPF-CIG(UNLP) Consortium Work

NW

- Seismic Section (and sonic logs) & Horizon Interpretation

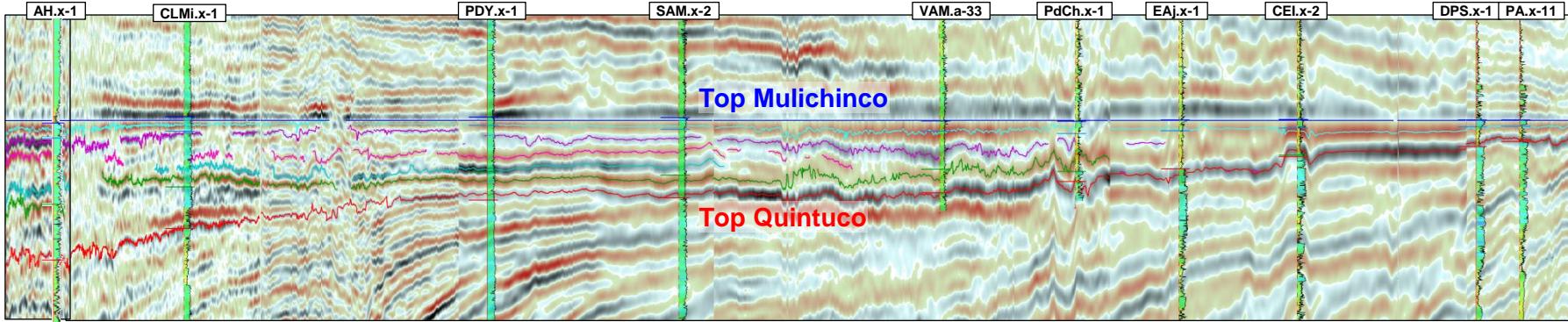
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Seismo-Stratigraphic Scheme

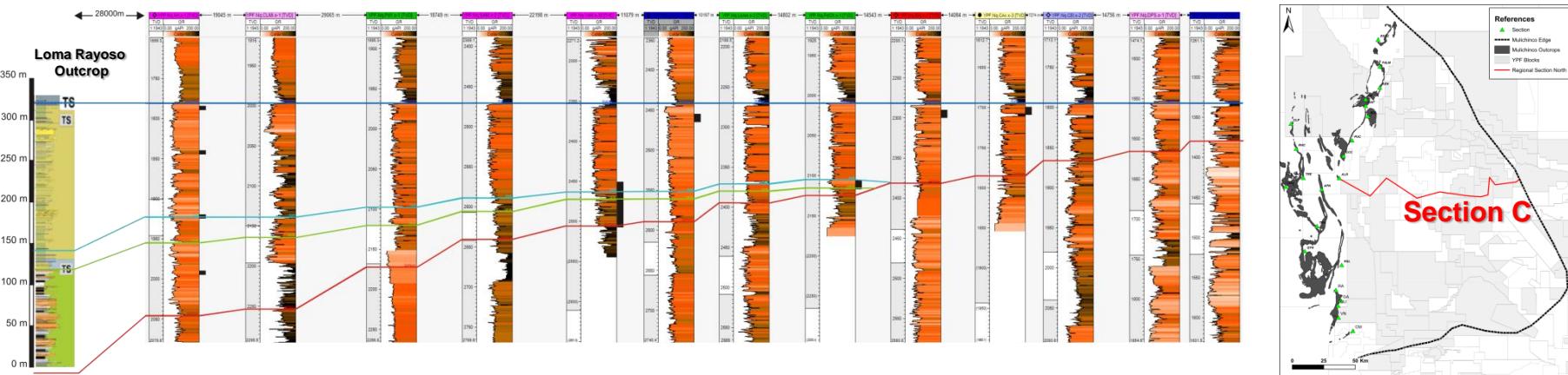
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- Seismic Section (and sonic logs) & Horizon Interpretation



- Wells (GR logs and cores) and Outcrop Section

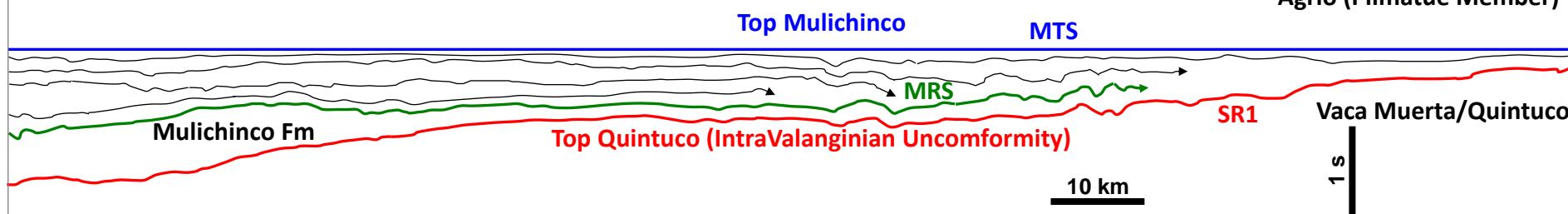


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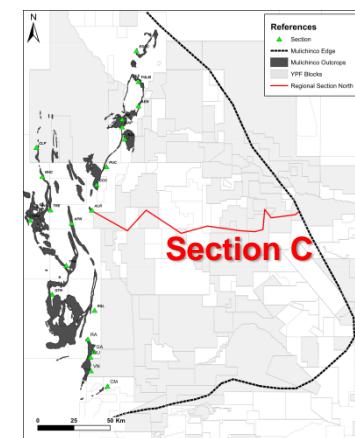
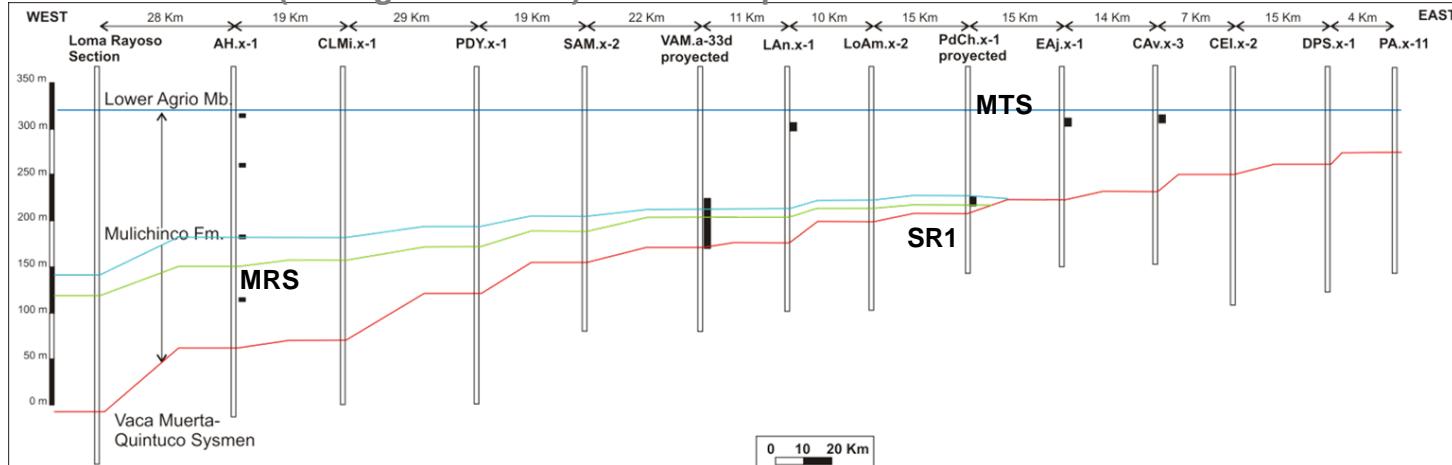
- Seismic Section (and sonic logs) & Horizon Interpretation

E

Seismo-Stratigraphic Scheme



- Wells (GR logs and cores) and Outcrop Section

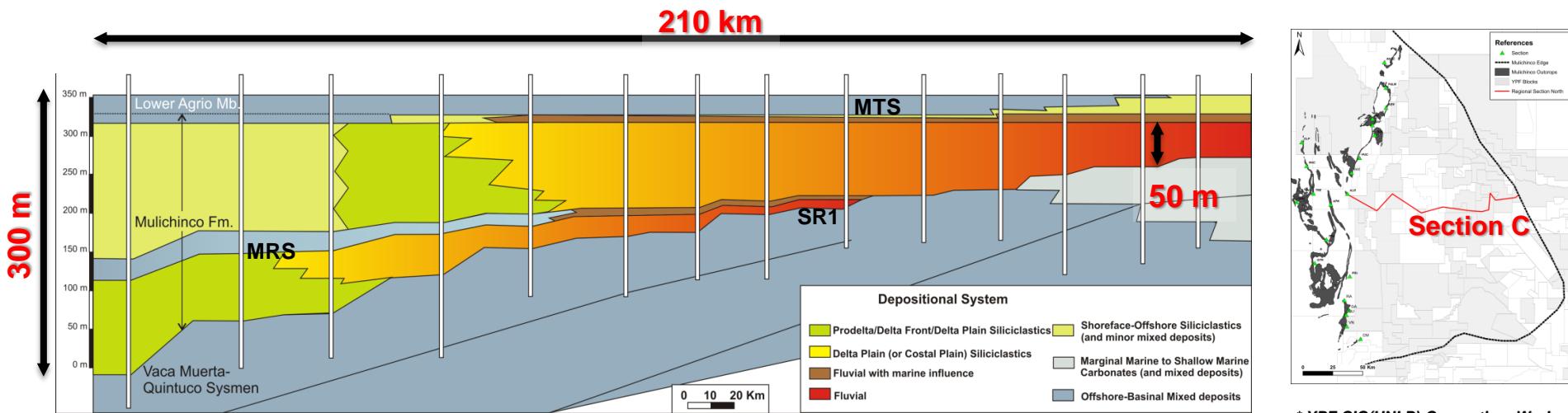
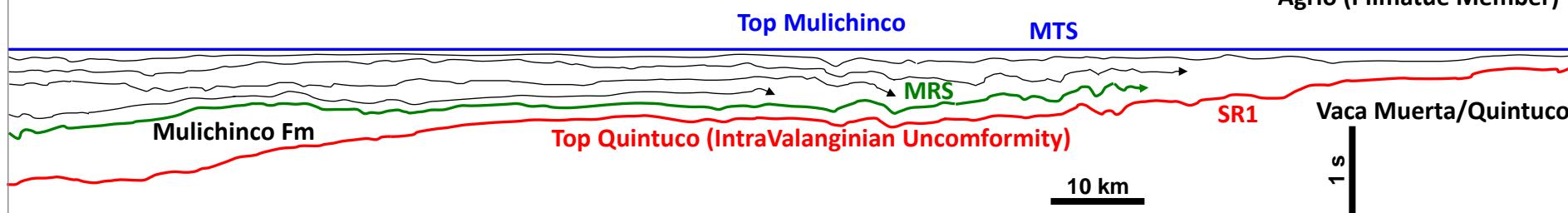


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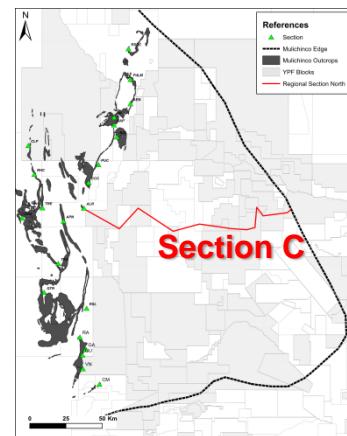
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Seismo-Stratigraphic Scheme



* From Schwarz & Howell, 2005



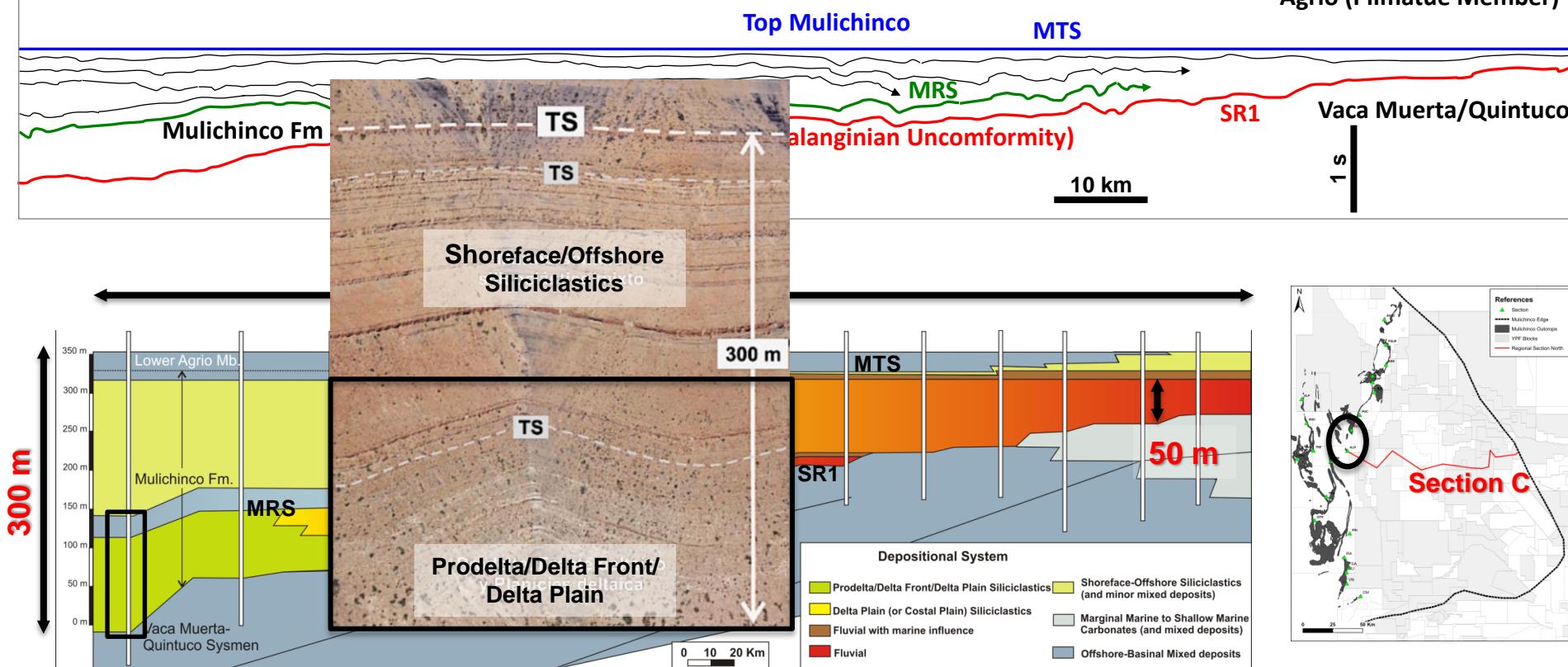
* YPF-CIG(UNLP) Consortium Work

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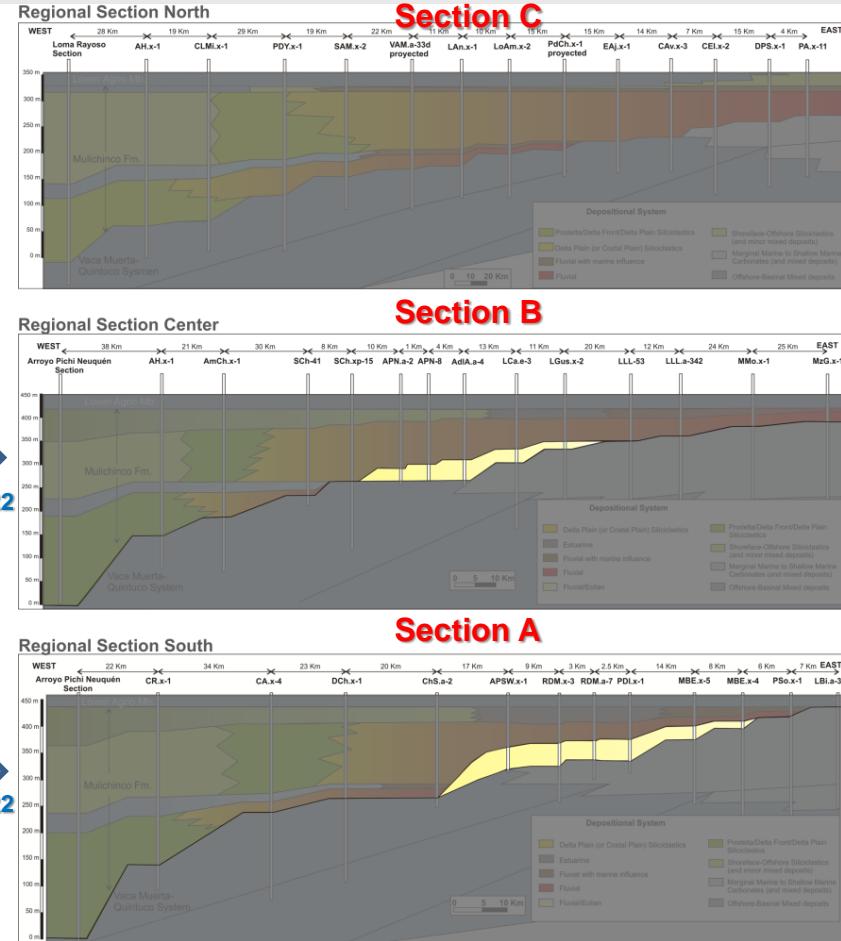
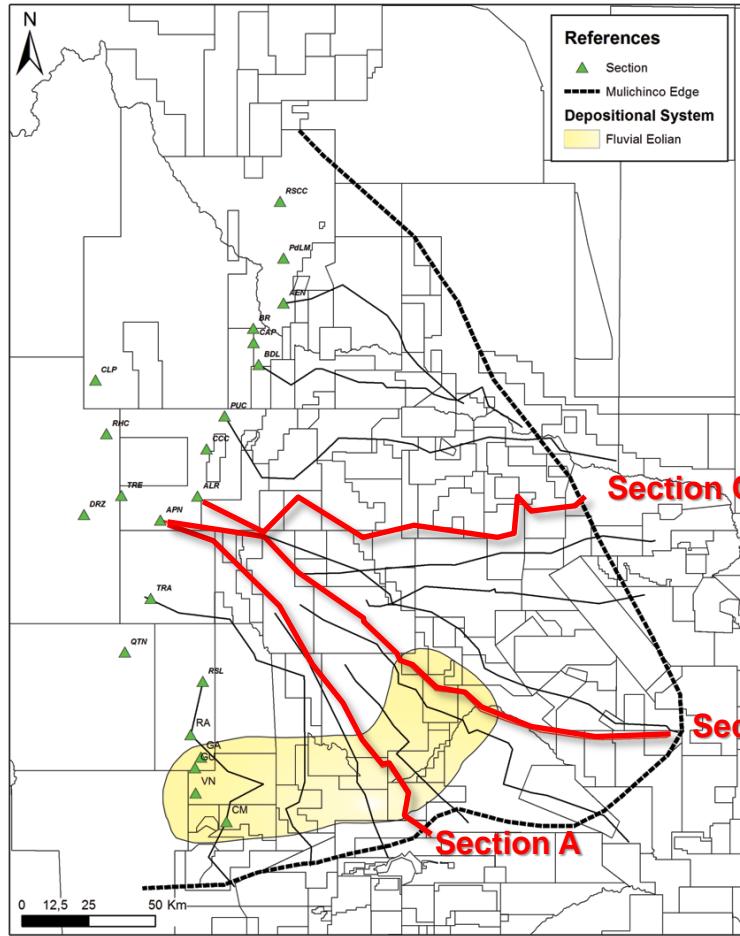
- Seismic Section (and sonic logs) & Horizon Interpretation

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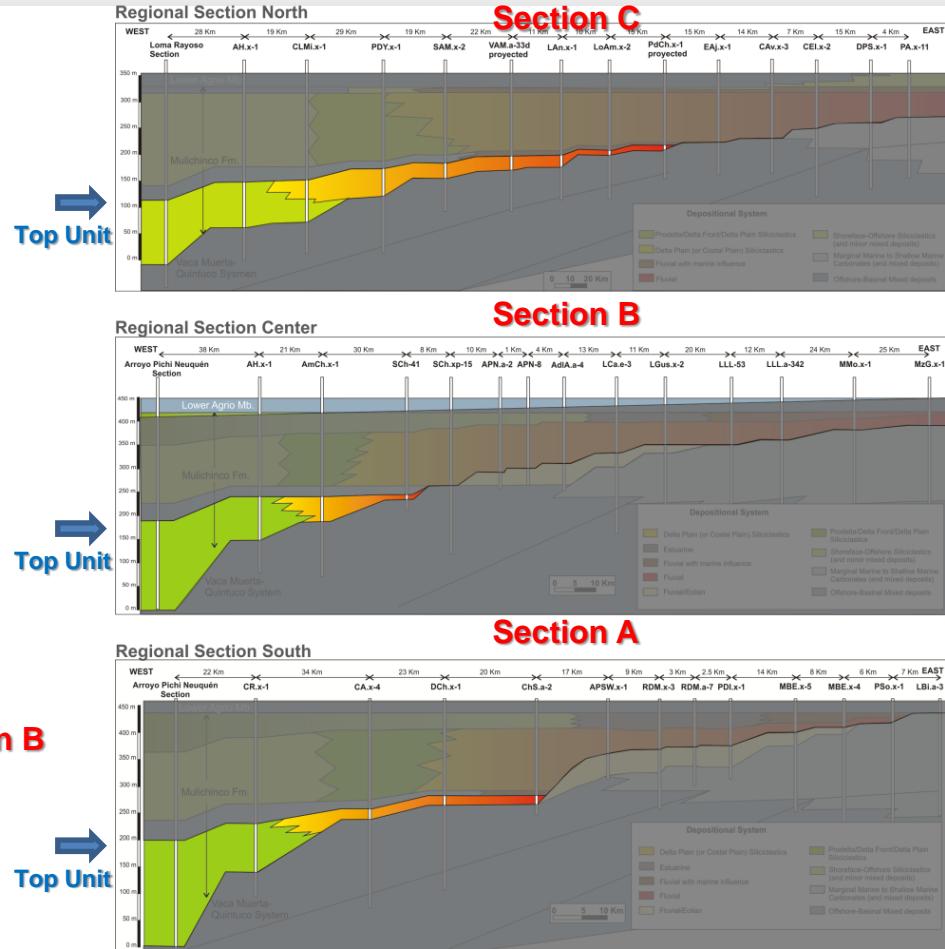
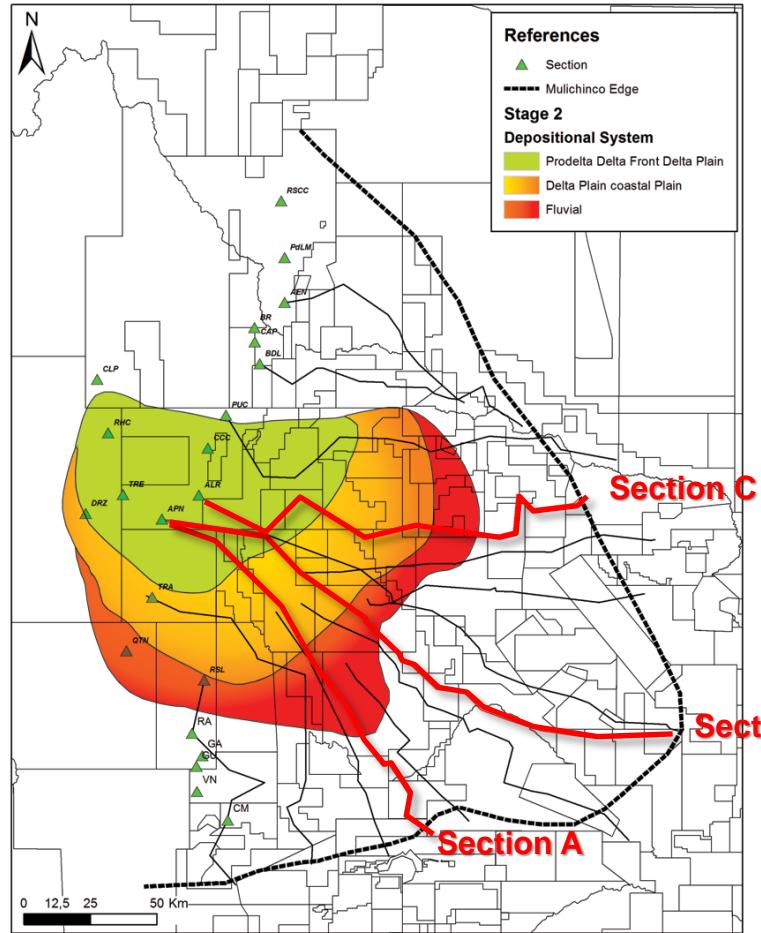
Seismo-Stratigraphic Scheme



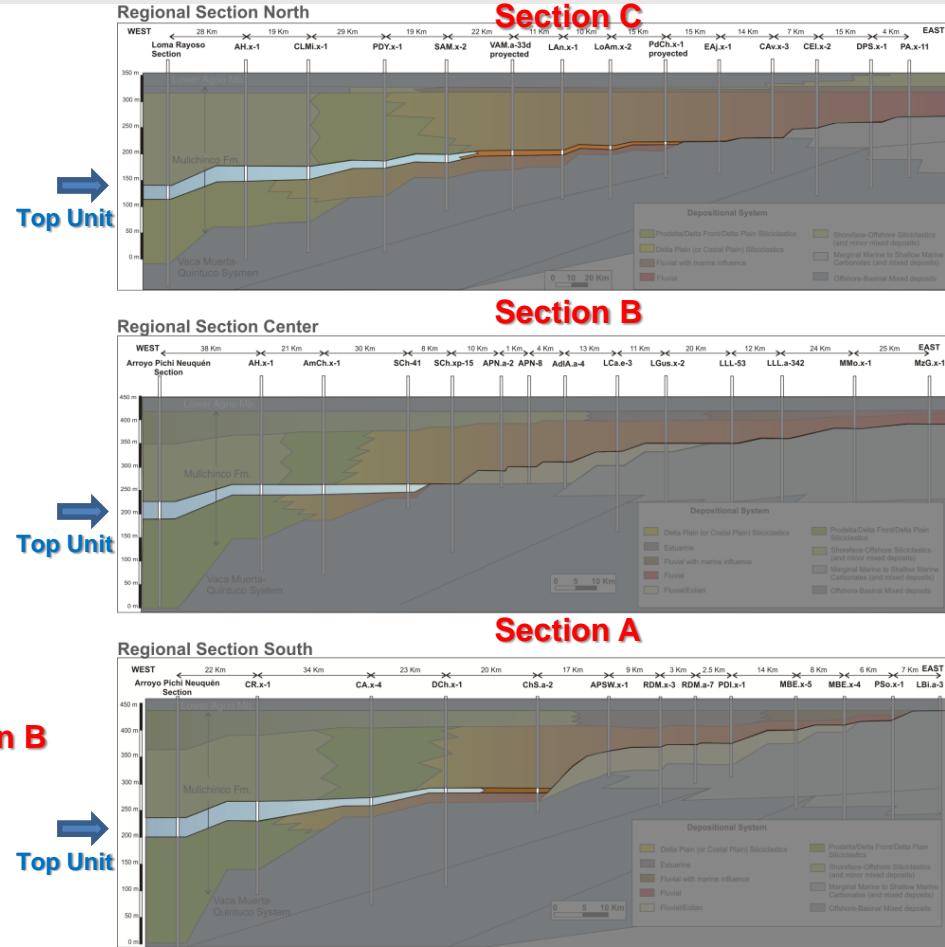
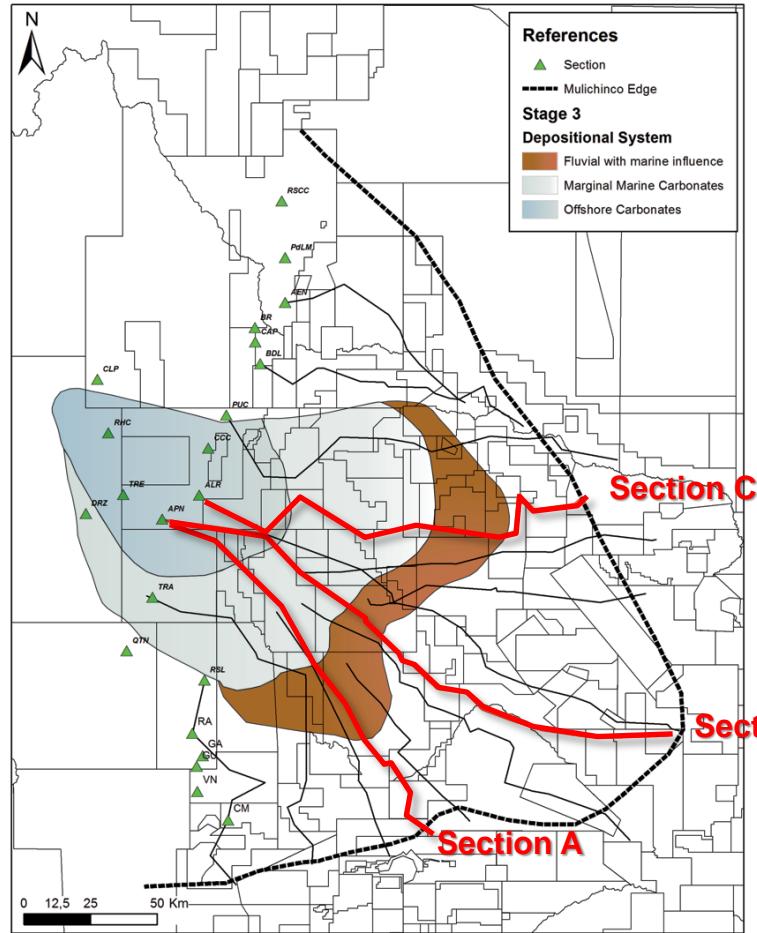
Mulichinco Formation - Regional Map: Stage 1 (SR1 - SR2)



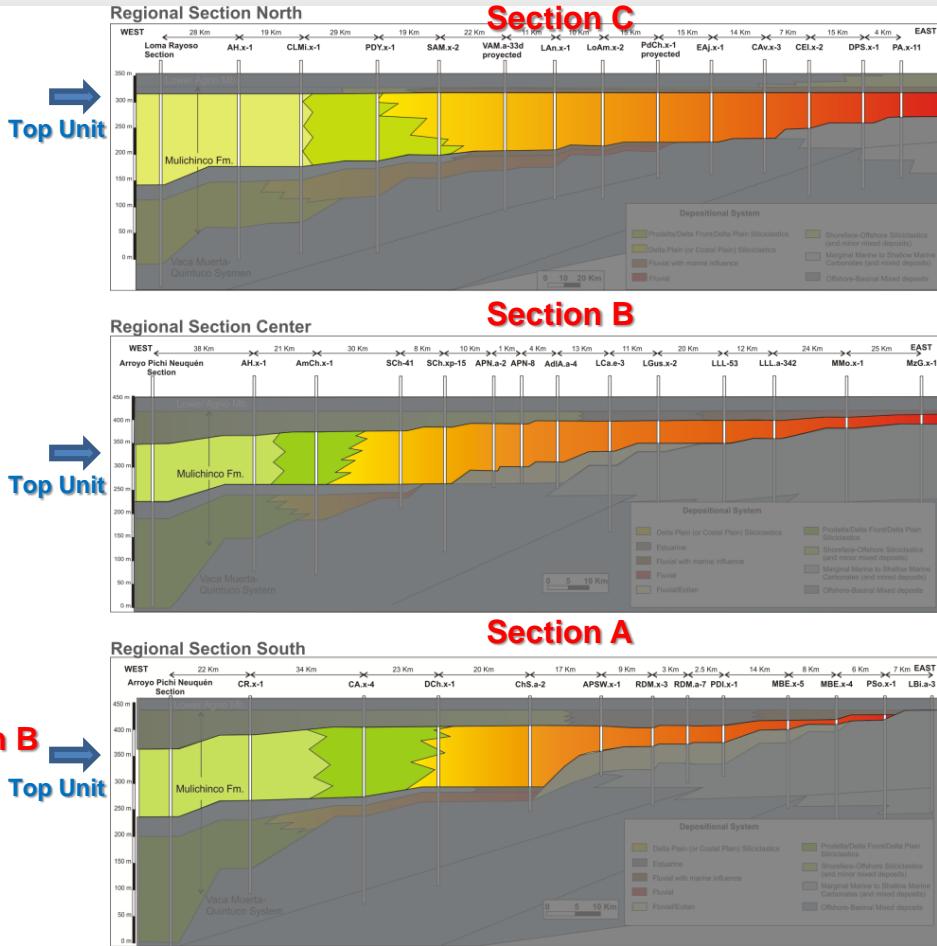
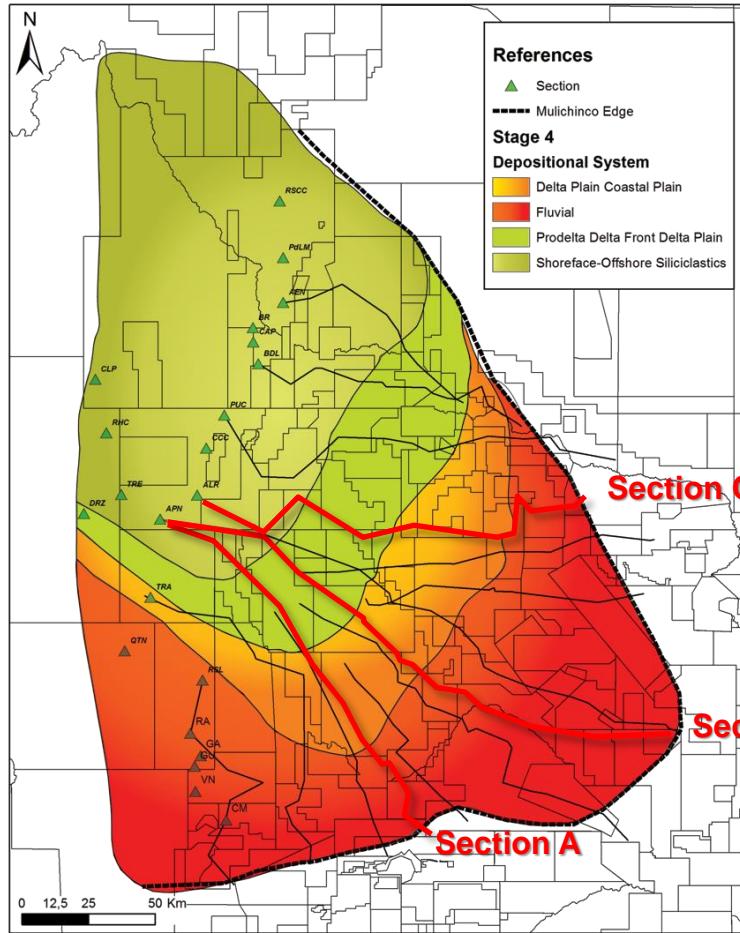
Mulichinco Formation - Regional Map: Stage 2 (SR2 - MRS)



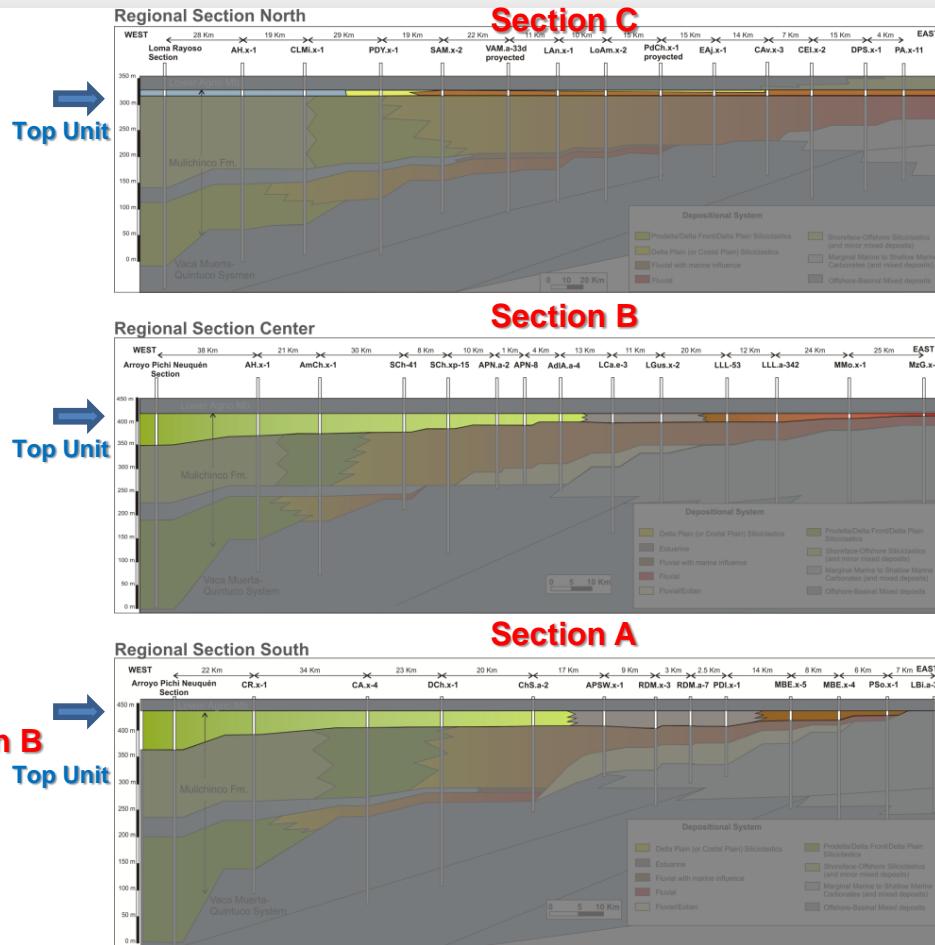
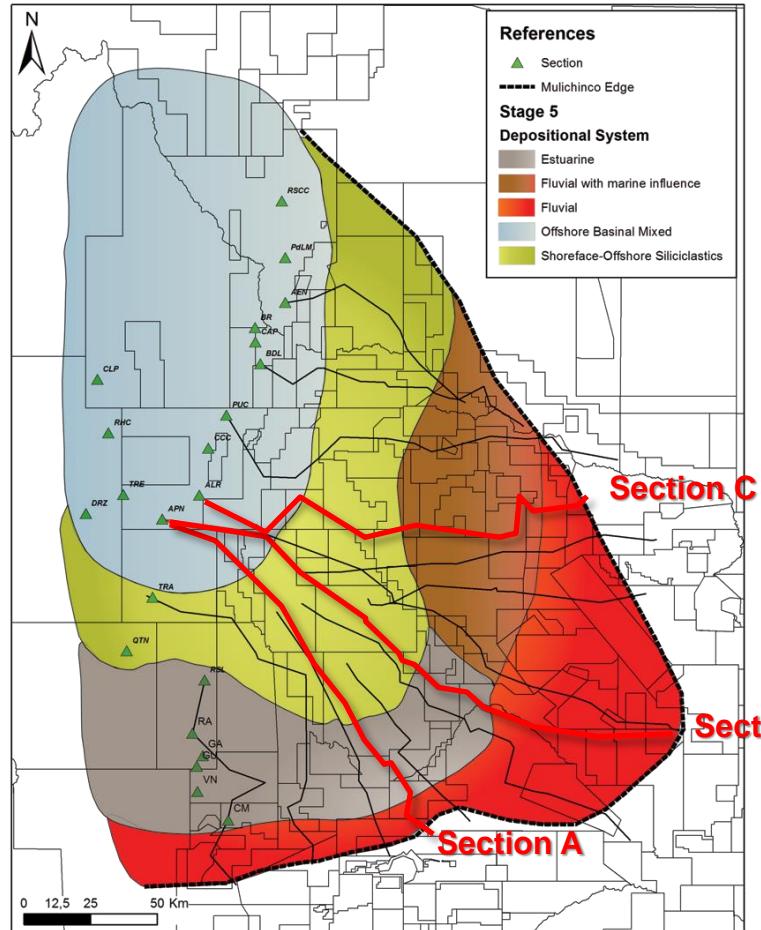
Mulichinco Formation - Regional Map: Stage 3 (MRS - MFS o MTS)



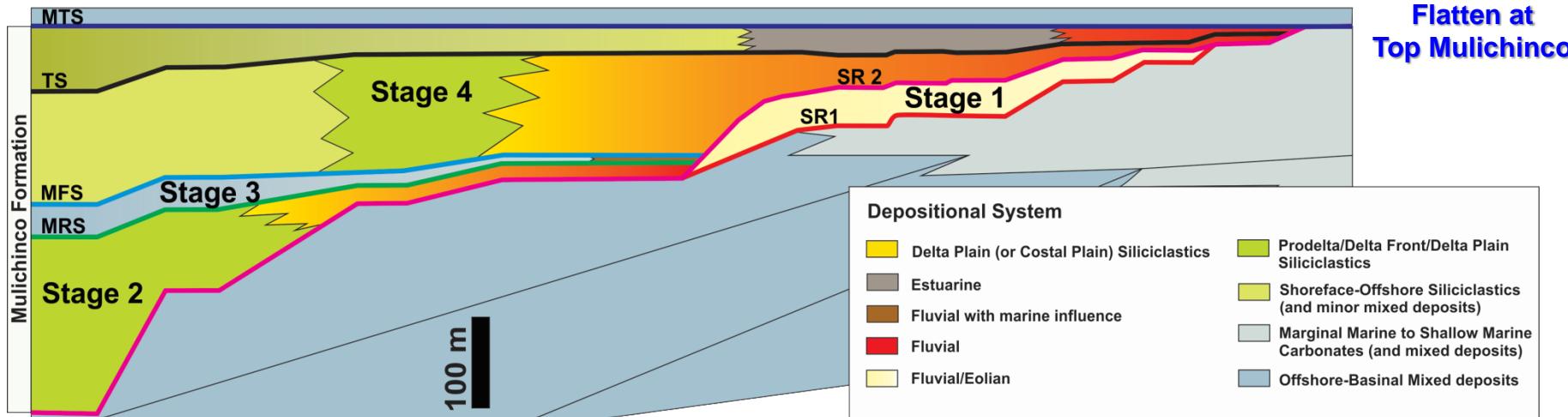
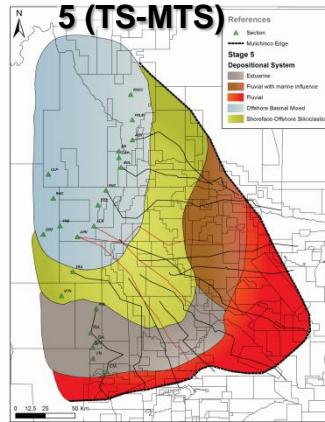
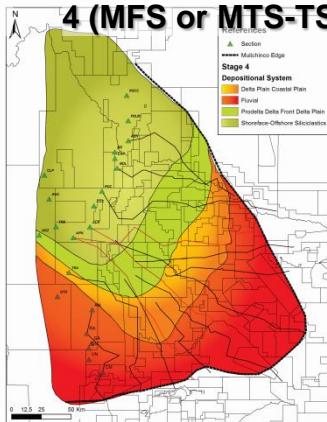
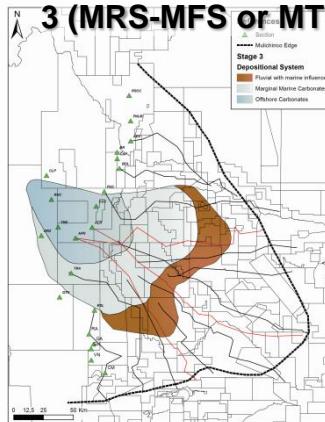
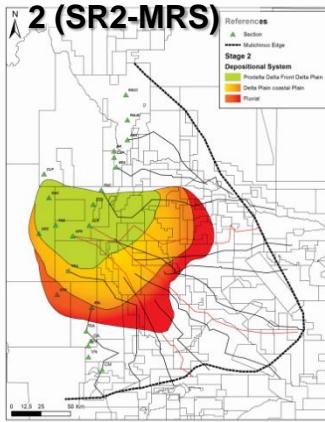
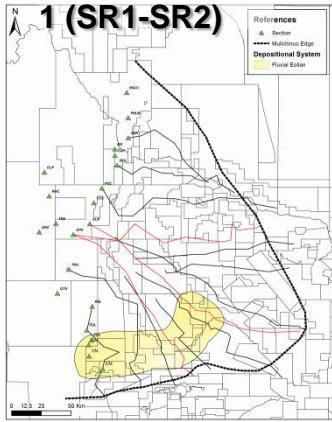
Mulichinco Formation - Regional Map: Stage 4 (MFS or MTS - TS)



Mulichinco Formation - Regional Map: Stage 5 (TS - MTS)



Mulichinco Formation: Stages Evolution



- This work is one of the first attempts at modern regional synthesis of the Mulichinco using all the available outcrop and subsurface information.
- The Mulichinco Formation represents an exceptional example of lowstand wedge. In all sections, the lowstand wedge morphology is clearly identified. It thickens gradually from a few meters in the basin borders up to 400 m in the distal portions, having an average length of 150 km.
- Remarkable is the presence of several depositional systems in such a thin unit, varying both laterally and vertically.
- 5 main units or evolutive stages were recognized and mapped from the integration of available data.
- A better regional understanding of the Mulichinco Formation will tend to be more predictive when exploring its remaining potential, specially for tight sandstone reservoirs in gas zones.

A photograph of an oil or gas drilling site in a desert environment. In the foreground, there's a tall, red and white lattice-boom drilling rig with cables extending from its top. To the left of the rig, several white and blue industrial trailers are parked. The terrain is dry and rocky. In the background, a majestic range of mountains is covered in a thick layer of white snow, contrasting sharply with the blue sky above.

YPF

NUESTRA ENERGÍA

Thank You!