

Shale Gas World Argentina 2013 (27th - 29th August, Buenos Aires)

Neuquén Basin. Argentina

Vaca Muerta Formation (Late Jurassic - Early Cretaceous): Sequences, Facies and Source Rock Characteristics

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(1)



Patagonia
Exploración s.a.

(2)



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Geología y Geofísica

Objectives

Stratigraphic distribution and geochemical characteristics of the main source rock intervals

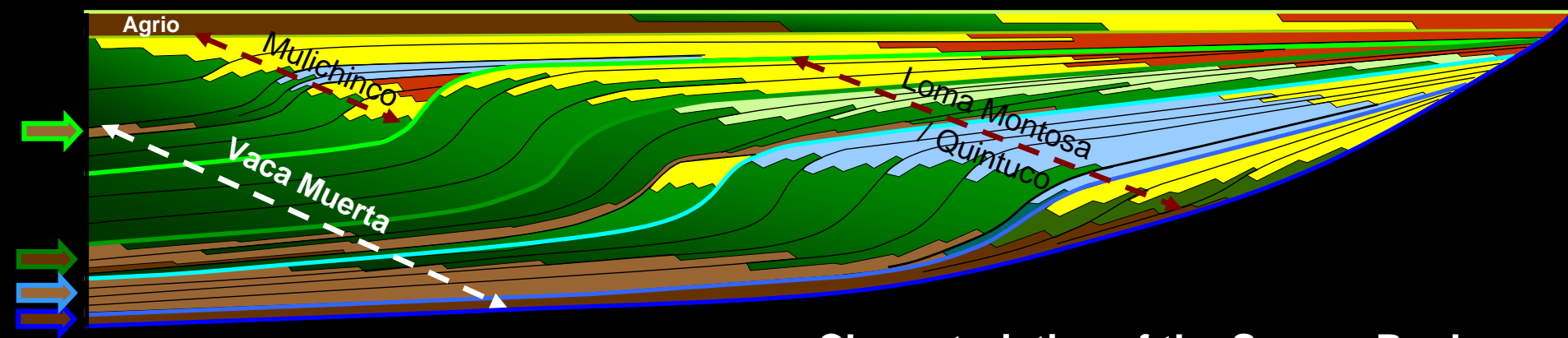
Age, paleogeography, composition of the organic-rich facies

Sequence stratigraphic framework (3rd & 2nd order cycles) of the source rocks

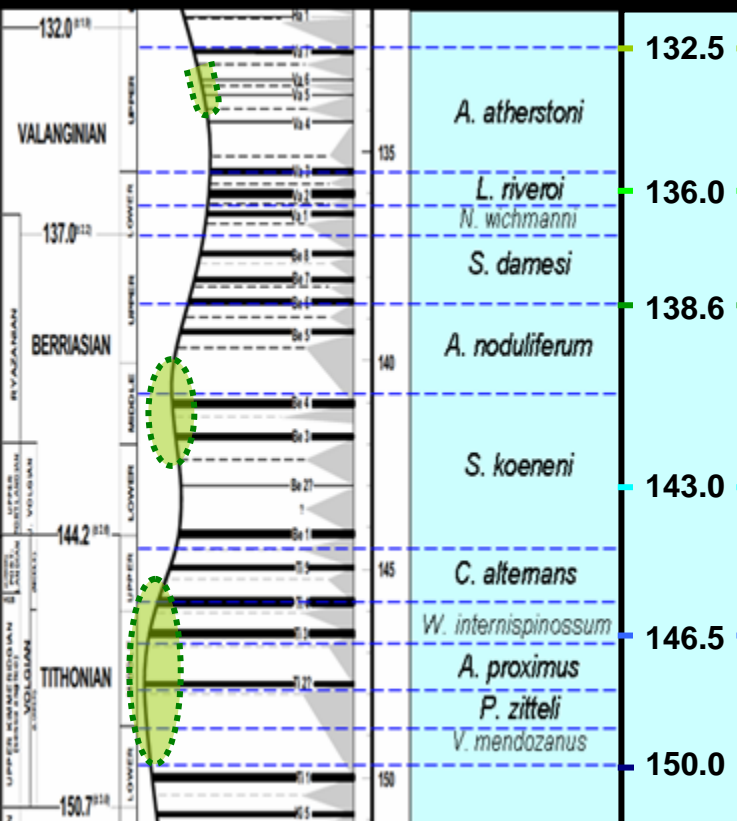
Sequence-sets, sequences, parasequences, facies architecture and rock types

Basin configuration and characteristics of the generative sections

Source Rock Intervals



Characteristics of the Source Rocks



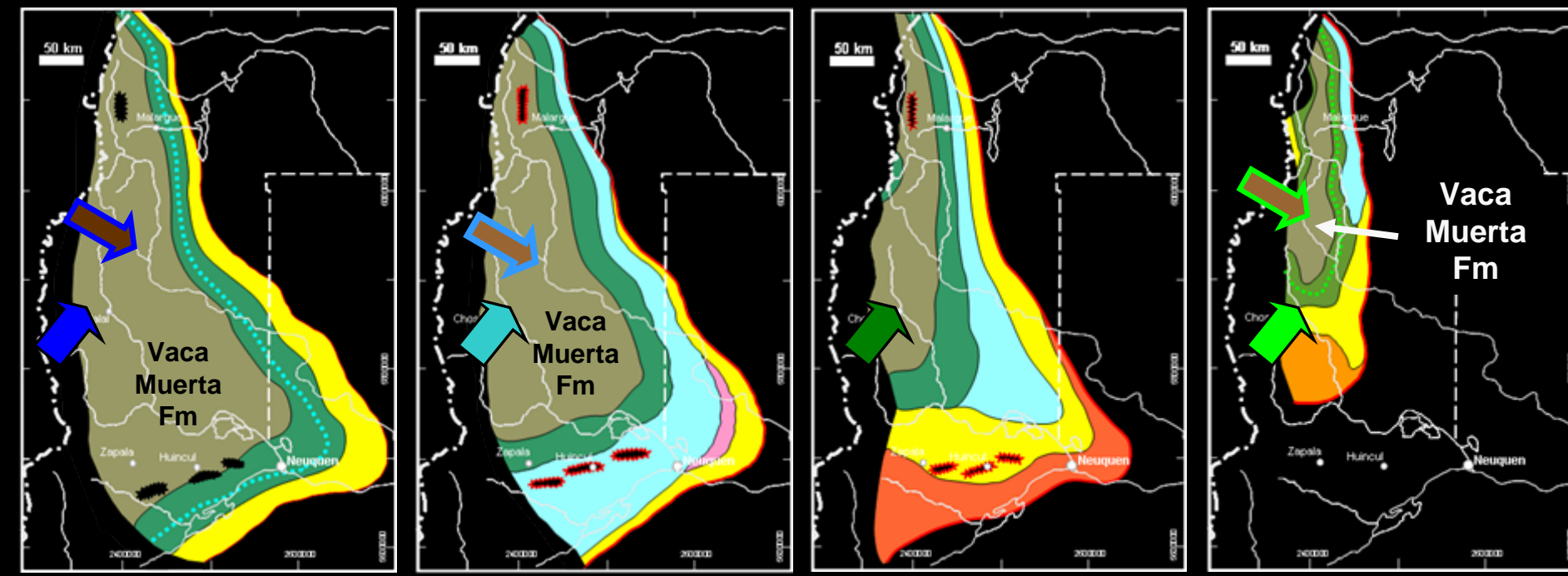
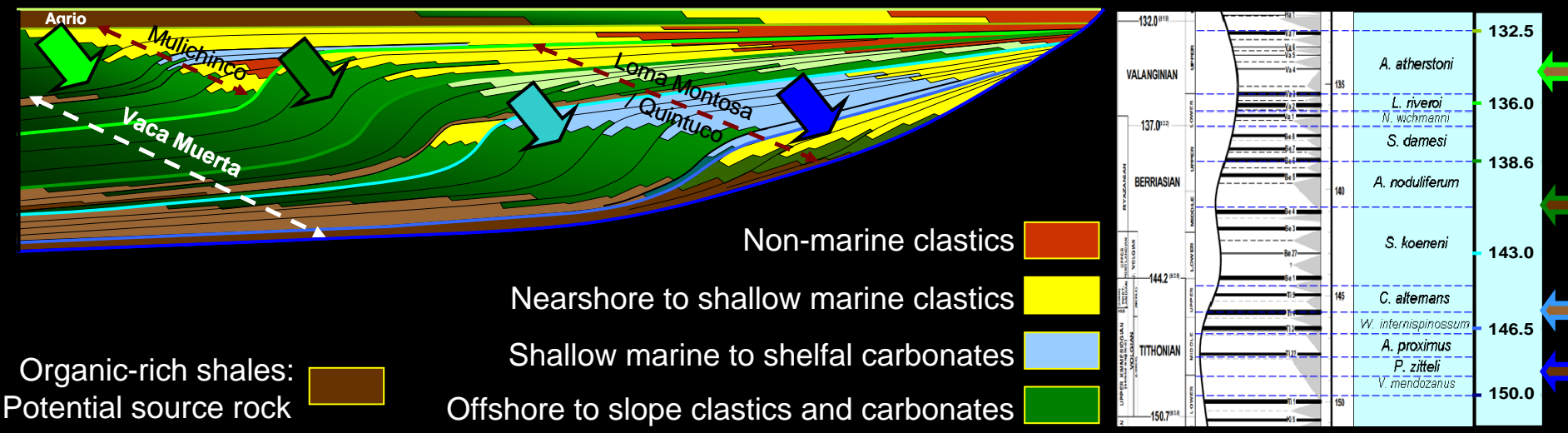
TOC: 1-2.5%. Kerogen Type: II; reduced terrigenous influence. Developed toward NW Neuquén and Malargüe. Up to **50 m**. Less studied

TOC: 6-8%, with isolated peaks up to 10%. **Kerogen Type: (I)/II.** Up to **50 m**. N-NW Neuquén Embayment

TOC: 4-6%, variable % within thin packages. **Kerogen Type: (I)/II.** Up to **300 m**

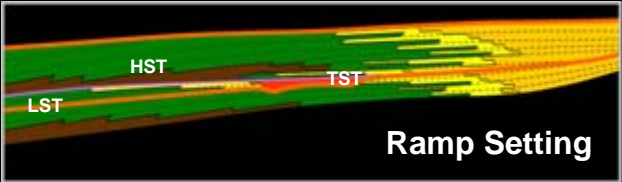
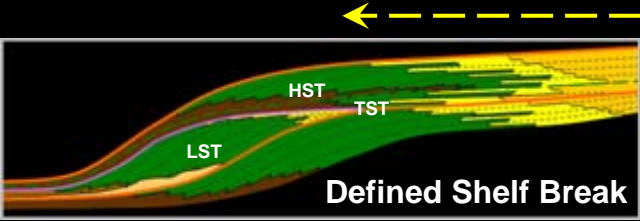
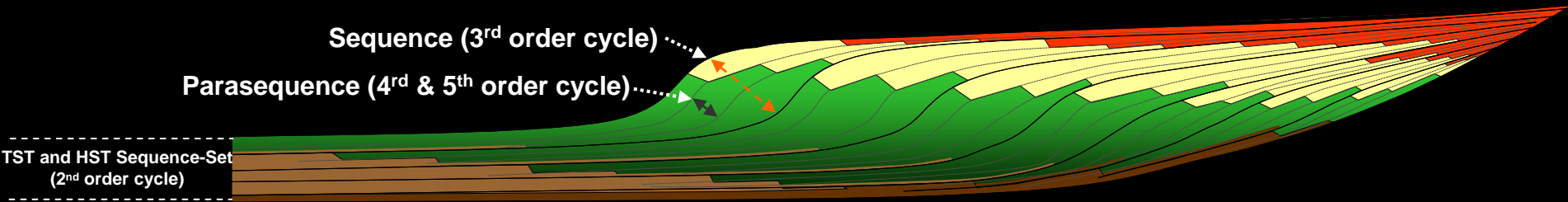
“Hot Shales”. **TOC: 6-8%, 12% max.** **Kerogen Type: (I)/II amorphous;** locally restricted **type II-S** in Picun Leufu depocenter. Up to **80-100 m**

Late Jurassic to Early Cretaceous Paleogeography, Facies and Source Rocks



2nd, 3rd & 4rd-5th Order Cycles: Sequence-Sets, Sequences and Parasequences

Source Rock Development and Main Rock Types (Basin to Slope)



— 3rd Sequence Boundary
LST: Lowstand
TST: Transgressive
HST: Highstand



Laminated siliceous mudstones



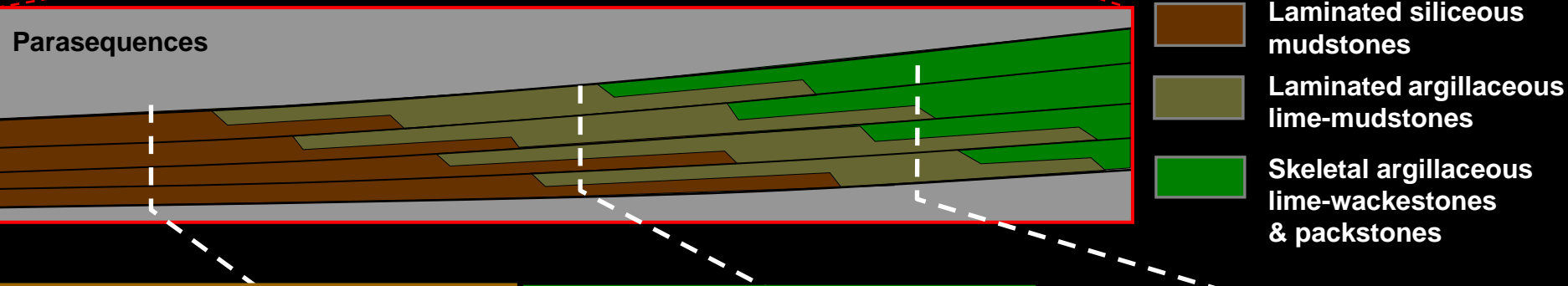
Laminated argillaceous lime-mudstones



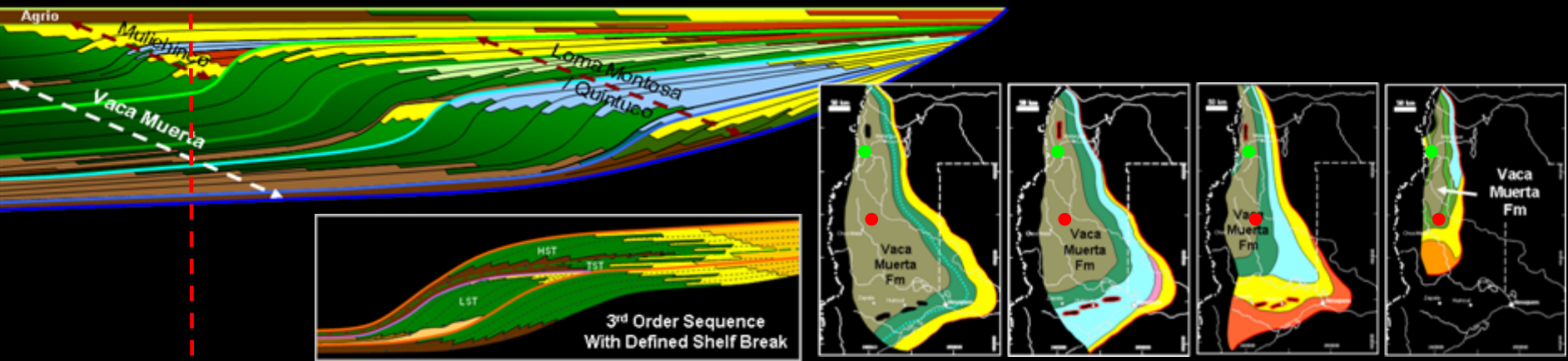
Skeletal argillaceous lime-wackestones & packstones



Parasequences, Facies Associations and Depositional System



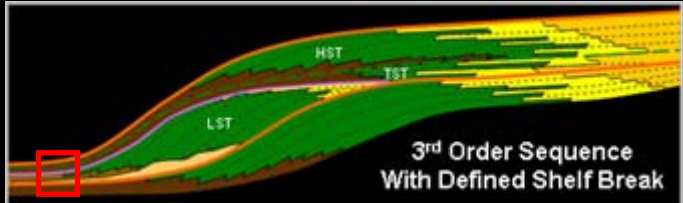
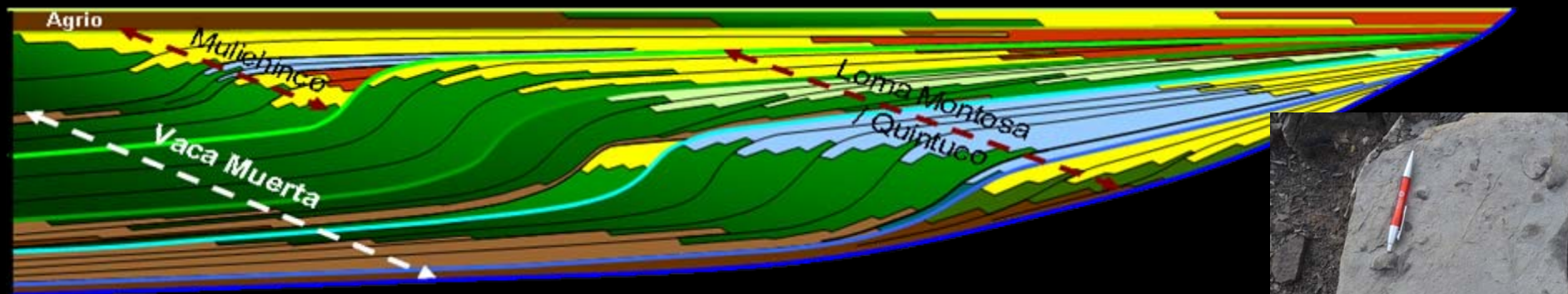
3rd Order Cycles Order Cycles and Source Rock Facies Sequence Stacking and Source Rocks Intervals



NW Neuquén ●

● West Malargüe

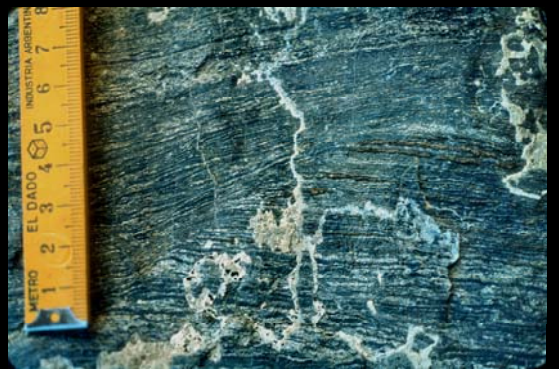
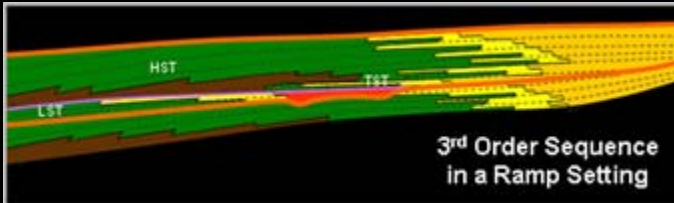
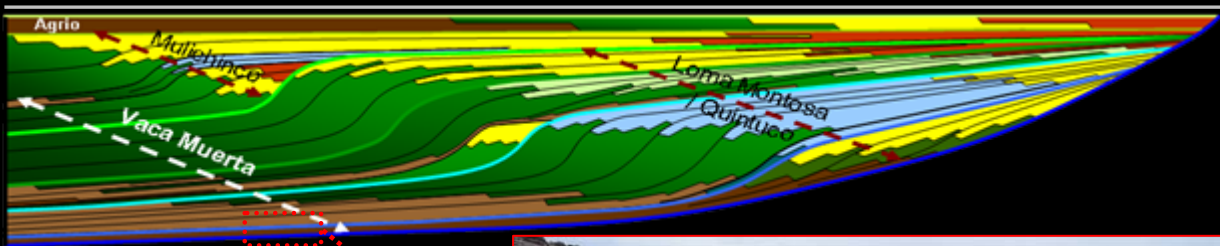
Facies Interbedded with Source Rock Terms



Early Tithonian (Kimmeridgian *sensu anglico*): Northwest Neuquén

Flooding Section at the Base of the Source Rock Interval

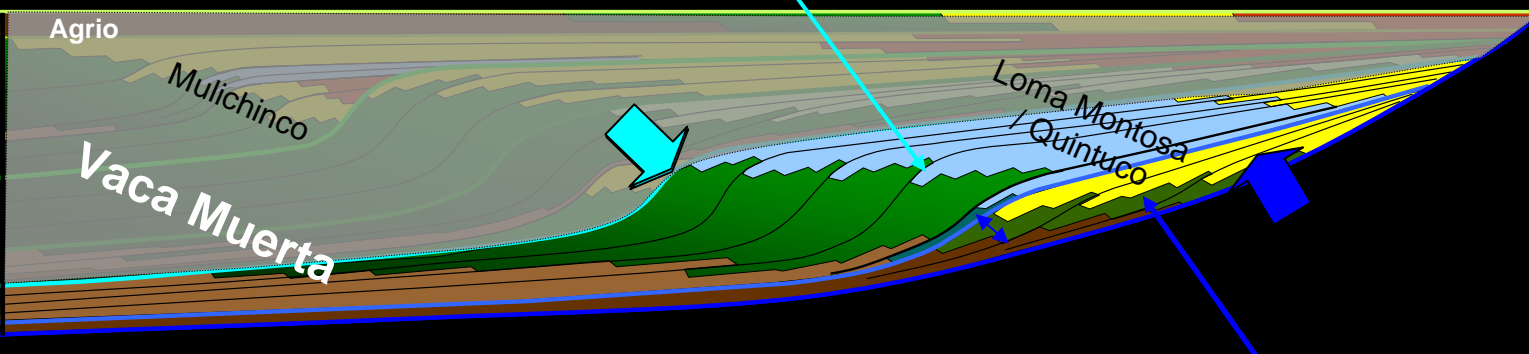
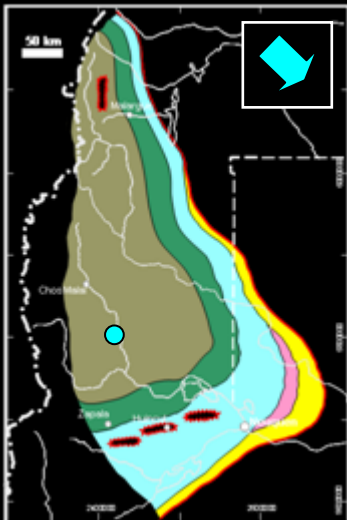
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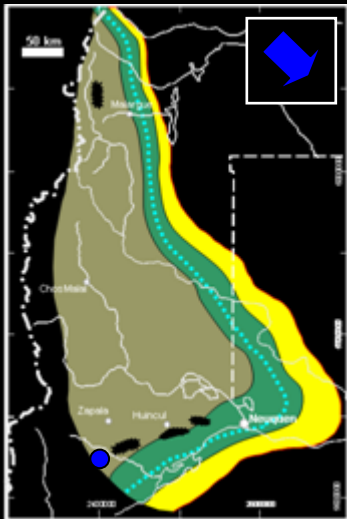
Early-Late Tithonian (Kimmeridgian to E. Portlandian *sensu anglico*) *Sequences, Internal Stratal Pattern and Facies Architecture*

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Mid-Late Tithonian



Early-Mid Tithonian

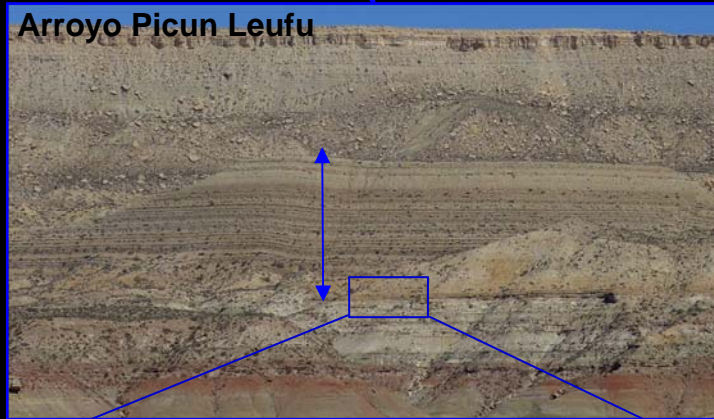
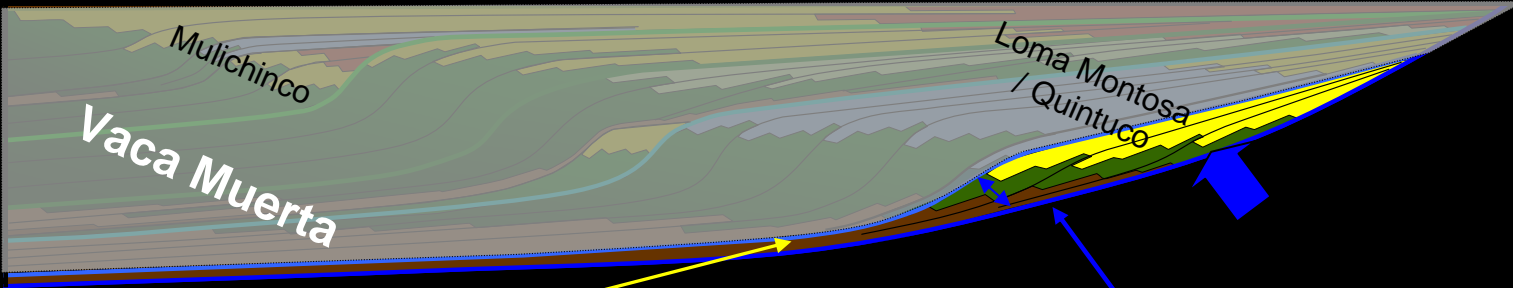
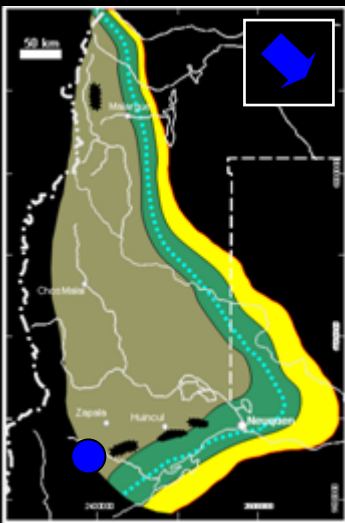


Early-Middle Tithonian: Picún Leufú Area and Sa. de la Vaca Muerta

Facies Associated with the Source Rocks

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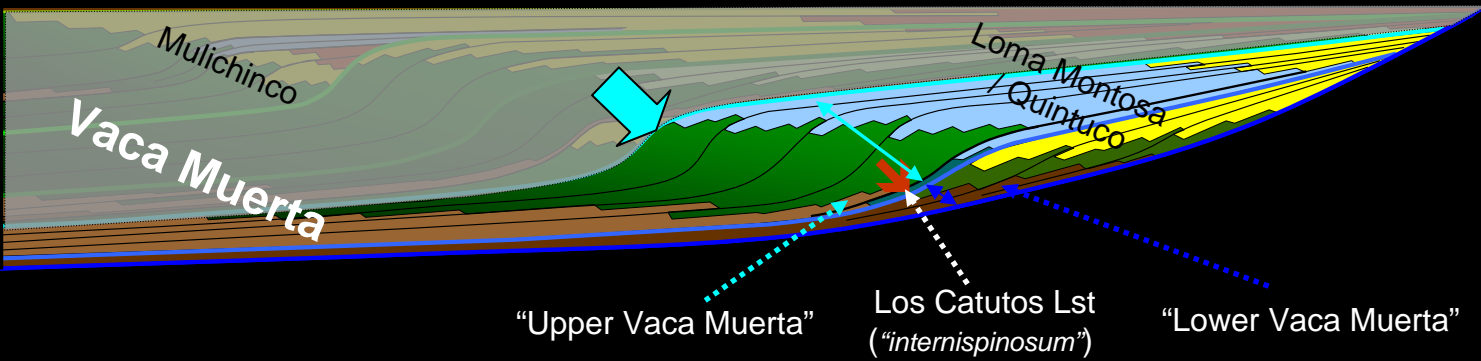
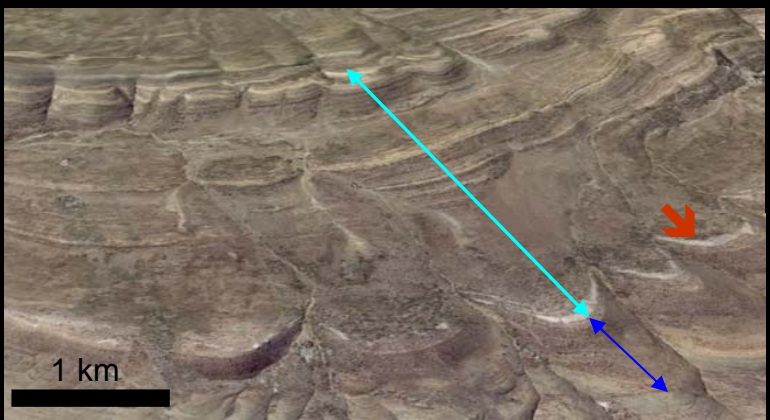
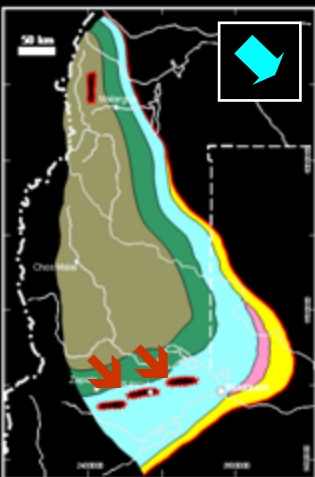
Early-Mid Tithonian



Early to Late Tithonian: Sierra de la vaca Muerta

Sequences and Lithostratigraphic Usage

Mid-Late Tithonian



(Scasso et al., 2005)

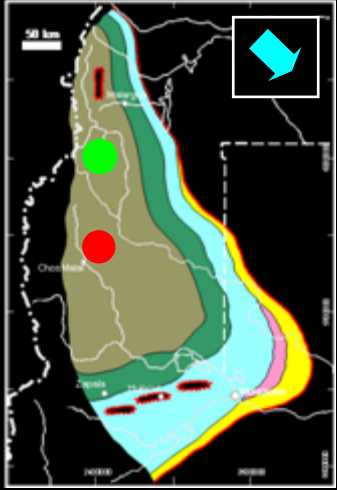
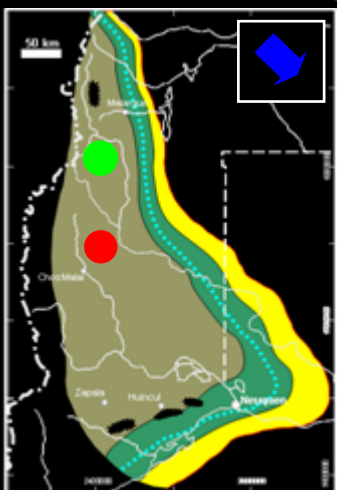
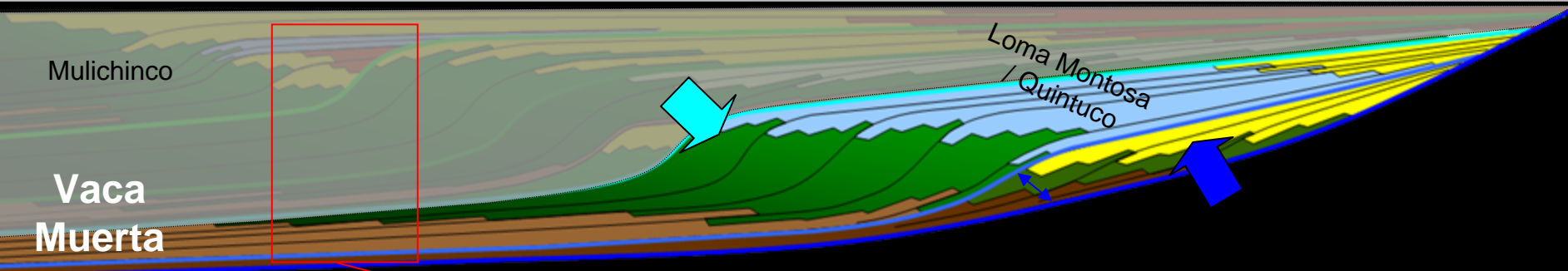
Unit	Age	Stratigraphic position	Approximate thickness (m)	Approximate position
TITHONIAN				
MIDDLE				
UPPER				
LOWER				
VACA MUERTA				
MULICHINCO				
LOMA MONTOSA / QUINTUCO				



Early-Late Tithonian: Northwest Neuquén and South Mendoza

Sequences and Facies Architecture of the Source Rocks

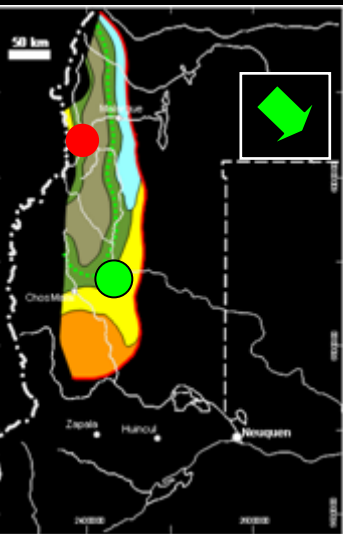
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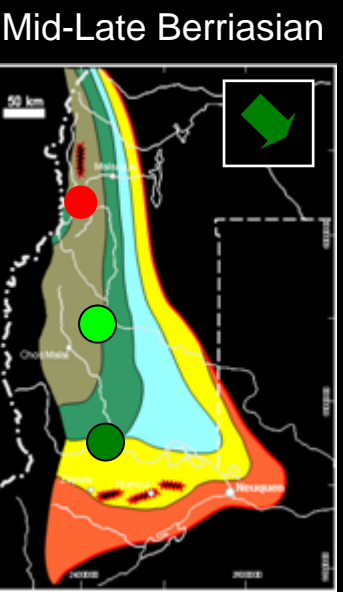
Middle-Late Berriasian (Ryazanian) and Valanginian

Sequences, Internal Stratal Pattern and Facies Architecture

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Valanginian



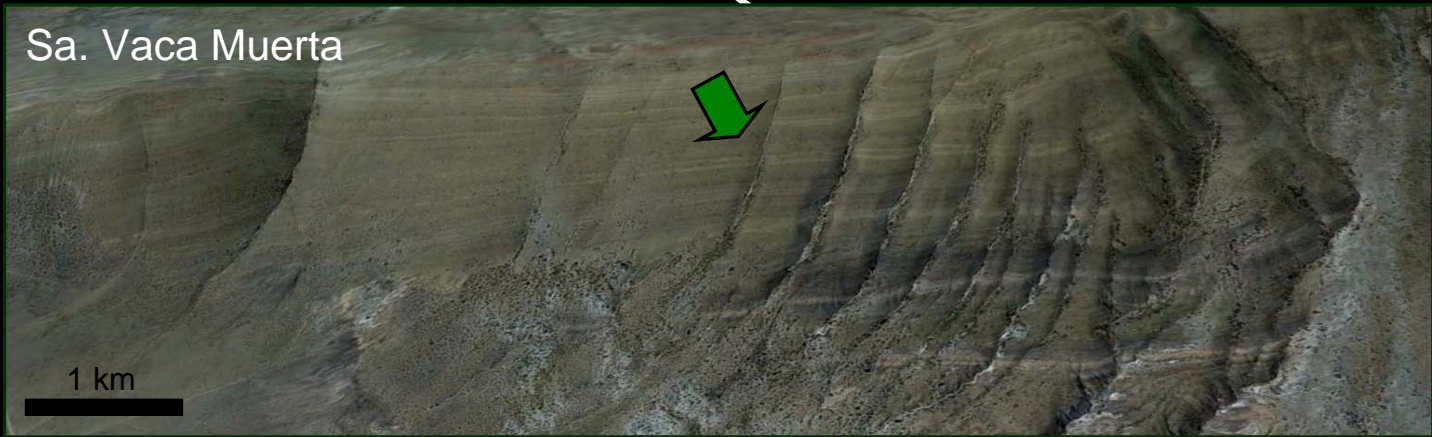
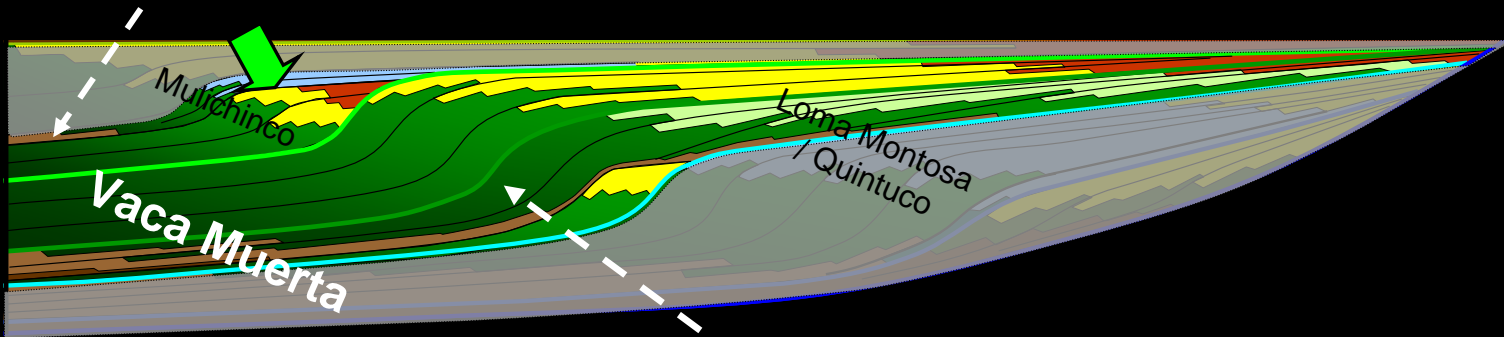
Mid-Late Berriasian



NW Neuquén



South Mendoza



Sa. Vaca Muerta

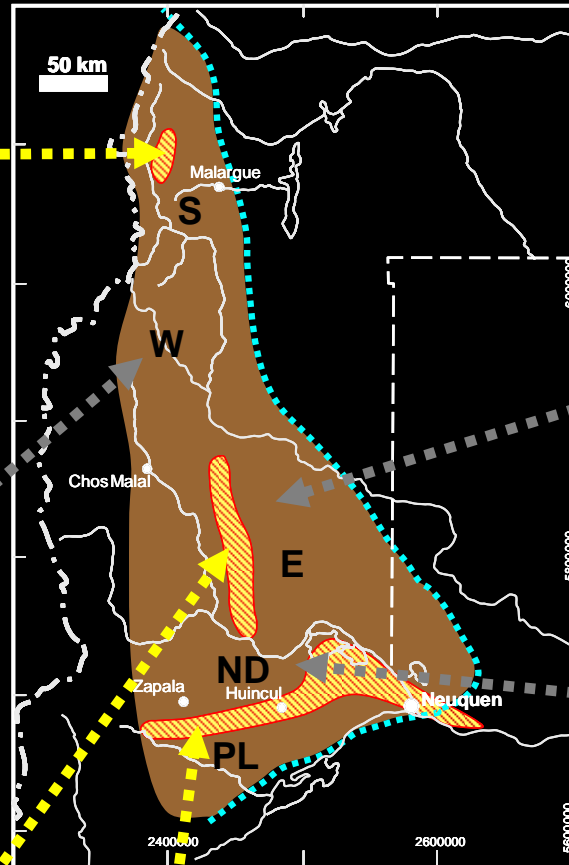
Paleogeographic Features and Source Rock Distribution

Widespread Early Tithonian marine flooding kept the basinal setting starved while clastic supply remained trapped along shoreline

Protected conditions along the depocenter located between Silla-Dedos structure and the eastern platform, coinciding with the Cerro Los Blancos - Serrucho axis (S)

Important development of parasequences dominated by laminated siliceous mudstones. Basal SR interval acted as detachment level of fold belt in Neuquén and Mendoza (W)

Chihuidos Axis acted as a subtle topographic high that generated gentle silled conditions in the Neuquén Embayment (E)



Gentle highs, mostly related to basement-cored blocks, affected sea-bottom conditions and the amount and preservation of the organic matter (●)

Presence of 3 main SR intervals and other thin levels associated with 3rd order maximum flooding surfaces

Well defined Lower and Upper Vaca Muerta with presence of Los Catutos Limestone (ND)

Huincul Dorsal was a protracted topographic high that created a local silled environment within the Picun Leufu depocenter (PL). Restriction was enhanced by northeasterly progradation. Euxinic conditions prevailed during the Early-Middle Tithonian

Highlights

Vaca Muerta Fm is a time-transgressive lithostratigraphic unit that contains several source rock intervals

The two richest intervals developed during 2nd order transgressive sequence-sets. A thick section accumulated during a highstand sequence-set but with relatively lower TOC content

A less known interval is associated with a Valanginian transgressive sequence-set (NW Neuquén and W Malargüe)

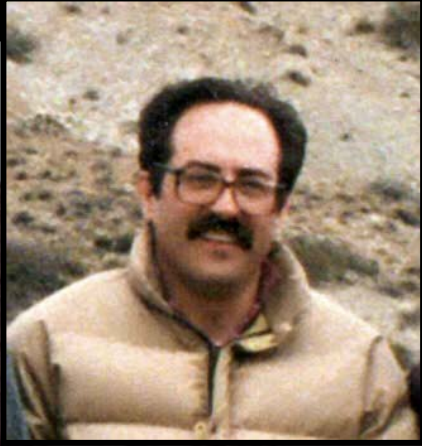
Thinner intervals can be present within slope “marls” facies associated with 3rd order maximum flooding

Accumulation during different systems tracts provided variable amount of key components of the unconventional reservoir

Basin configuration had influence on the characteristics and distribution of the source rock intervals

Acknowledgments

To Miguel A. Uliana, Robert M. Mitchum and Peter R. Vail



To Pablo N. Legarreta author of most outcrop pictures