Neuquén Basin. Argentina

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

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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
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

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Organic-rich shales: Potential source rock

Non-marine clastics

Nearshore to shallow marine clastics

Shallow marine to shelfal carbonates

Offshore to slope clastics and carbonates

Vaca Muerta Fm
2\textsuperscript{nd}, 3\textsuperscript{rd} & 4\textsuperscript{rd}-5\textsuperscript{th} Order Cycles: Sequence-Sets, Sequences and Parasequences

\textit{Source Rock Development and Main Rock Types (Basin to Slope)}

- Sequence (3\textsuperscript{rd} order cycle)
- Parasequence (4\textsuperscript{rd} & 5\textsuperscript{th} order cycle)

- LST: Lowstand
- TST: Transgressive
- HST: Highstand

- Defined Shelf Break
- 3\textsuperscript{rd} Sequence Boundary
- Ramp Setting

- Laminated siliceous mudstones
- Laminated argillaceous lime-mudstones
- Skeletal argillaceous lime-wackestones & packstones

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4th and 5th Order Cycles and Source Rock Facies

Parasequences, Facies Associations and Depositional System

Laminated siliceous mudstones
Laminated argillaceous lime-mudstones
Skeletal argillaceous lime-wackestones & packstones

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3rd Order Cycles and Source Rock Facies

Sequence Stacking and Source Rocks Intervals

NW Neuquén
West Malargüe

Auquilco  Tordillo  Vaca Muerta  Quintuco  Mulichinco

3rd Order Sequence With Defined Shelf Break

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Sequences Boundaries and Lowstands

Facies Interbedded with Source Rock Terms

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

*Flooding Section at the Base of the Source Rock Interval*

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Aquit
Makoshika
Vaca Muerta
Lomita Antinosa
Quintero

3rd Order Sequence in a Ramp Setting

1 m
Early-Late Tithonian (Kimmeridgian to E. Portlandian *sensu anglico*)

Sequences, Internal Stratal Pattern and Facies Architecture

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

Facies Associated with the Source Rocks

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Early to Late Tithonian: Sierra de la vaca Muerta

Sequences and Lithostratigraphic Usage

Mid-Late Tithonian

1 km

(Vaca Muerta

Mulichinco

Loma Montosa

Quintuco

“Upper Vaca Muerta”

“Lower Vaca Muerta”

Los Catutos Lst

(“internispinosum”)

(Scasso et al., 2005)

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Shale Gas World Argentina 2013
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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The Vaca Muerta Fm

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).

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.

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).
Vaca Muerta Source Rock Intervals (Late Jurassic-Early Cretaceous)

**Highlights**

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

The two richest intervals developed during 2\textsuperscript{nd} 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 3\textsuperscript{rd} 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

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