Source Rocks and Paleogeography, Austral Basin, Argentina*

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Abstract

The Austral Basin, located in the extreme south of South America, produces oil and gas both onshore and offshore. The fill of the basin includes rocks ranging in age from Jurassic to Quaternary. The objective of this work is the characterization of the source rocks in relation to the paleoenvironmental and paleogeographic changes of the Austral Basin, based on geological and geochemical information.

Several successions have source potential, however with different quality. Basin development began with a rift phase represented by the rocks of the “Serie Tobífera” (Jurassic), including shales with some source potential. After that, a regionally extended thick succession, mainly of marine fine sediments, was deposited in a sagging stage. Two main source sections are present, informally known as “Lower Inoceramus” (Tithonian-Aptian) and “Margas Verdes” (Aptian-Albian). Deposition occurred in an offshore ramp, probably under dysaerobic to anaerobic conditions. Organic-rich sediments in the “Lower Inoceramus” seem to be related to the presence of physical barriers that restricted the basin and produced stages of water stratification. During that period a general transgression occurred, associated with warm and humid climatic conditions. The restricted sea developed during the tectonic instability related to the opening of the South Atlantic Ocean.

The “Lower Inoceramus”, the main source rock, is composed of black shales with TOC ranging from 0.6 to 2% and kerogen type II to III. The Springhill Formation was deposited partially contemporaneously with the “Lower Inoceramus” in marginal paleoenvironments ranging from continental to shallow marine. In the Springhill Formation, continental and marine black shales are interbedded with the main reservoir sandstones and have some source potential. Additional possible source levels in the basin are of lower potential.

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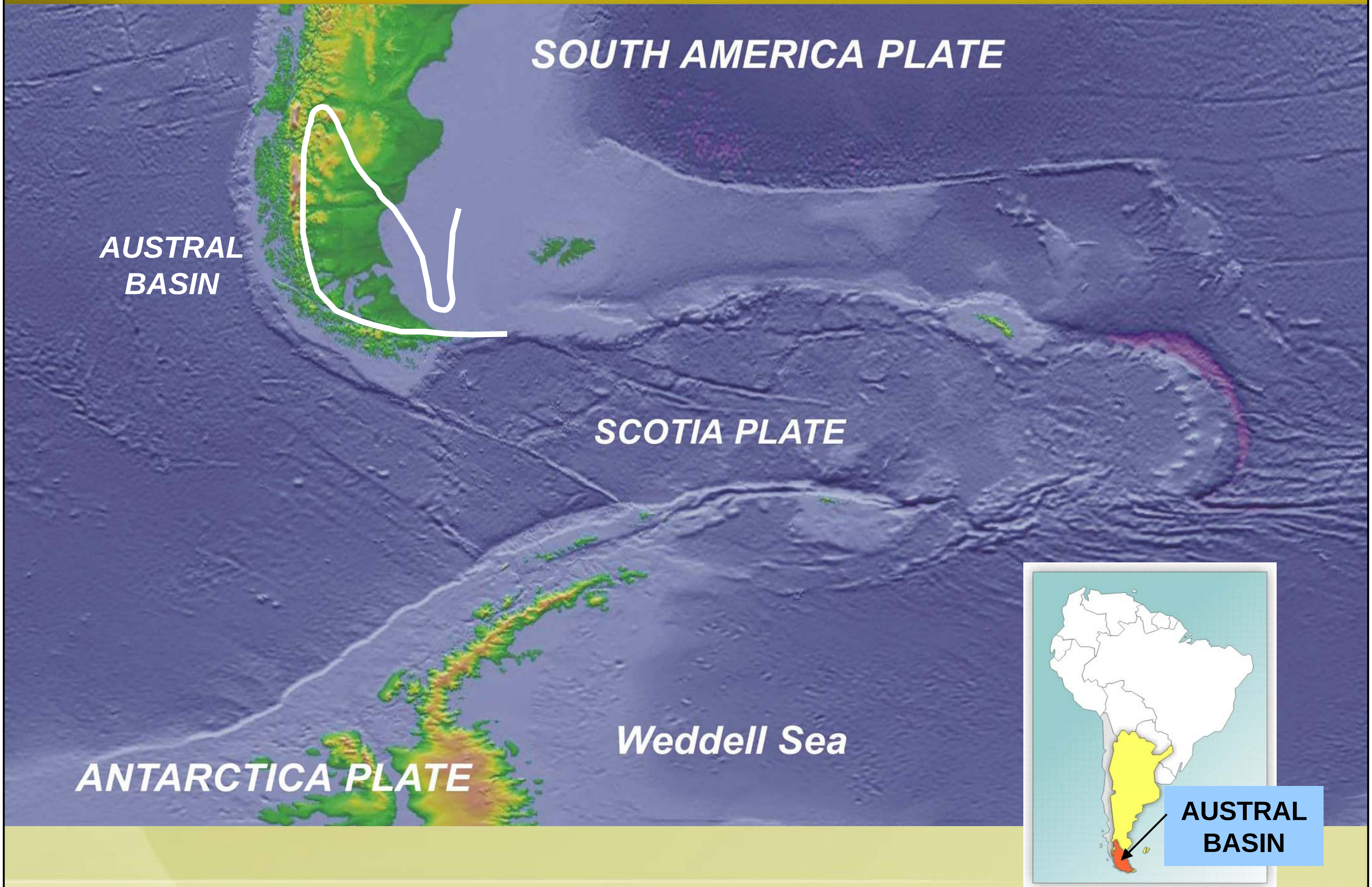
OUTLINE

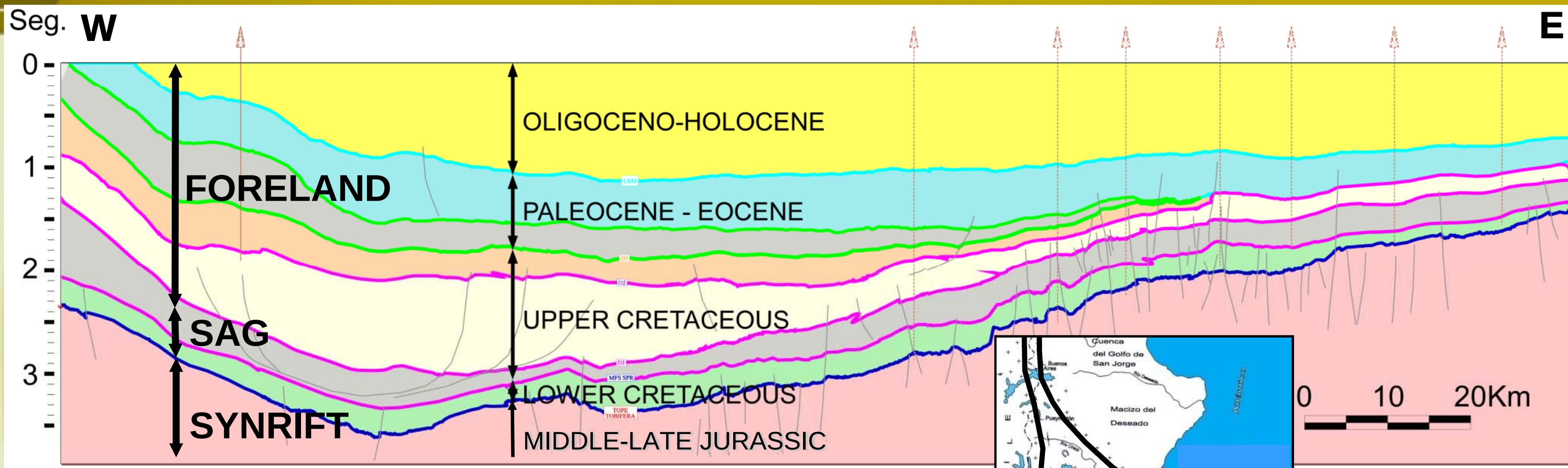
PETROBRAS

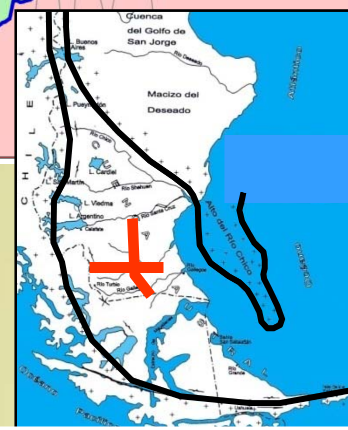
- Basin characteristics
- Paleogeography and Source Rocks
- Conclusions

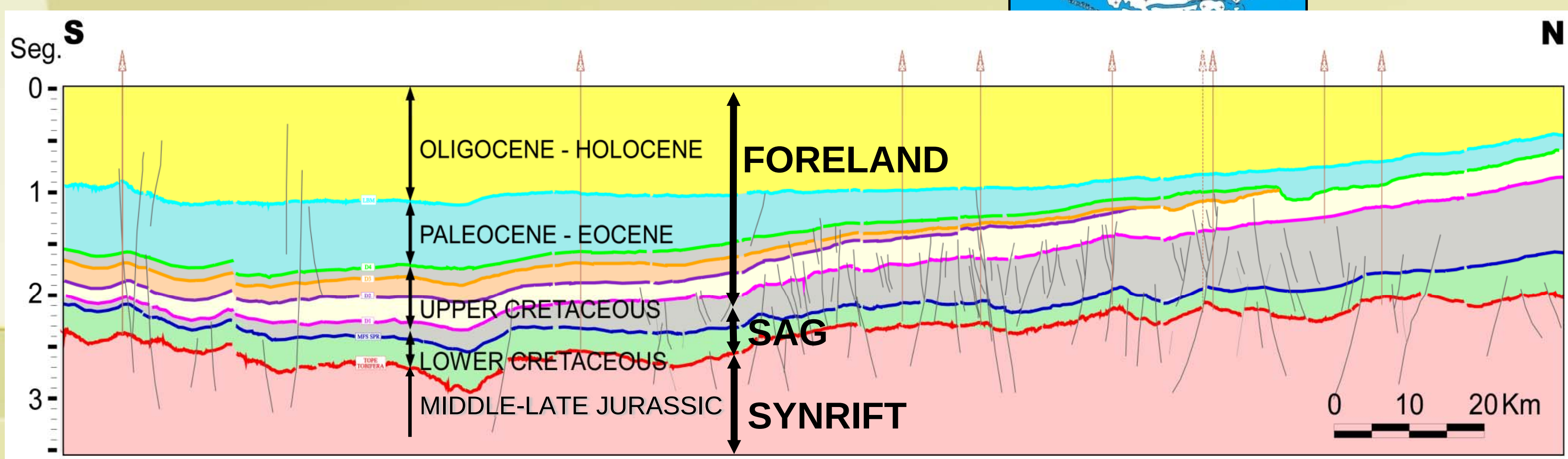
TECTONIC LOCATION



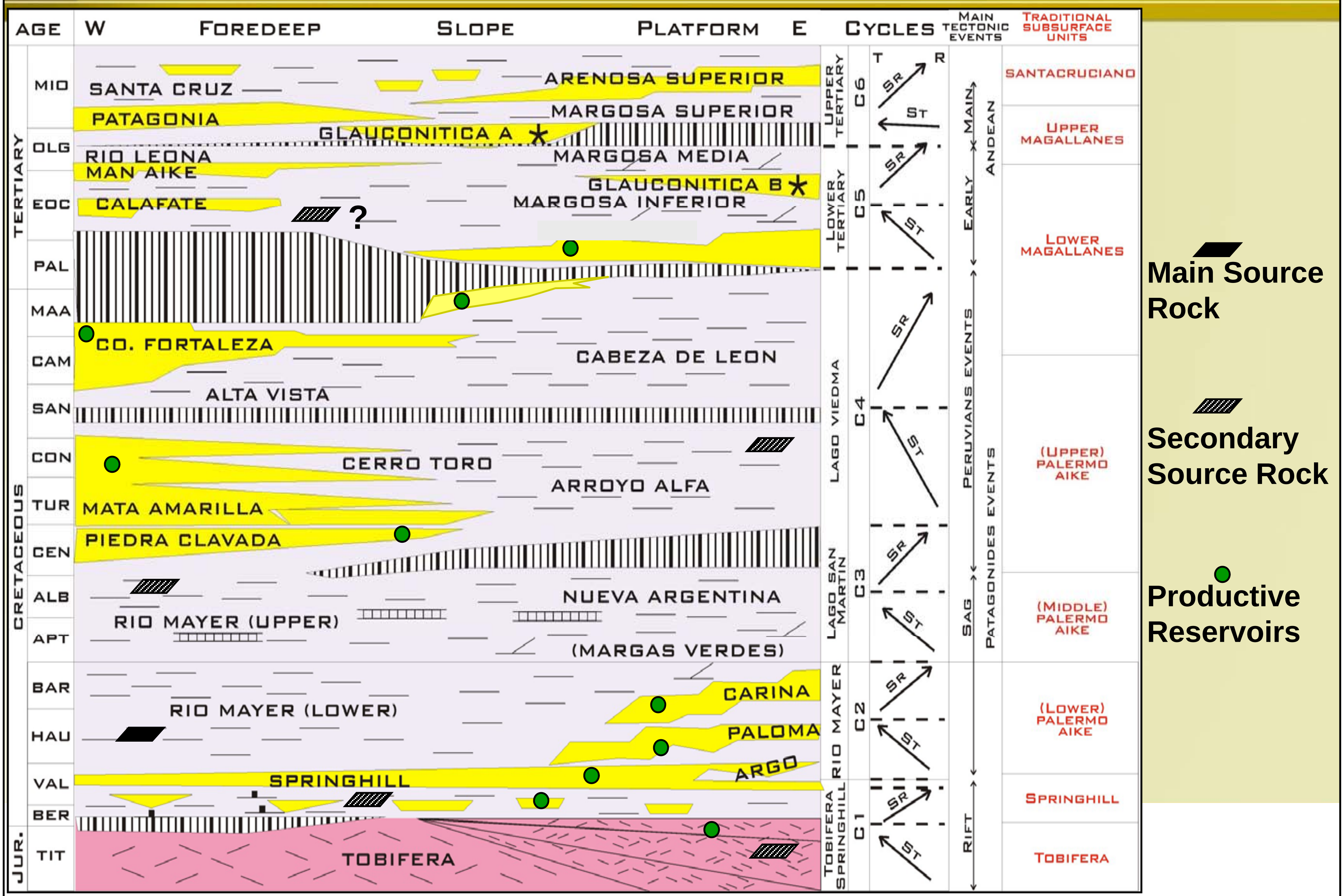
TECTO-SEDIMENTARY EVOLUTION



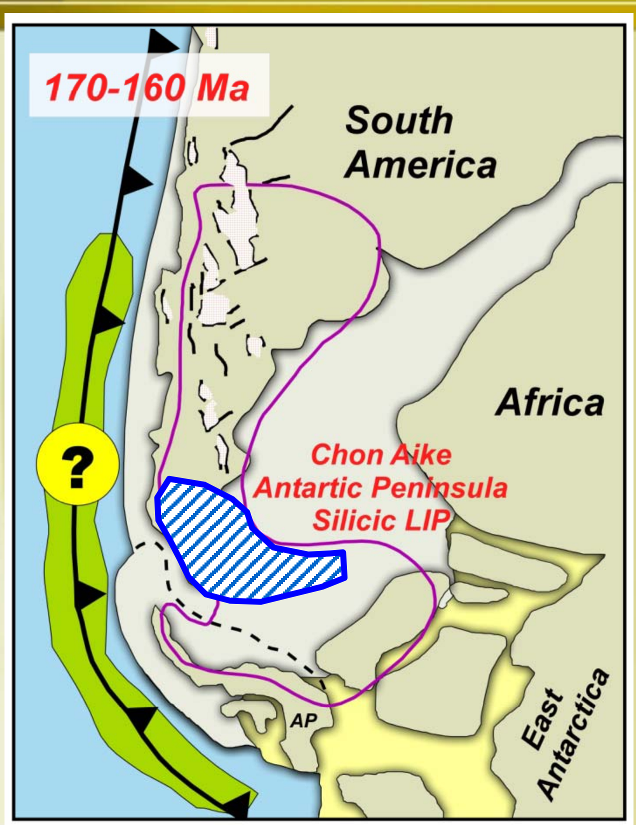


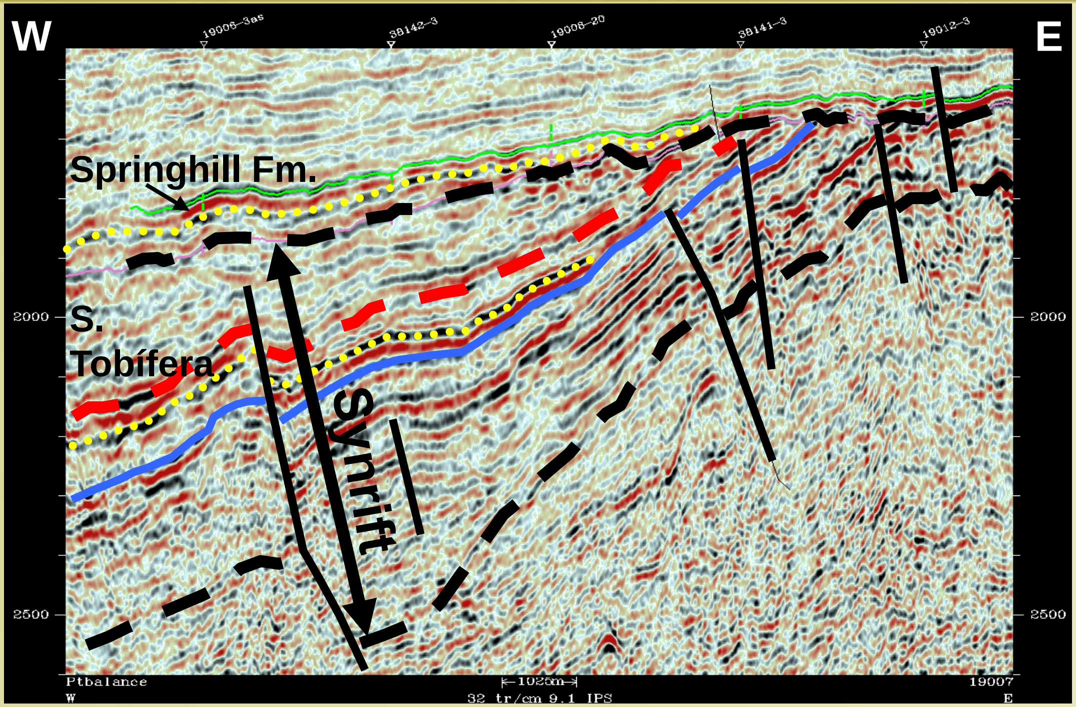


CHRONOSTRATIGRAPHY



SYNRIFT (SERIE TOBÍFERA)



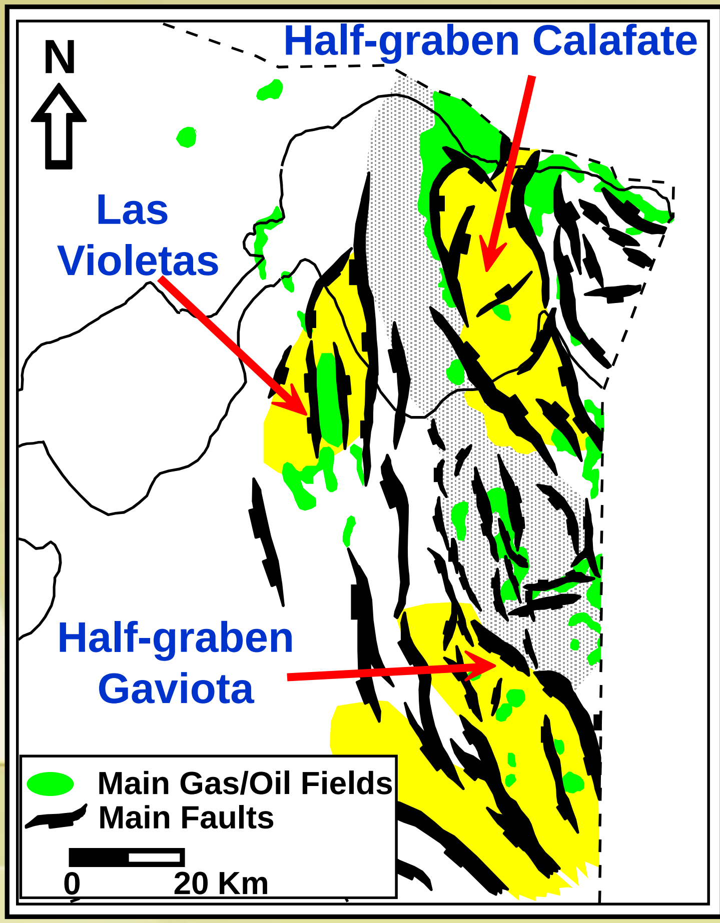


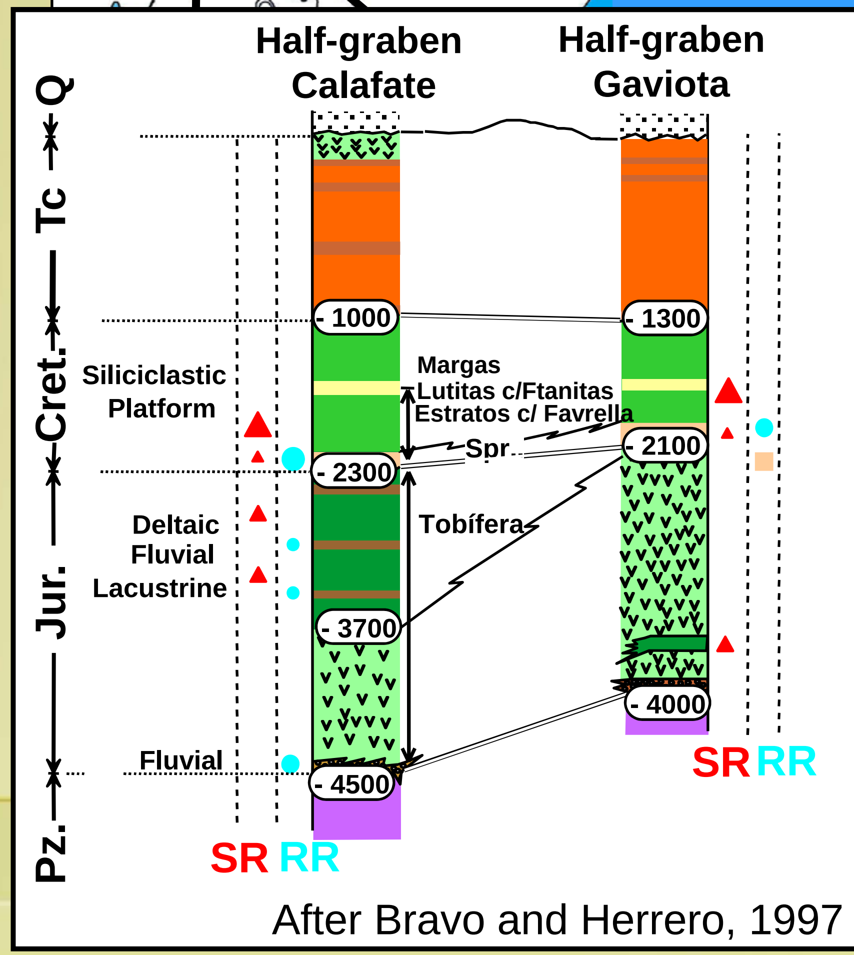
Modified after Hathway, 2000

- Part of the Chon Aike silicic large igneous province. Before and during early break-up of Gondwana (Early Jur. and earliest Cret. ca. 188–140 Ma, Pankhurst et al., 98)
- Tobífera is the phase (170 - 160 Ma) of migration to the W and SW (Féraud et al., 1999; Pankhurst et al., 2000)
- Half-grabens limited by NNW to NW faults (Uliana et al., 1989) and laterally extended layers.
- Mainly continental, submarine evidences in SW and S (fossils, hyaloclastites, pillow lavas, etc.)

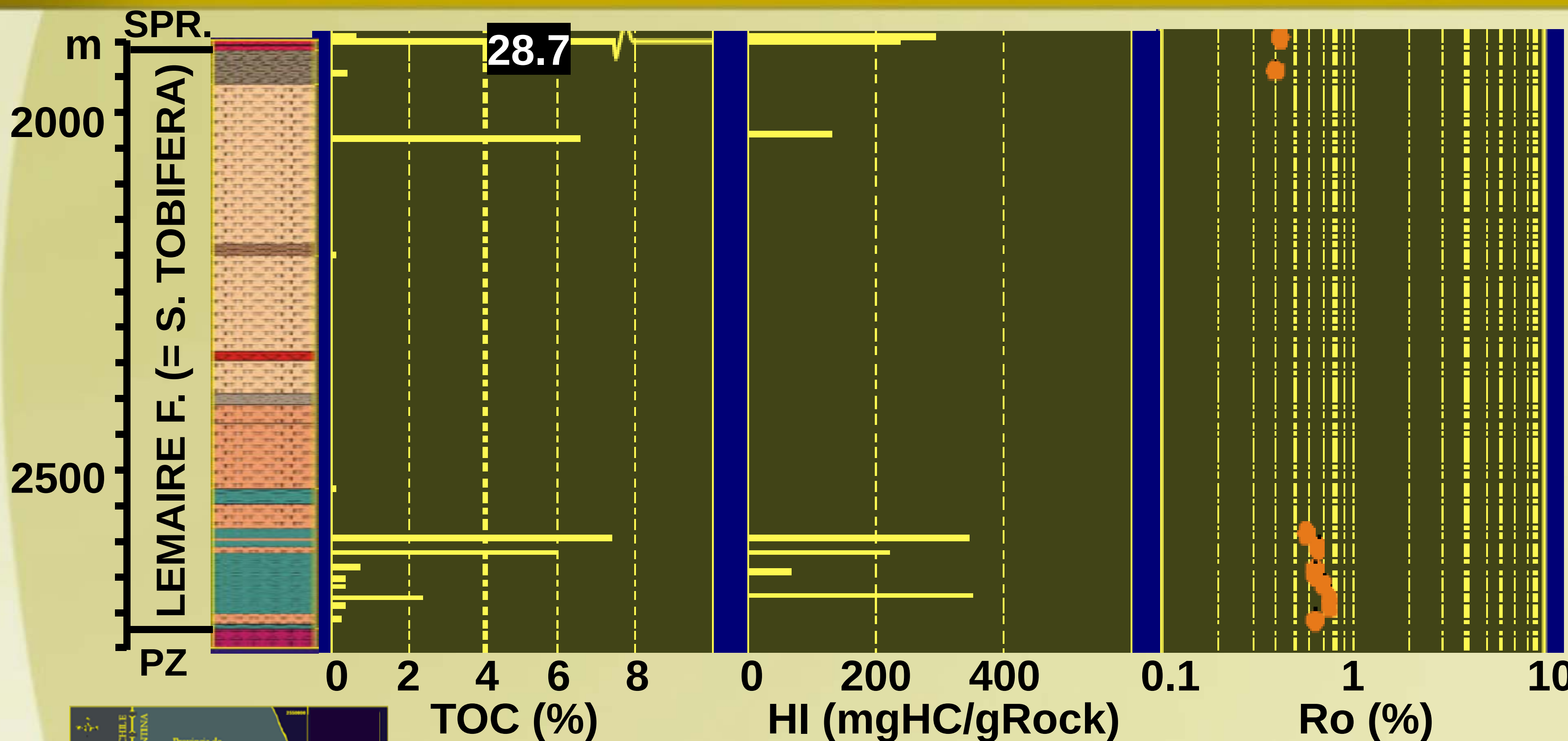
SYNRIFT SOURCE ROCK

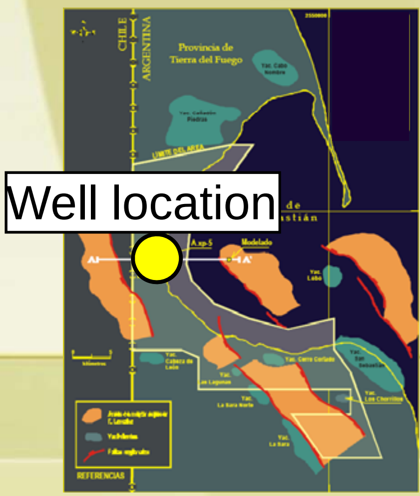
- Half-graben and grabens
- Lacustrine and terrigenous mudstones interbeded with volcaniclastics
- TOC: 0.5 to 7.3%
- Kerogen mainly III, minor I
- High lateral and vertical variability





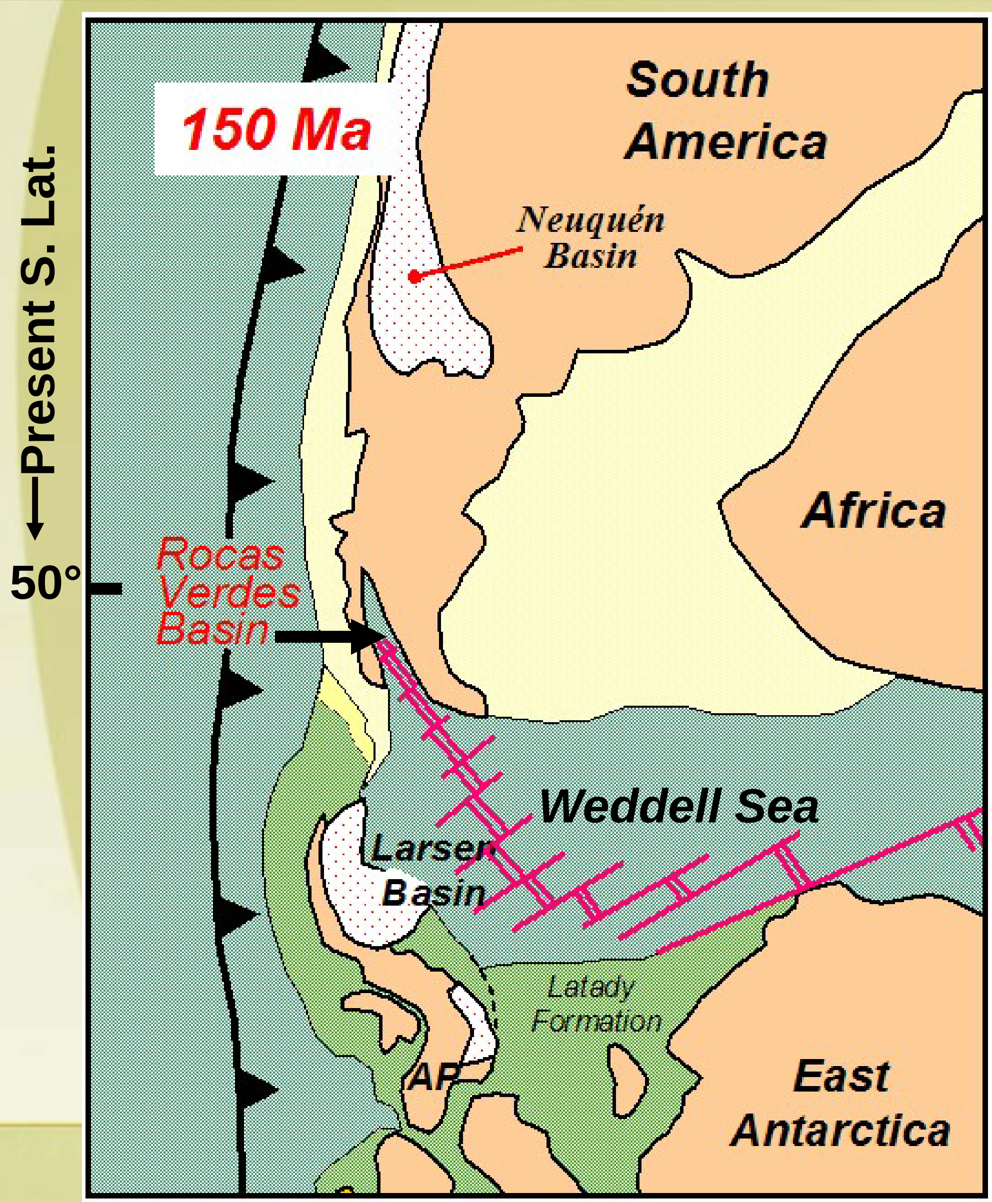
SYNRIFT SOURCE ROCK





Cagnolatti M.J., R. Martins
& H.J. Villar, 1996

ROCAS VERDES BASIN

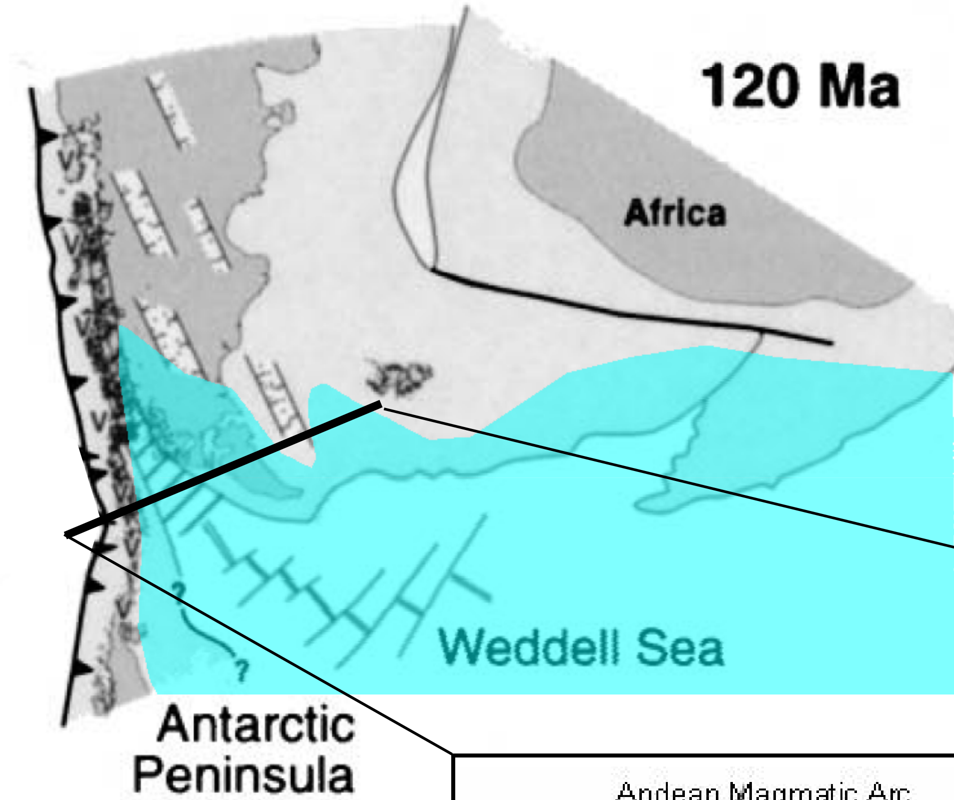


Modified after Hathway, 2000

Rifting of the Rocas Verdes B. (south of 51° South Lat.): 152 to 142 Ma (Calderón et al., 2007), related to Weddell Sea.

Closing in early Late Cretaceous (Fildani et al., 2003).

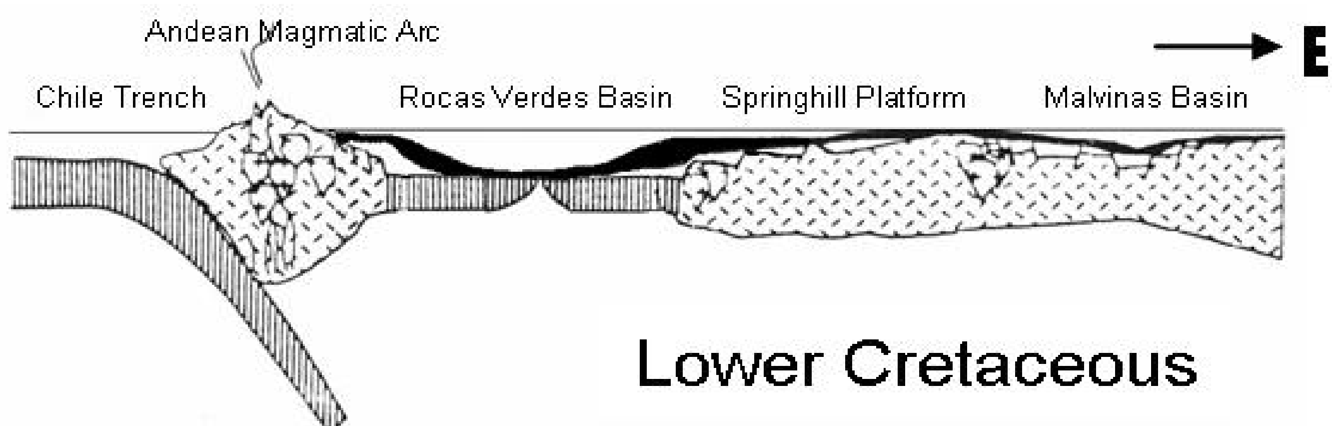
PALEOGEOGRAPHY OF EARLY CRETACEOUS



Diraison et al., 2000

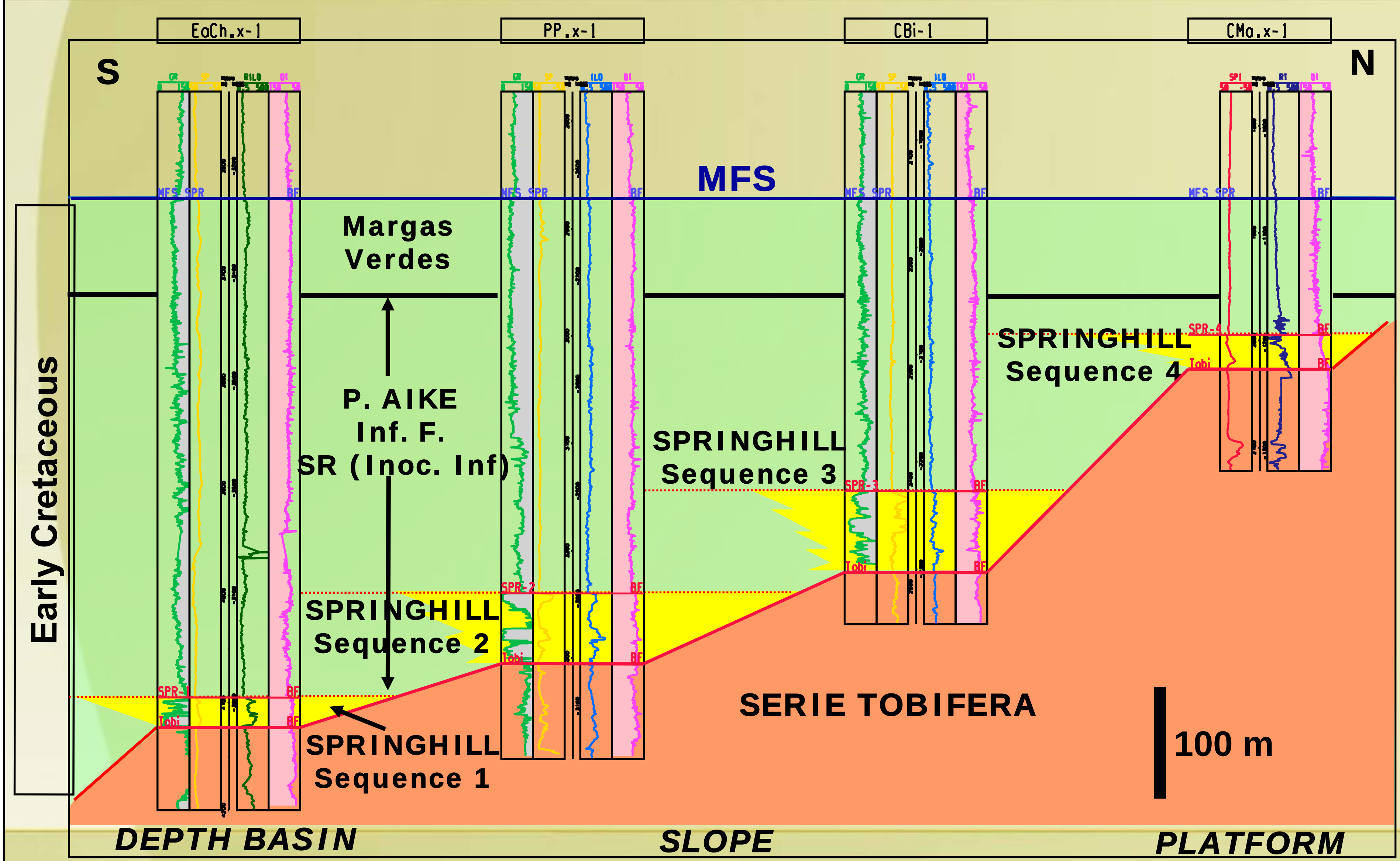
Late Jurassic and Early Cretaceous (Tithonian to Albian)
Paleofloristic diversity, dominated by gymnosperms (Del Fueyo et al., 2007).

Paleoclimate: temperate to hot
- Exuberant vegetation in Antartica
- High CO2 content in the atmosphere (Passalía, 2004).

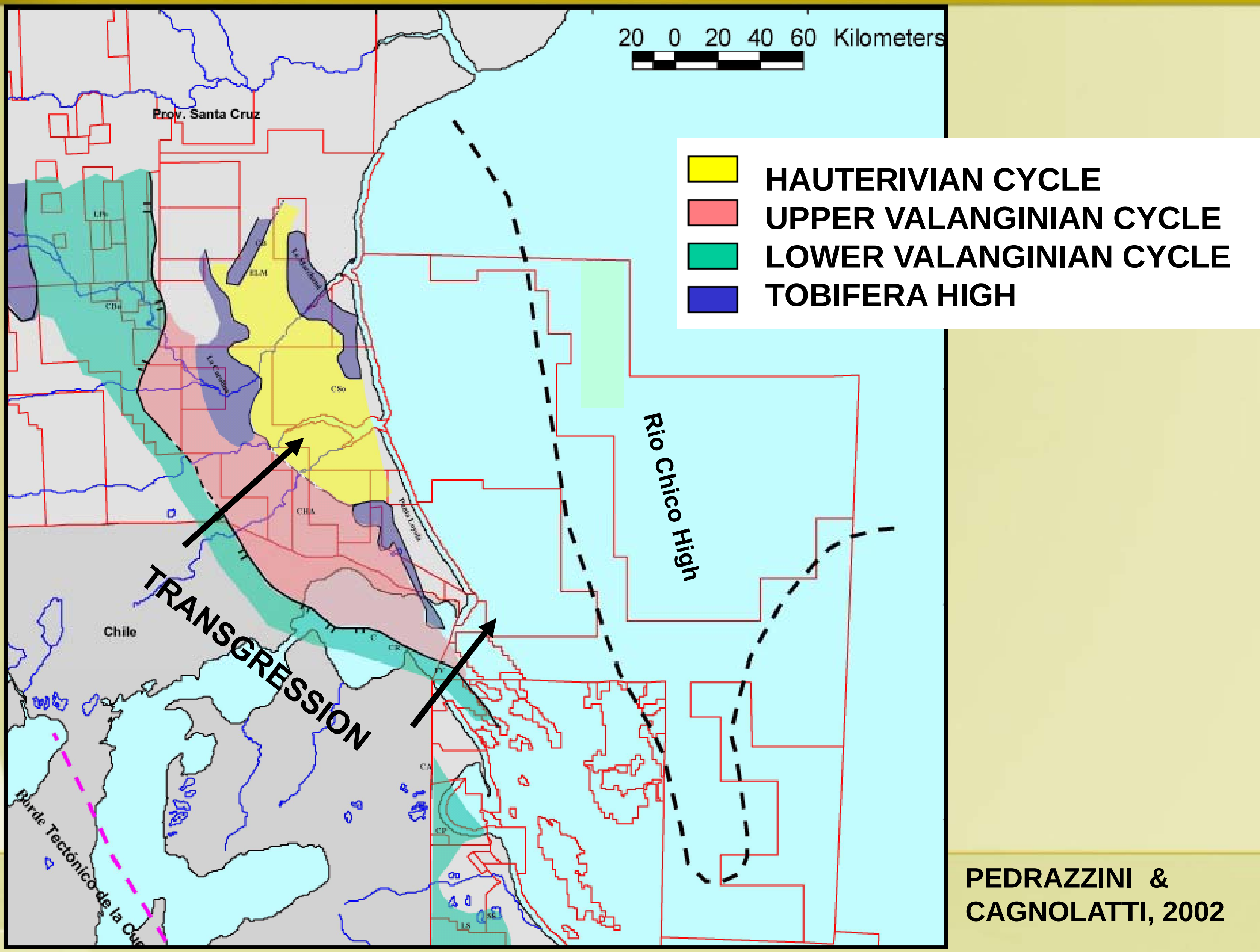


Modified by S. Harambour, 2000, after Galeazzi,1998

EARLY CRETACEOUS



SPRINGHILL CYCLES - EARLY CRETACEOUS

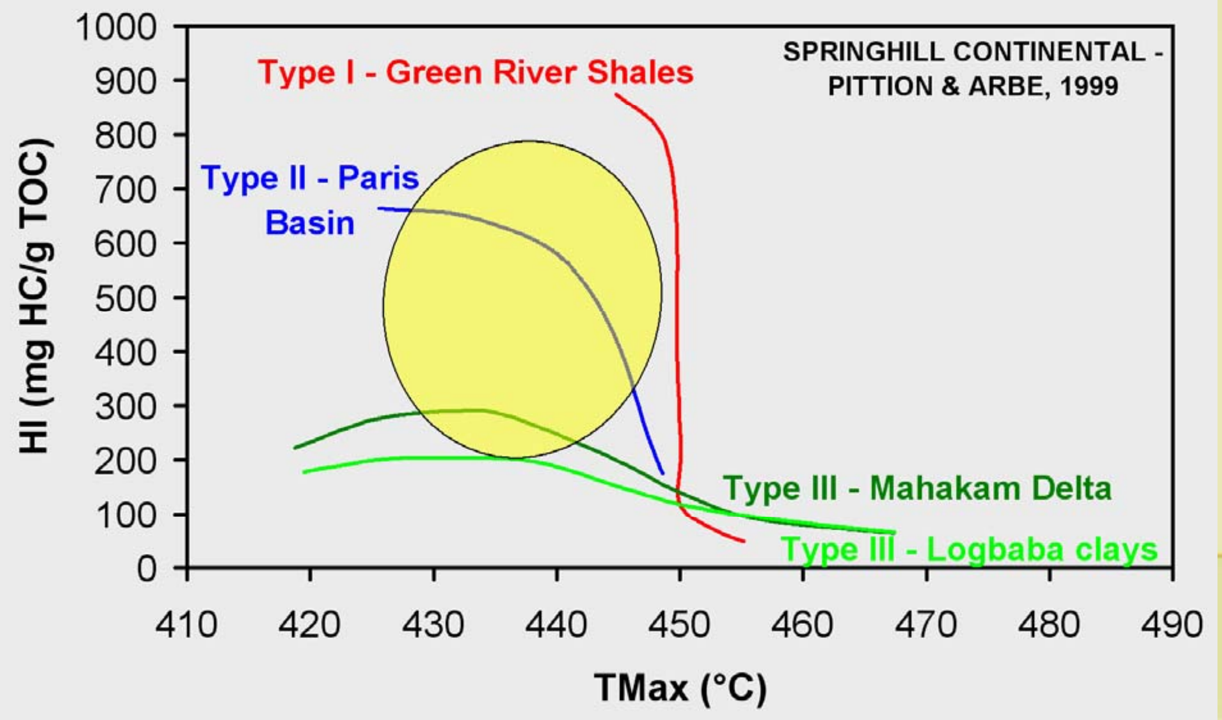


PEDRAZZINI & CAGNOLATTI, 2002

SPRINGHILL SOURCE ROCK

Springhill F. (Tithonian to Barremian)
Continental and marine mudstones interbedded with sandstone reservoirs.

Continental mudstones (lower part)
Proved SR (Decastelli and Arias 1989; Pittion and Gouadain, 1992; Pittion and Arbe, 1999).
TOC: mainly 2 to 6 % (higher in coal levels of 0.5 to 20 cm). Widespread (areally and temporally) high contents.
Kerogen II to III. *Botryococcus.*
Oil prone quality possibly due to preservation of OM. Thickness: 1 to 5 m

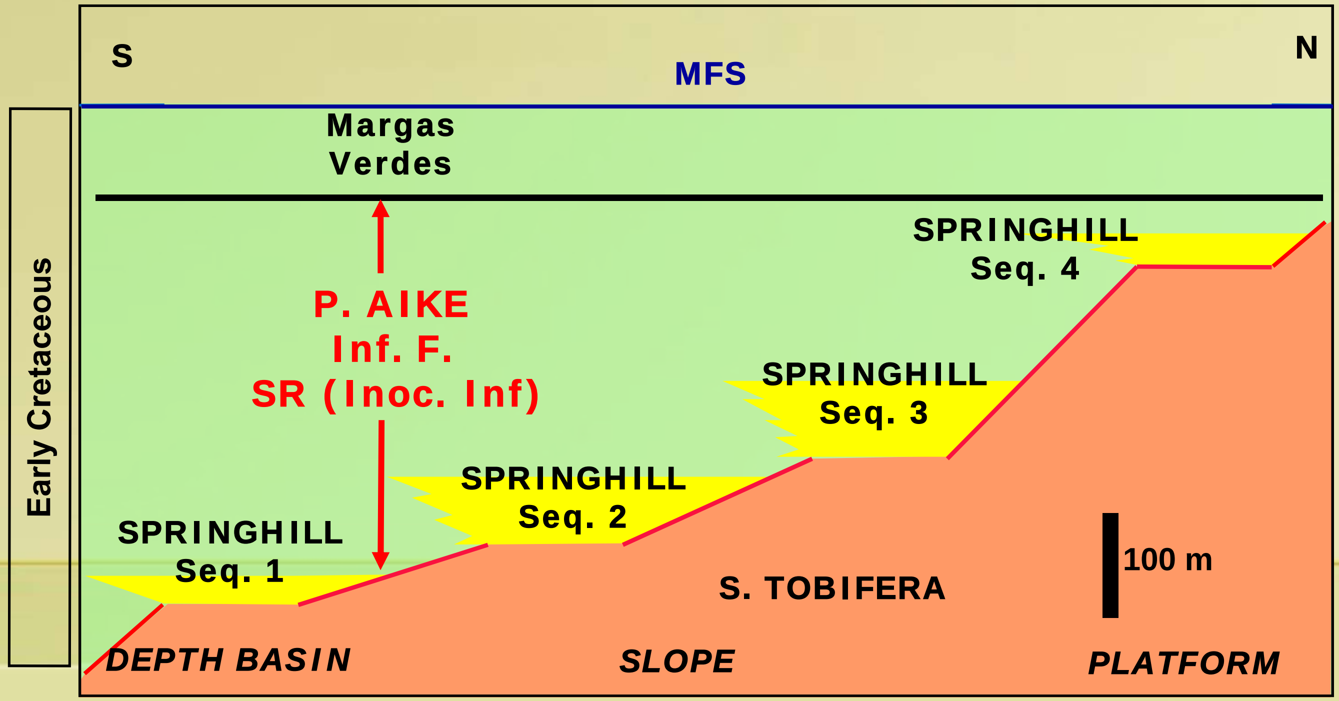


INOCERAMUS INFERIOR SOURCE ROCK

Inoceramus Inferior (Berriasian to Aptian)

Main SR (Pittion and Gouadain, 1992; Pittion and Arbe, 1999).
Black marine mudstones, in contact with reservoirs (Springhill F.)
TOC: mainly 0.6 to 2%
Kerogen II to III
Thickness 50 to 150 m (south). Increasing to the SW and W.

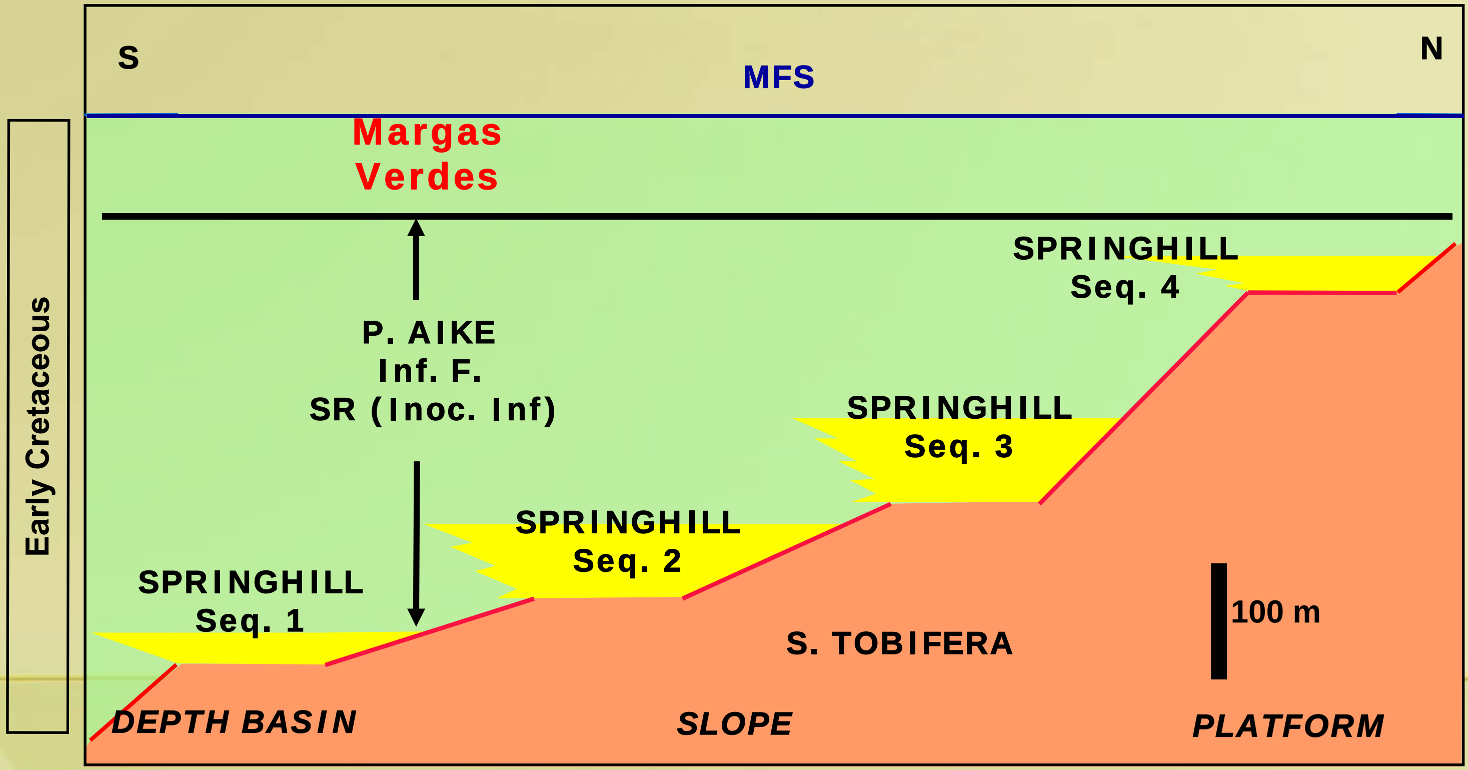
Restricted marine offshore ramp. Dysaerobic to anaerobic. Water stratification due to fresh water runoff ?



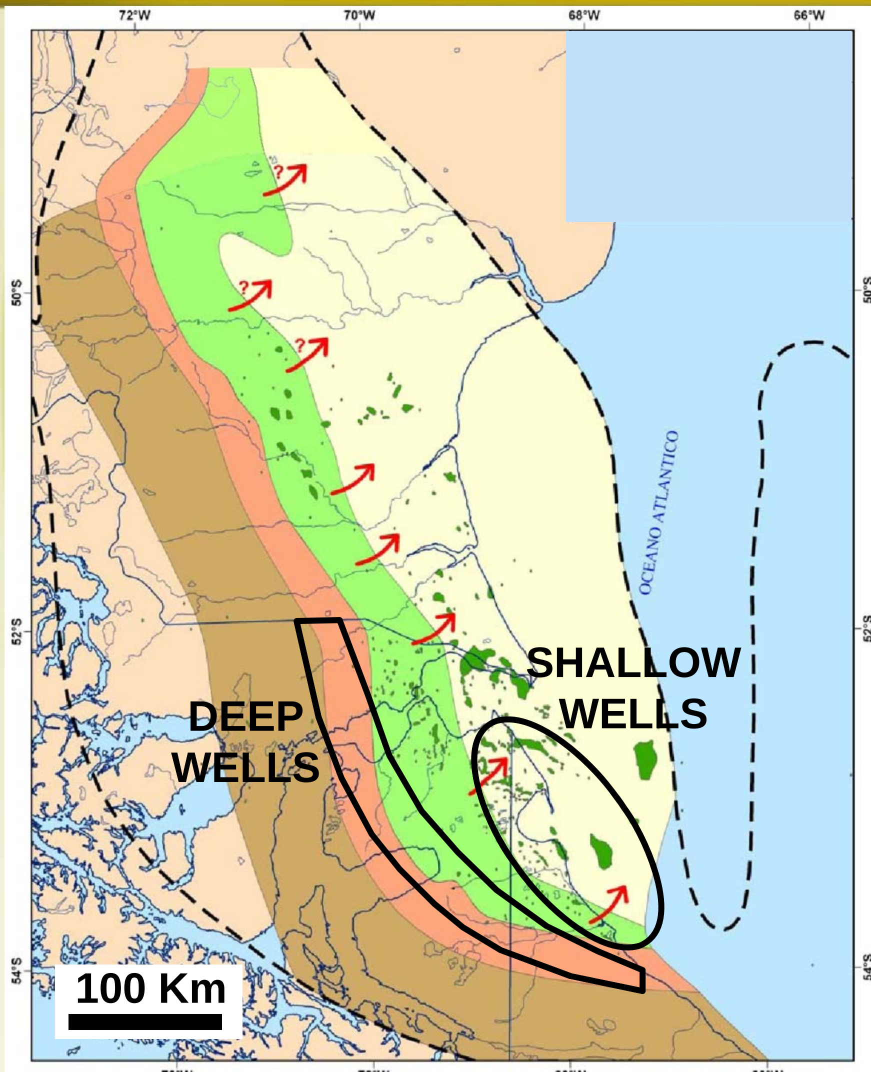
MARGAS VERDES SOURCE ROCK

Margas Verdes (Aptian to Albian)

Proved SR (Pittion and Gouadain, 1992, Pittion and Arbe, 1999).
Marine mudstones and marls.
TOC: mainly 0.5 to 2%
Kerogen II to III.
Main source potential in the base (thickness: 30 to 40 m - south)



LOWER INOCERAMUS AND MARGAS VERDES SOURCE ROCKS



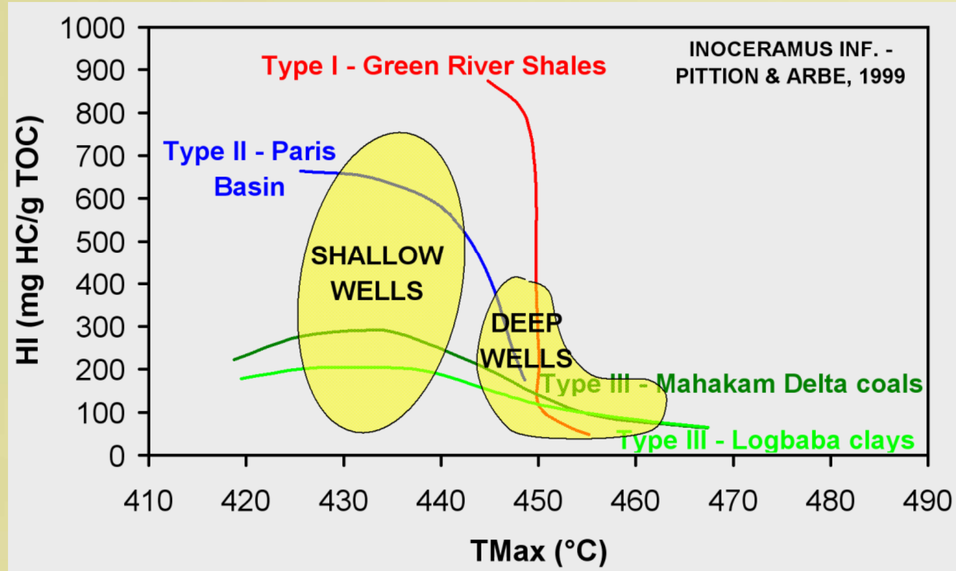
HC. "WINDOWS" – EARLY CRET. SR.

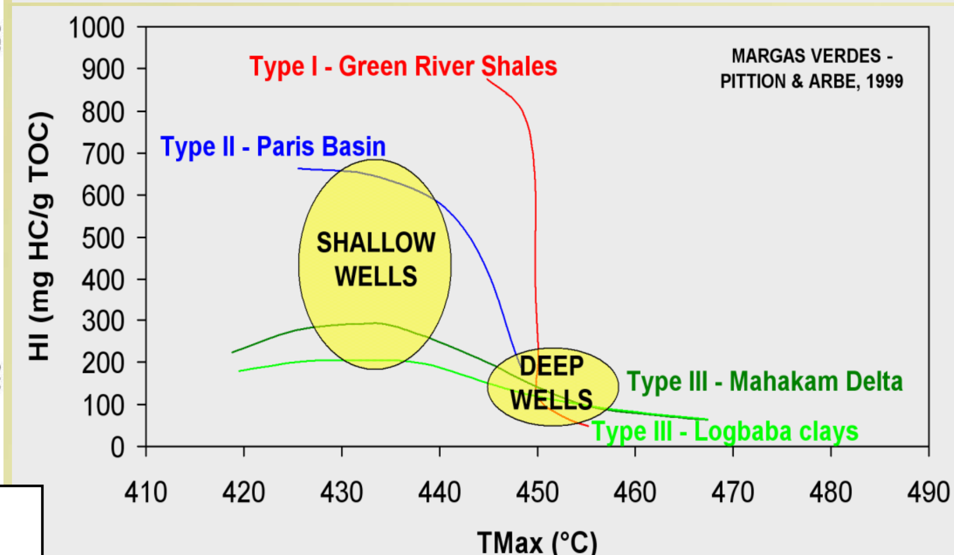
IMMATURE

WET GAS AND COND.

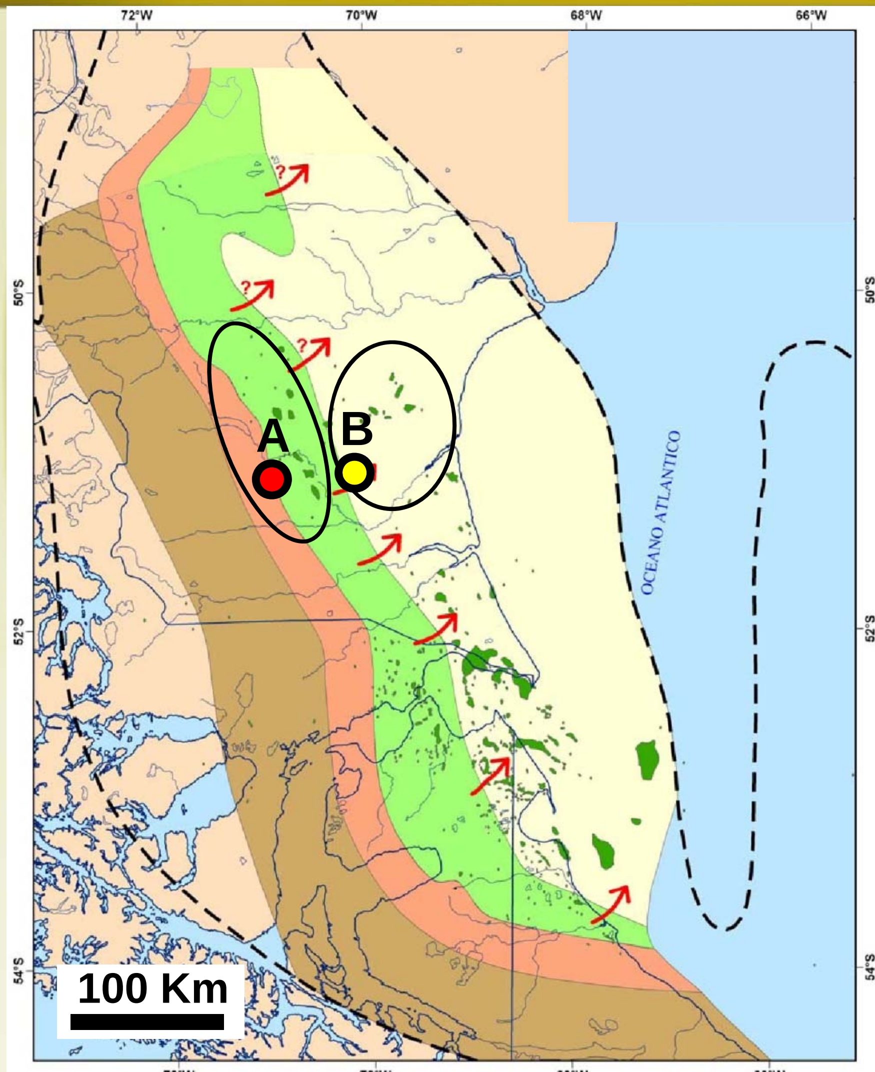
OIL

DRY GAS



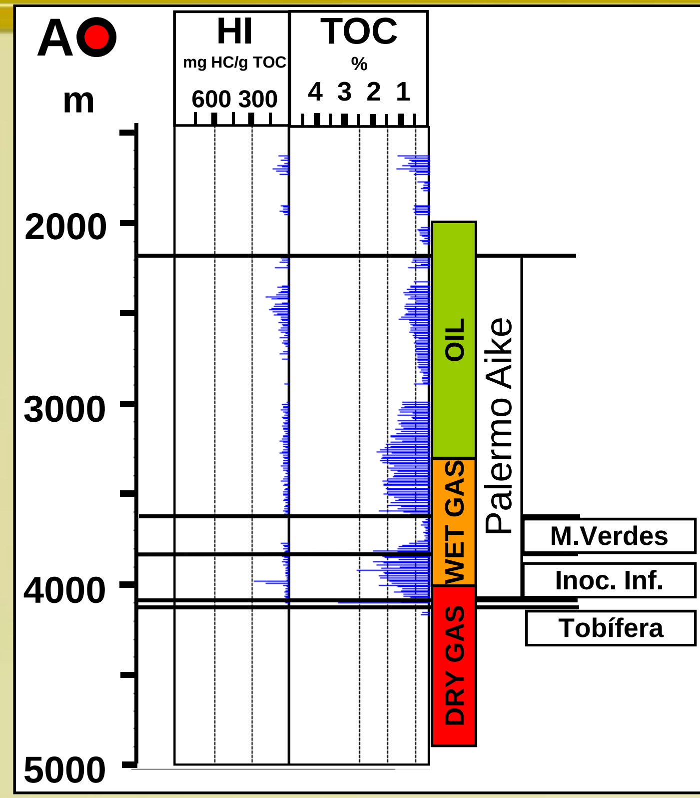


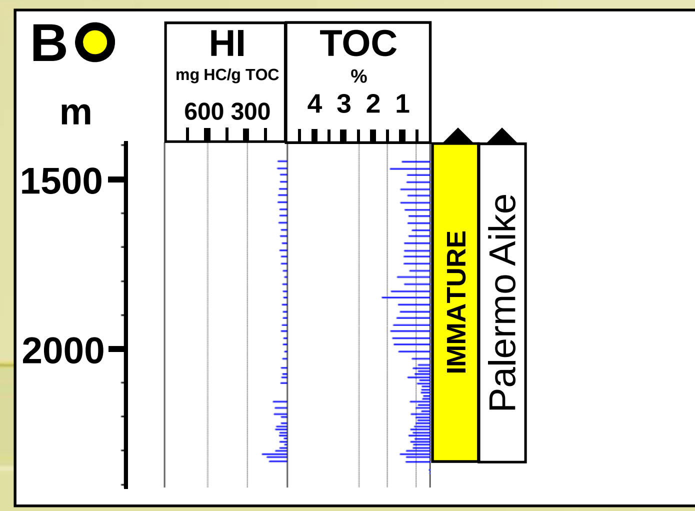
LOWER INOCERAMUS AND MARGAS VERDES SOURCE ROCKS



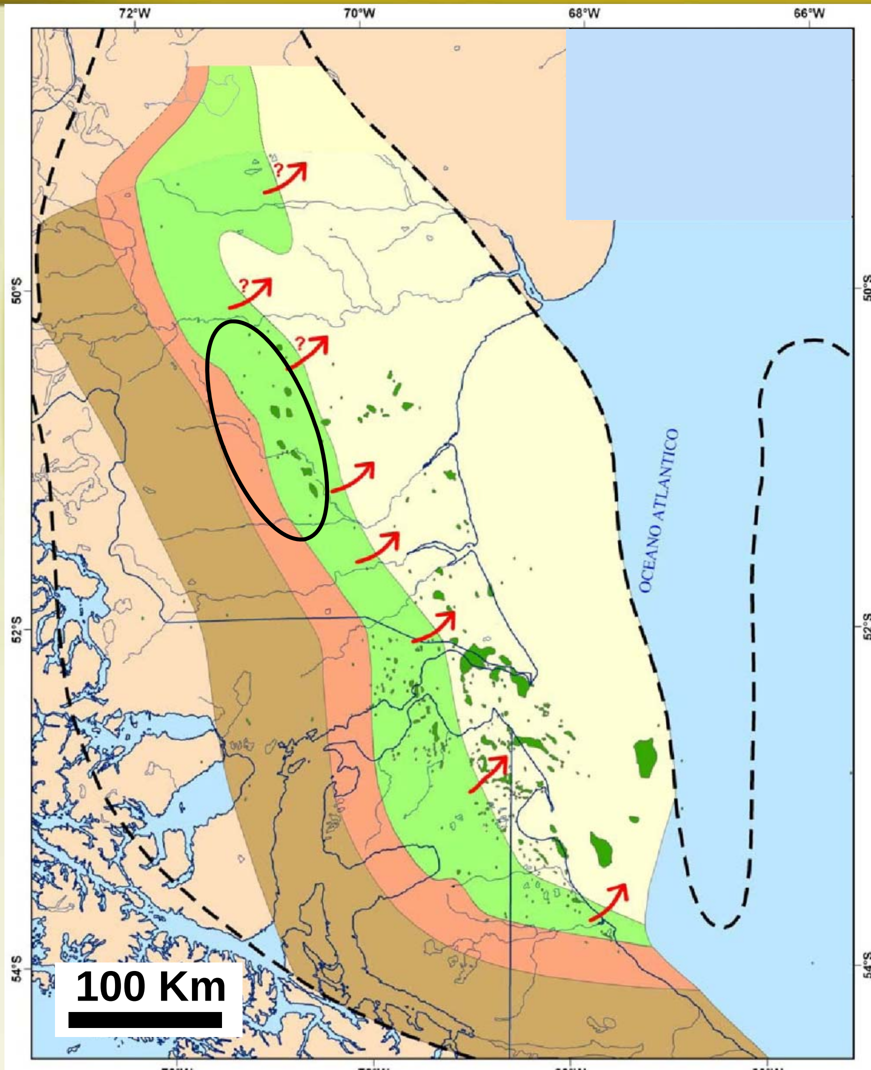
HC. "WINDOWS" – EARLY CRET. SR.

- IMMATURE
- WET GAS AND COND.
- OIL
- DRY GAS





LOWER INOCERAMUS AND MARGAS VERDES SOURCE ROCKS



HC. "WINDOWS" – EARLY CRET. SR.

- IMMATURE
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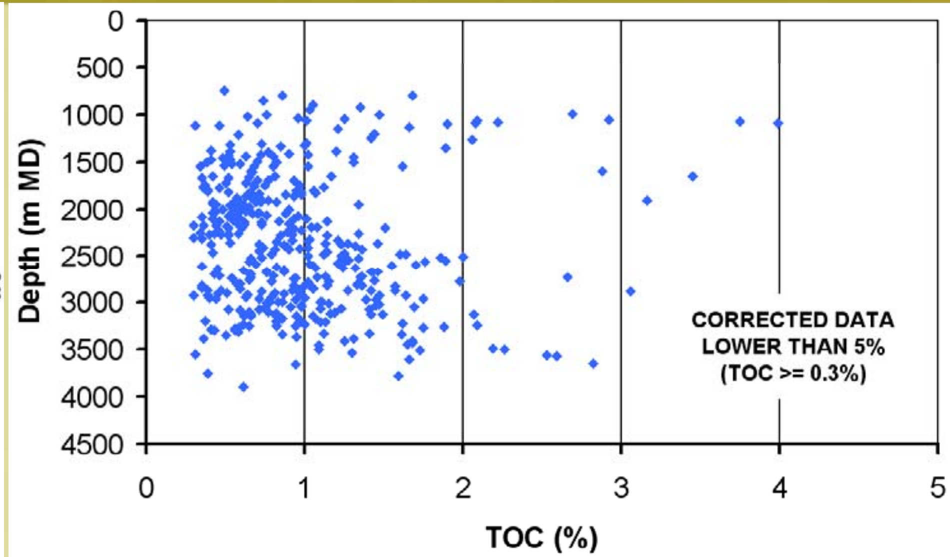
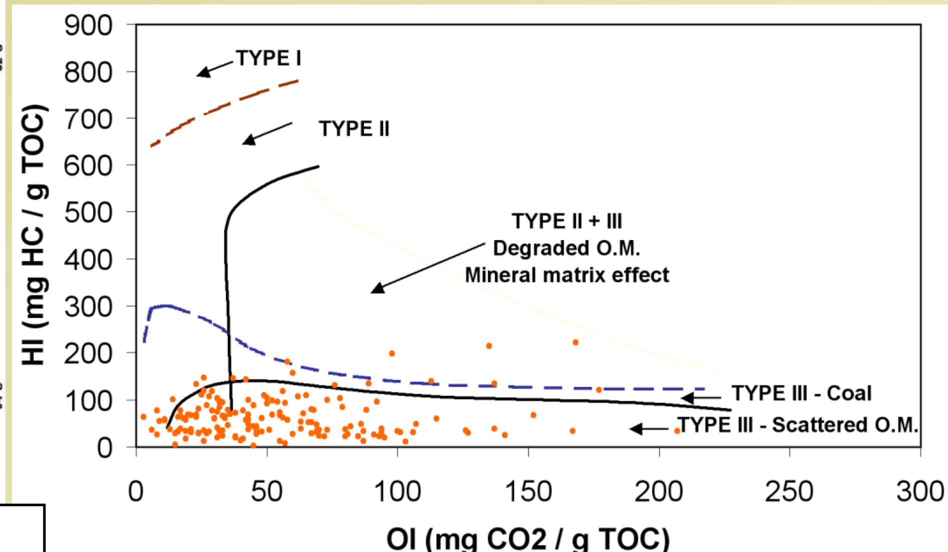
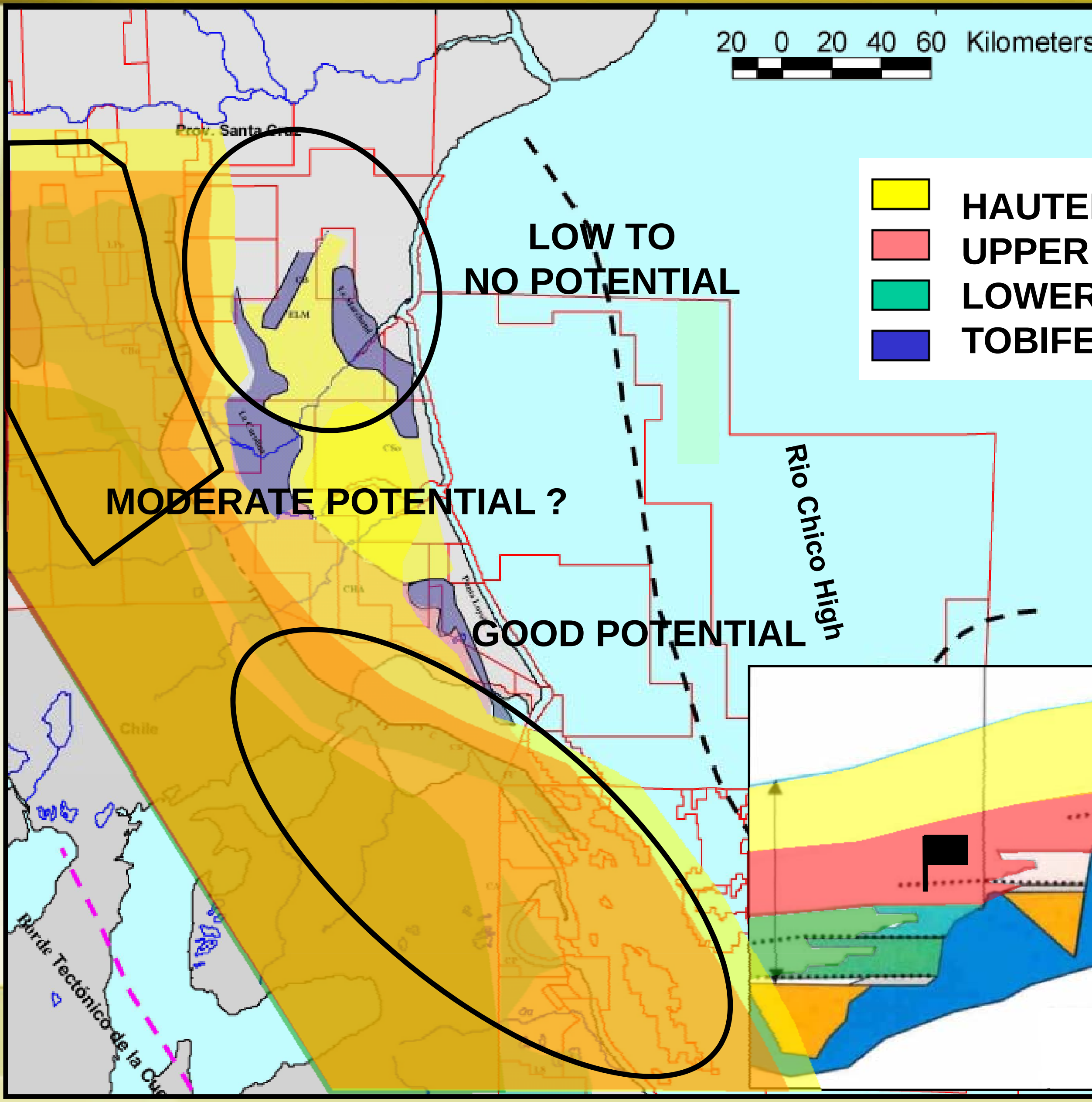
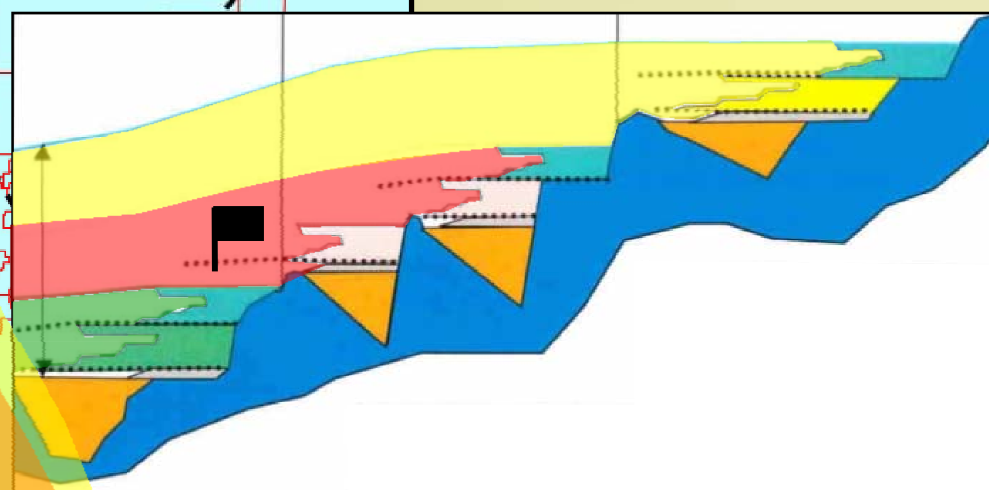




SPRINGHILL AND INOCERAMUS CYCLES



HAUTERIVIAN CYCLE
UPPER VALANGINIAN CYCLE
LOWER VALANGINIAN CYCLE
TOBIFERA HIGH



CONCLUSIONS

- Synrift SR are lacustrine and terrigenous mudstones interbedded with volcaniclastics. Real contribution of hydrocarbons is poorly known.

- Springhill F. continental shales are diachronic swamp and lacustrine rocks with high source potential, deposited under temperate to hot humid conditions. Widespread. Small thicknesses.

- Inoceramus Inferior (Palermo Aike F.), the most important SR, is diachronic. Deposited in an offshore ramp under dysaerobic to anaerobic conditions, in the sag phase of a restricted basin related to the Weddell Sea. Dysaerobic to anaerobic conditions seem to be related to the input of fresh water to the marine basin, producing water stratification.

- We documented variability of Inoceramus Inferior source potential and propose that Valanginian cycles have higher potential than the Hauterivian cycle. Hence, NE area has poor to no potential. The central-W area has moderate potential, possibly mainly gas and light-oil prone. Oil prone quality seems to increase to the S and SW.

- Margas Verdes is a SR with good potential and similar distribution to the Inoceramus Inf.

- Upper Cretaceous to Tertiary levels have low and variable potential as SR. Immature.

PETROBRAS

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Thank you for your attention !!

Photo: Gualter Chebli