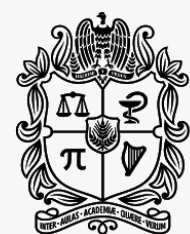


COLOMBIA ROUND 2021



GEOLOGICAL INTEGRATION, PETROLEUM SYSTEMS AND PROSPECTIVITY OF COLOMBIA'S FRONTIER BASINS: SINU OFFSHORE

AUGUST 20TH 2021

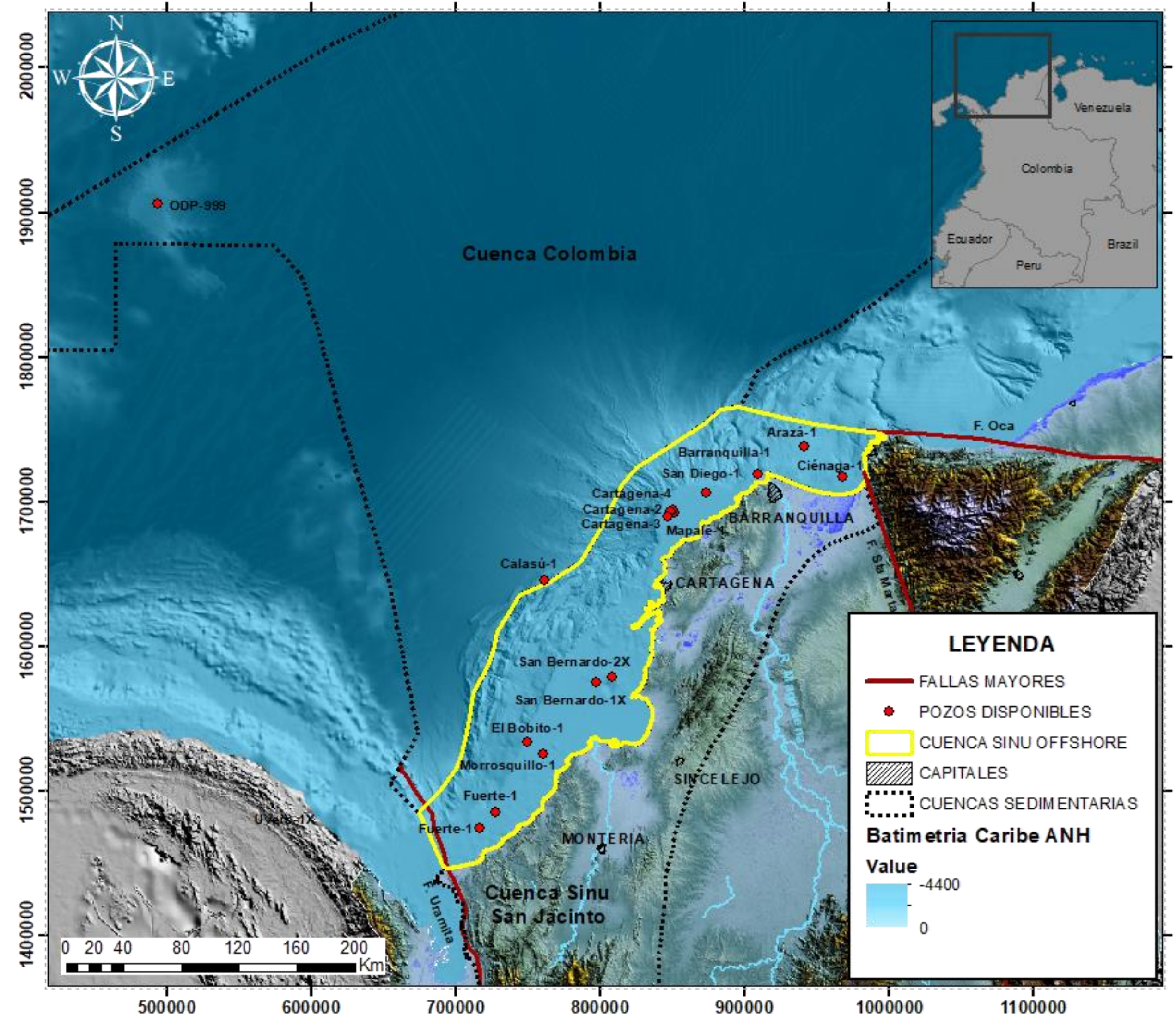
- General Information
- Available Data
- Geologic Framework and Stratigraphy
- Seismic Well Tie
- Geological Provinces in the Sinu Offshore Basin
- Areas of Exploratory Interest
- Conclusions

SINU OFFSHORE BASIN

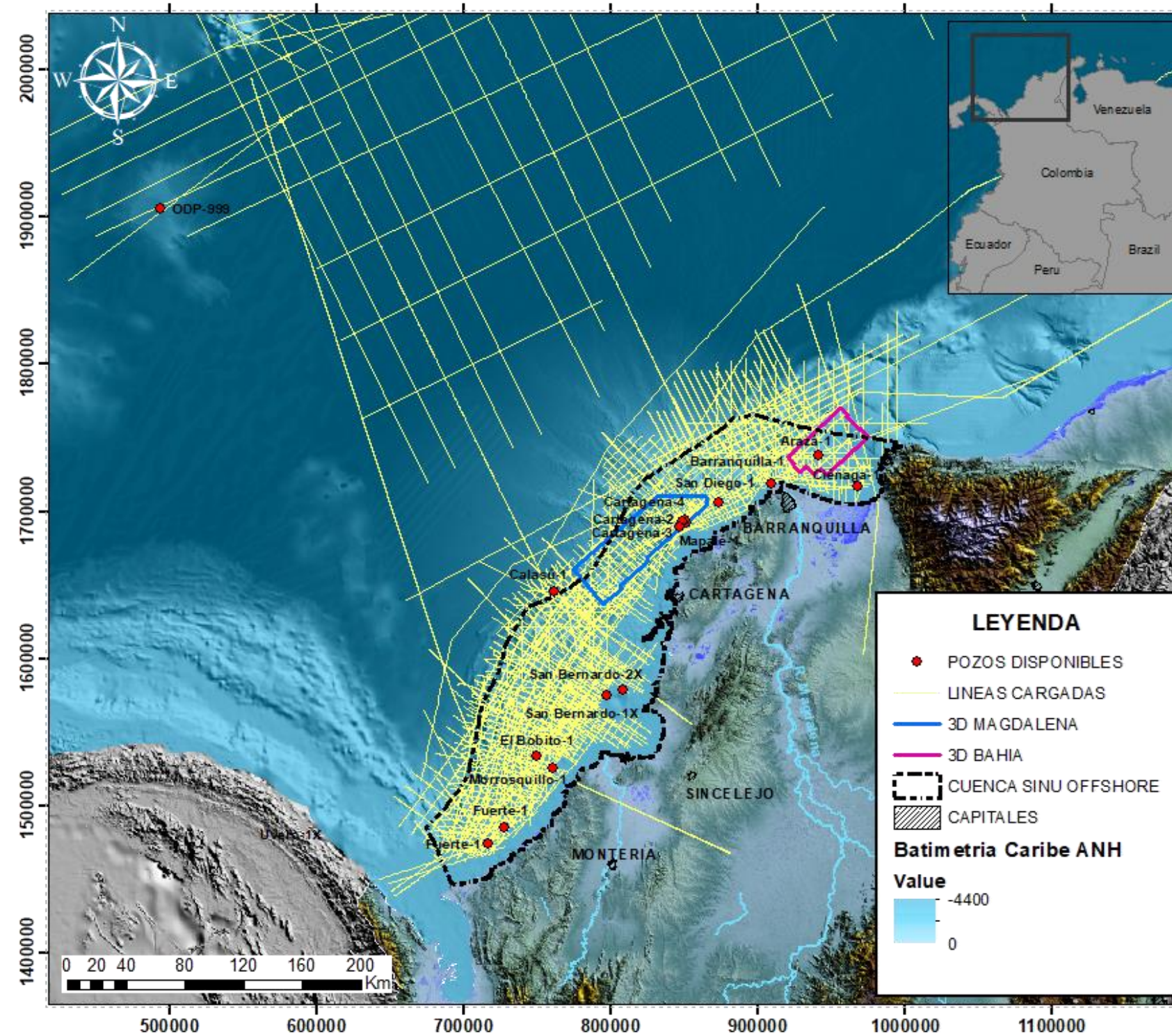
Geological Borders

- ❖ West: Colombia Basin
- ❖ East: Sinu-San Jacinto Basin
- ❖ North East: Guajira Offshore Basin
- ❖ South West: Uraba Basin

AREA 29.520 Km²
Water depths 130 to 2620 mt

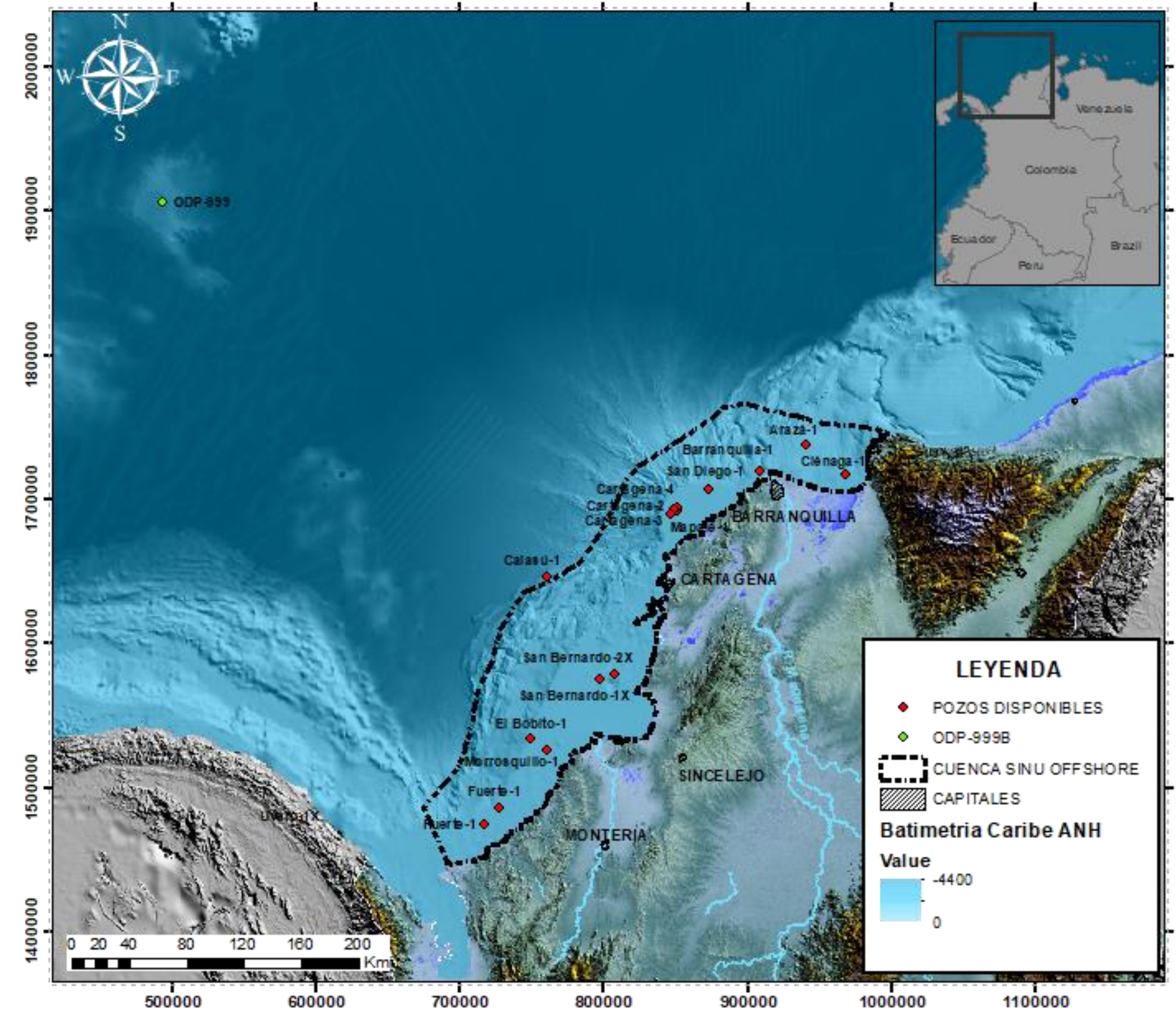


2D – 3D Seismic Data



624 2D seismic lines equivalent to 42.642 km
(Colombia Basin-Sinu Offshore Basin)
2 3D seismic volumes equivalent to 4.592 km²

Well distribution

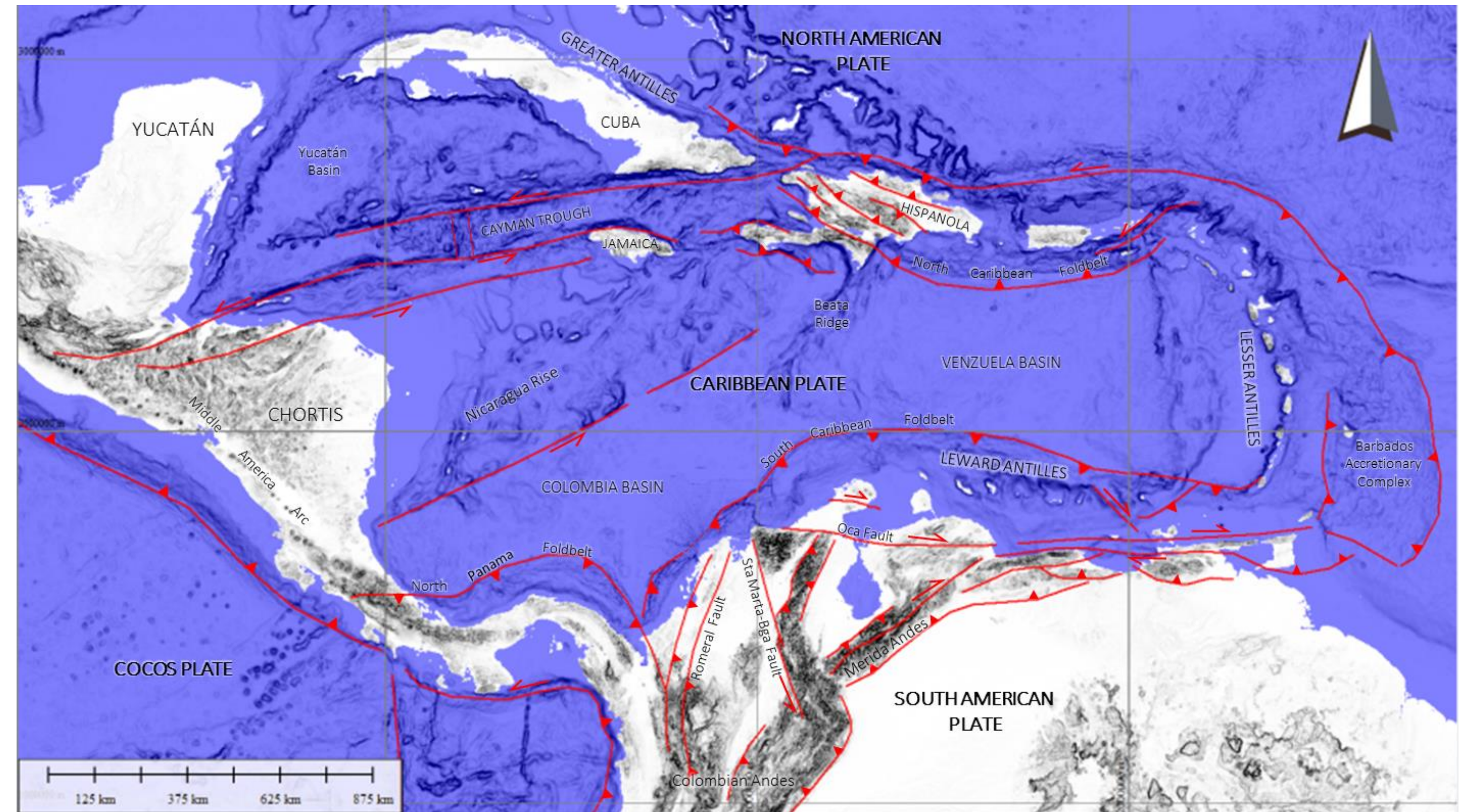


19 wells drilled between 1969 and 2015
(1 well /2500 km²)

GEOLOGIC FRAMEWORK AND STRATIGRAPHY

TECTONIC SETTING

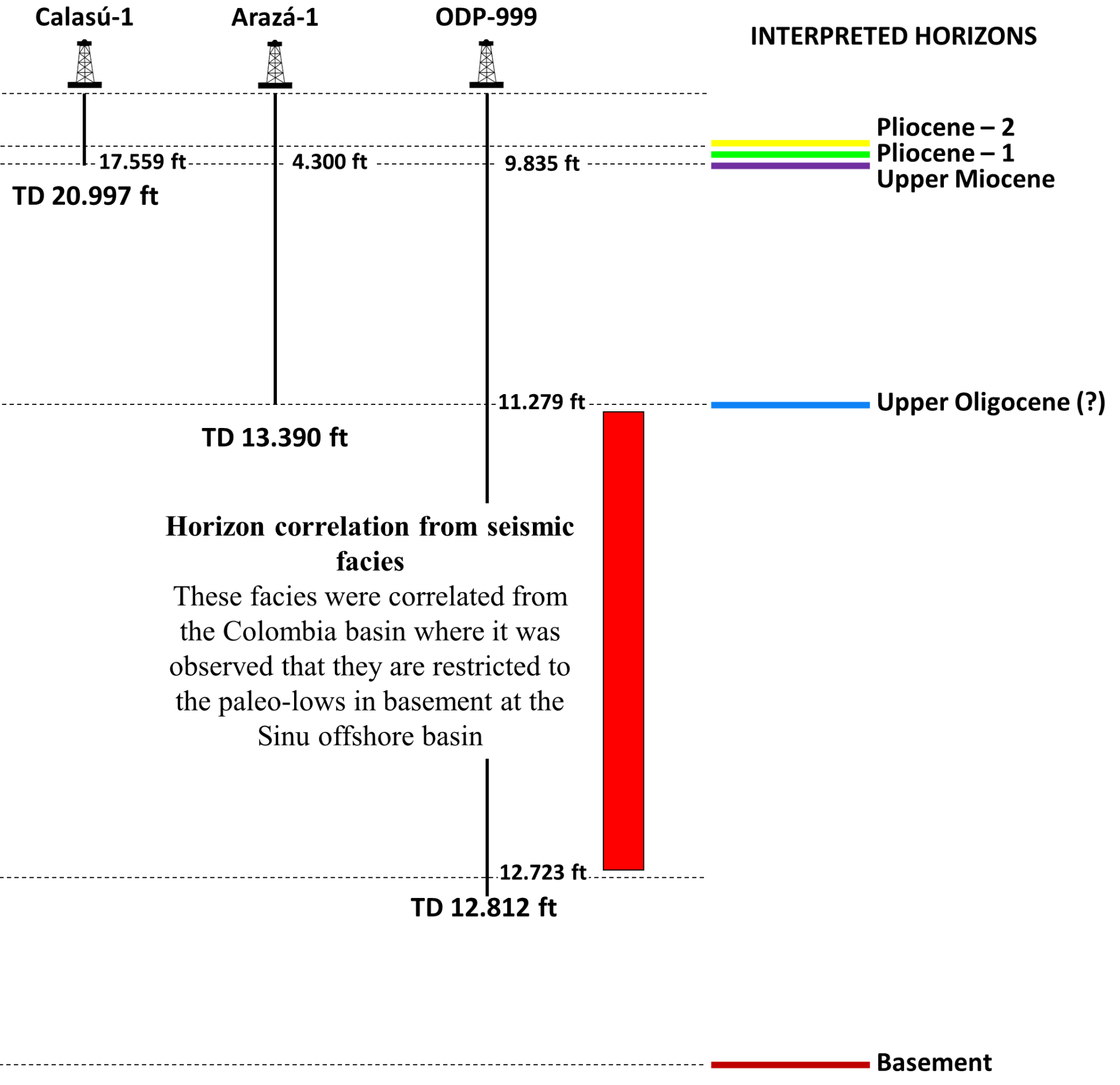
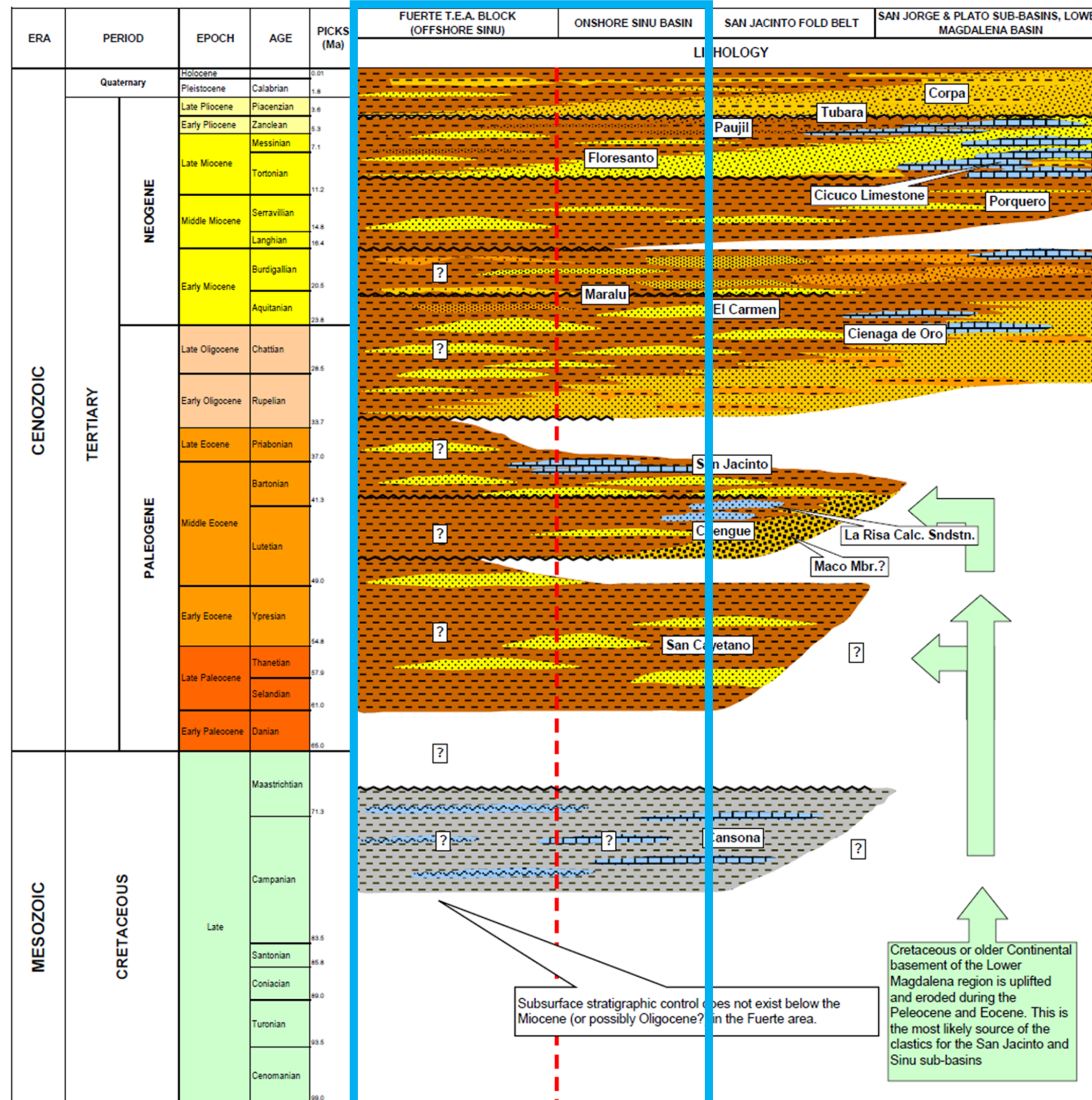
Description



Actual configuration of Caribbean region indicating the possible plate boundaries and some main fault systems. Source: Pindell and Barrett, 1990; Taboada, 2000; Mantilla 2009 Giunta et al. (2006).

GEOLOGIC FRAMEWORK AND STRATIGRAPHY

SINU OFFSHORE STRATIGRAPHIC CHART



Horizon correlation from seismic facies
 These facies were correlated from the Colombia basin where it was observed that they are restricted to the paleo-lows in basement at the Sinu offshore basin

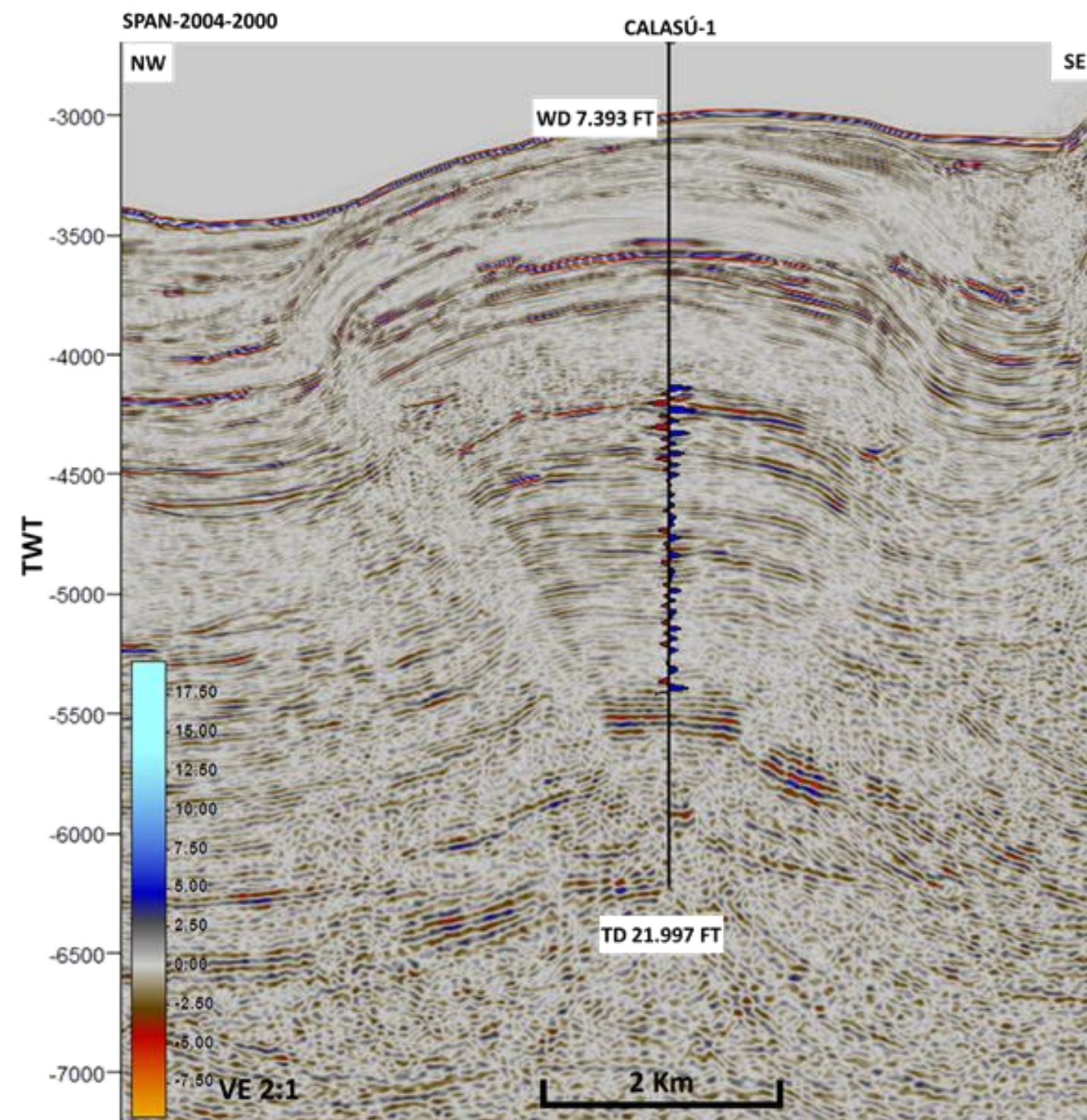
Subsurface stratigraphic control does not exist below the Miocene (or possibly Oligocene?) in the Fuerte area.

Cretaceous or older Continental basement of the Lower Magdalena region is uplifted and eroded during the Paleocene and Eocene. This is the most likely source of the clastics for the San Jacinto and Sinu sub-basins

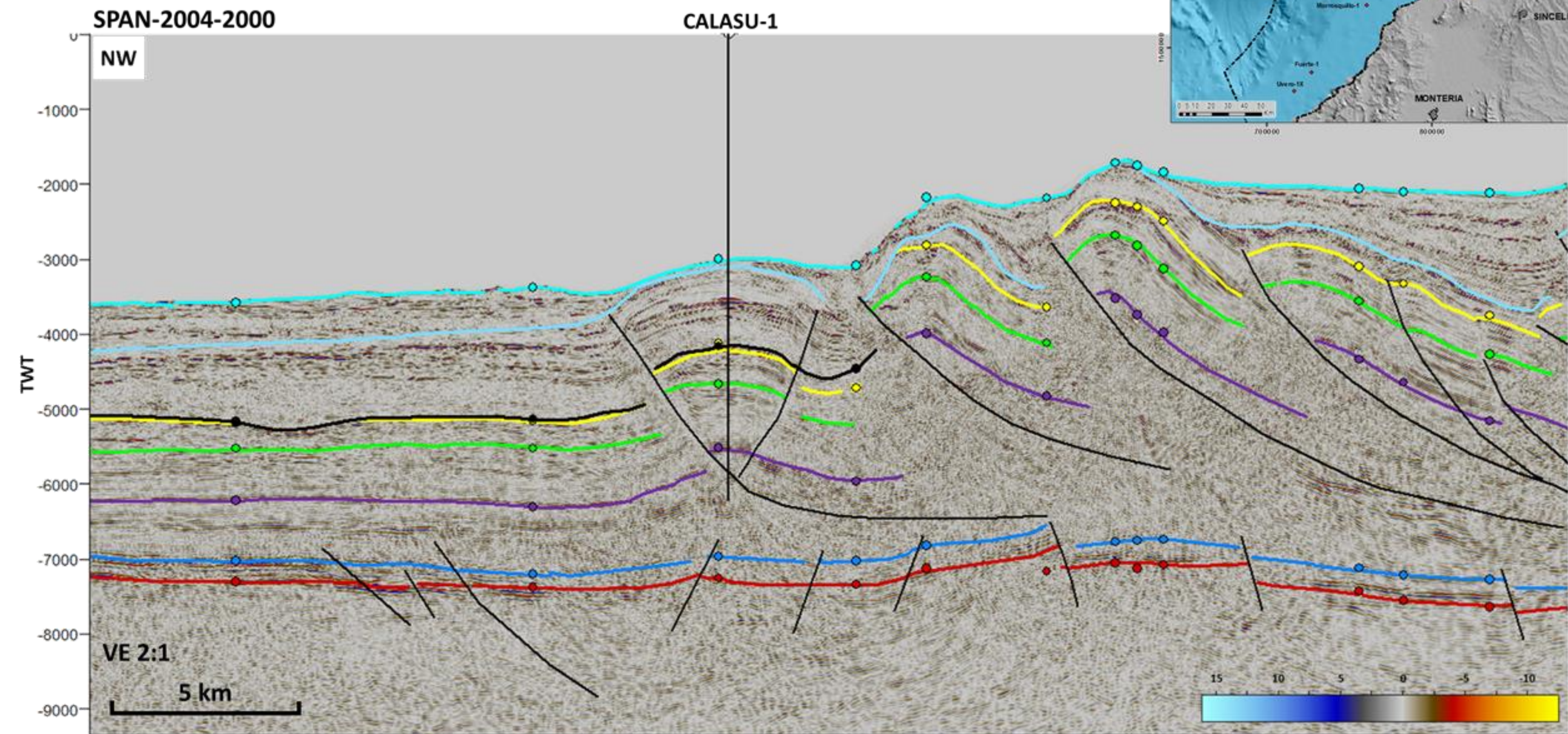
Generalized stratigraphic column modified from "Fuerte technical evaluation contract-Final evaluation report", BHP Billiton Petroleum (Americas) Inc. January 2007. Comparing the penetration of wells drilled in the Sinú Offshore basin related to possible units present.

SEISMIC WELL TIE

CALASÚ-1 WELL: DEFINITION OF HORIZONS/INTERVALS OF INTEREST

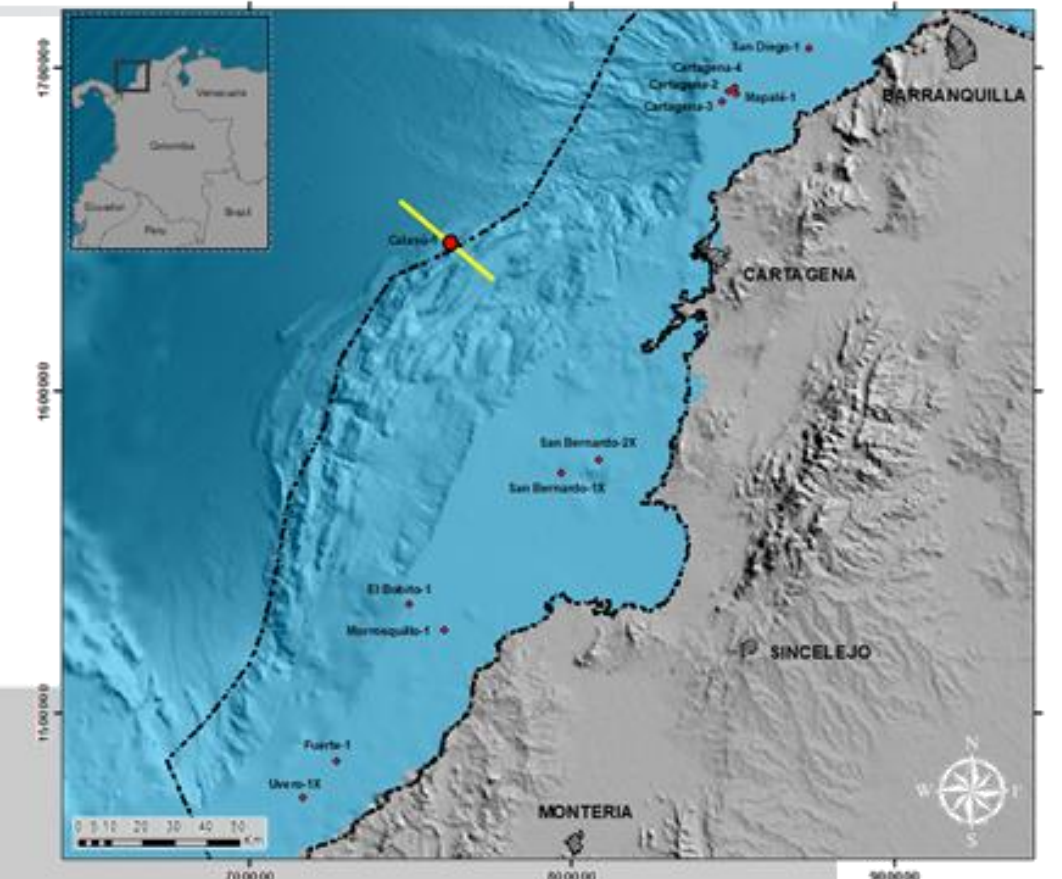


SPAN-2004-2000 seismic line showing the Calasú-1 seismic well tie. It is possible to see the event correlation between seismic events and the synthetic trace.



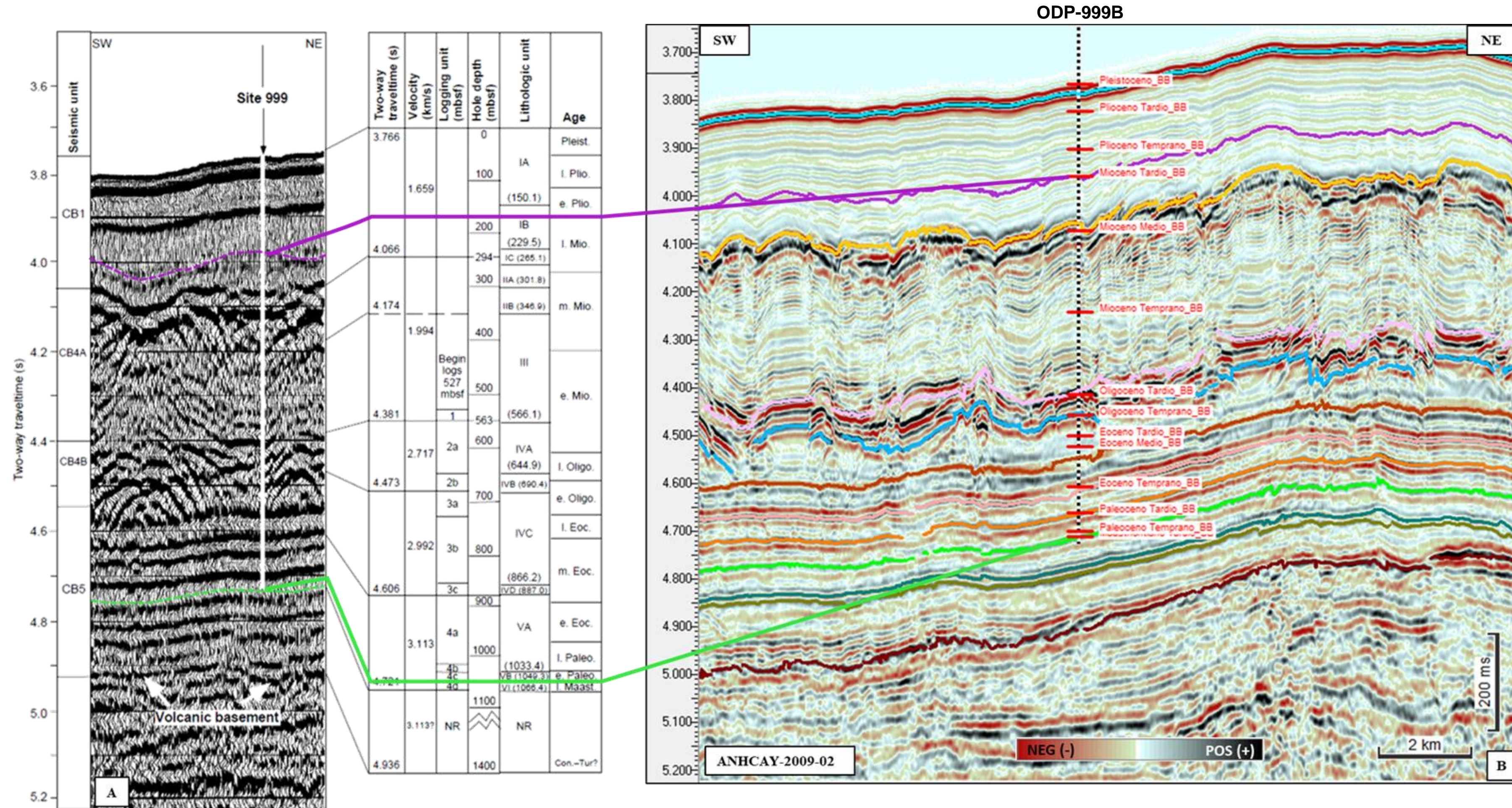
Basamento — Oligoceno Tardío? — Mioceno Tardío — Plioceno Temprano-1 — Plioceno Temprano-2 — Disc - 1 — Fondo Marino

SPAN-2004-2000 2D line indicate defined horizons for the basin as a result of the regional correlation using Calasu-1 and ODP-999B wells. Oligocene and oldest intervals were correlated using ODP-999B



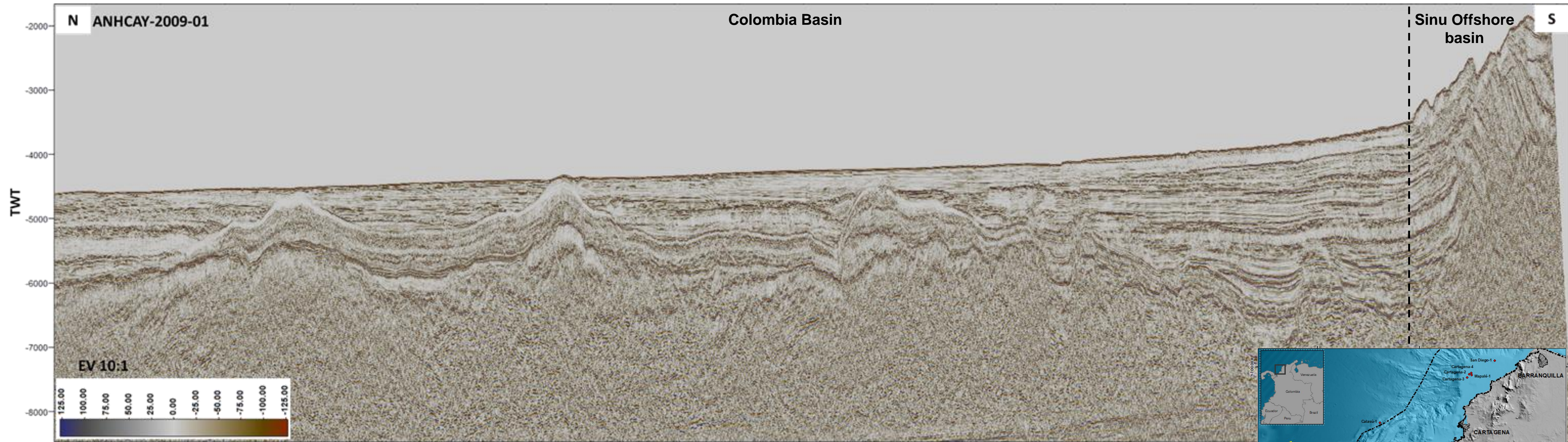
SEISMIC WELL TIE

ODP-999B: TIME – DEPTH TABLE, PICKS AND MAIN CORRELATED EVENTS

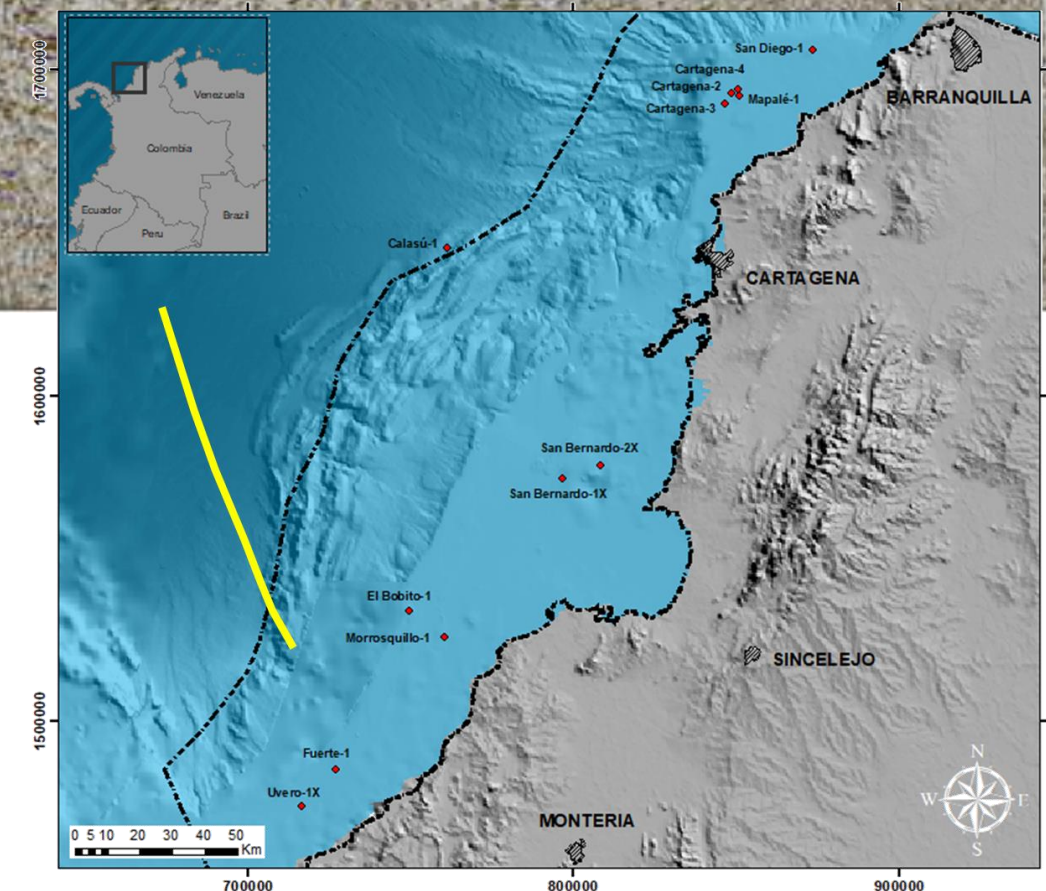


Data from ODP-999B well report used to tie the ages of the tops to the ANHCAY-2009-02 line.

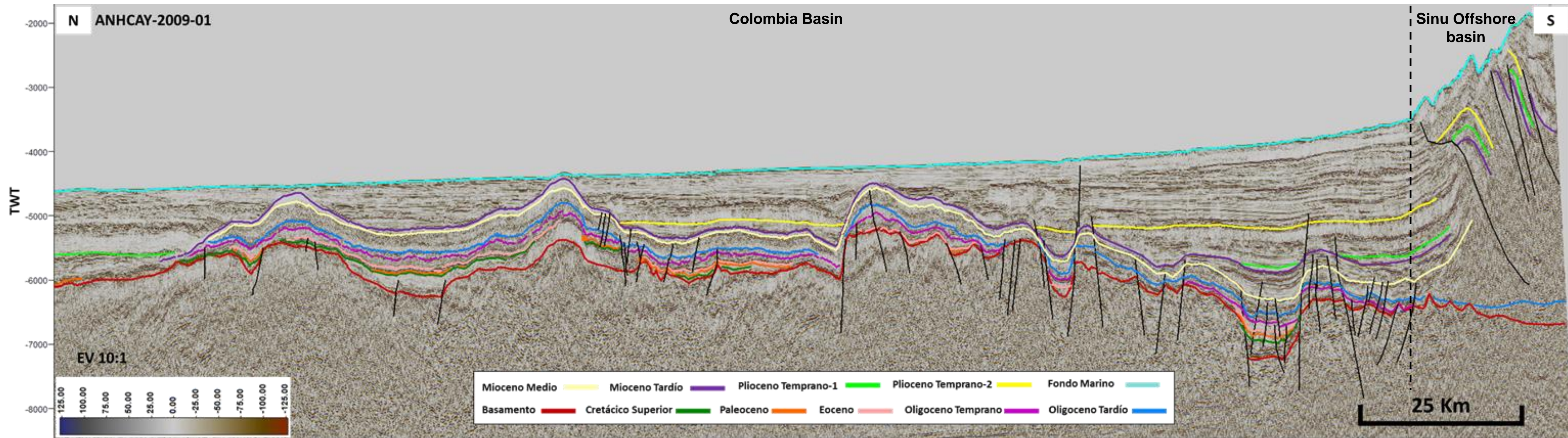
HORIZON CORRELATION THROUGHOUT THE COLOMBIA AND SINU OFFSHORE BASINS



ANHCA Y-2009-01 line revealing the seismic nature of the reflectors in the Colombia basin and their expression in the Sinu Offshore basin.



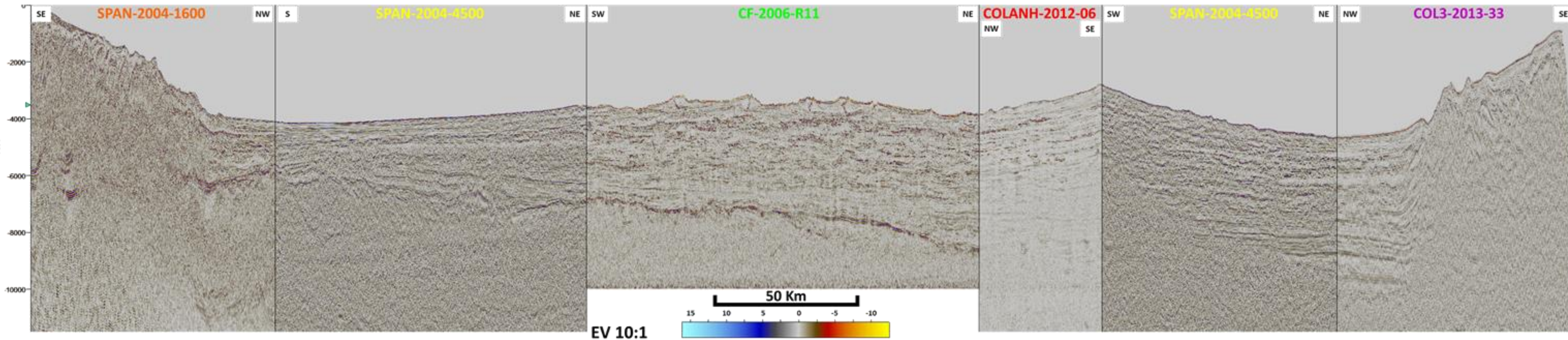
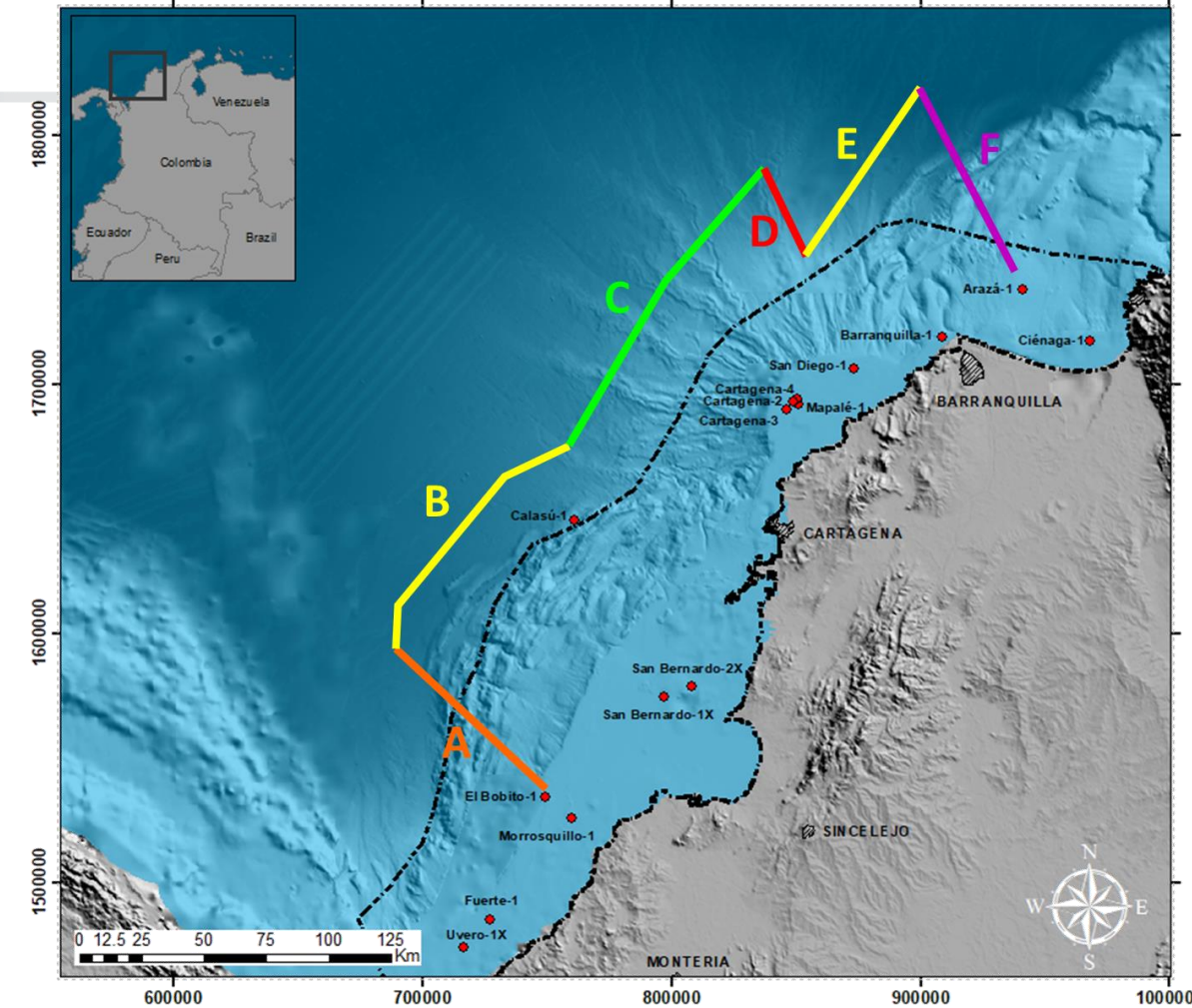
HORIZON CORRELATION THROUGHOUT THE COLOMBIA AND SINU OFFSHORE BASINS



ANHCA-2009-01 line where the seismic horizons brought from well ODP-999B are observed. The horizons referring to the Cretaceous and Paleogene are restricted to the lower part of the basement.

GEOLOGICAL PROVINCES IN THE SINU OFFSHORE BASIN

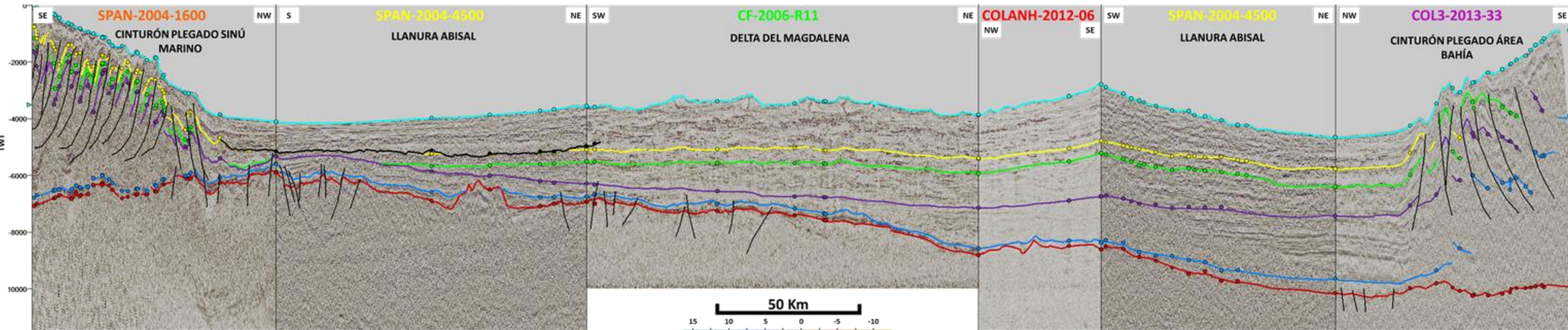
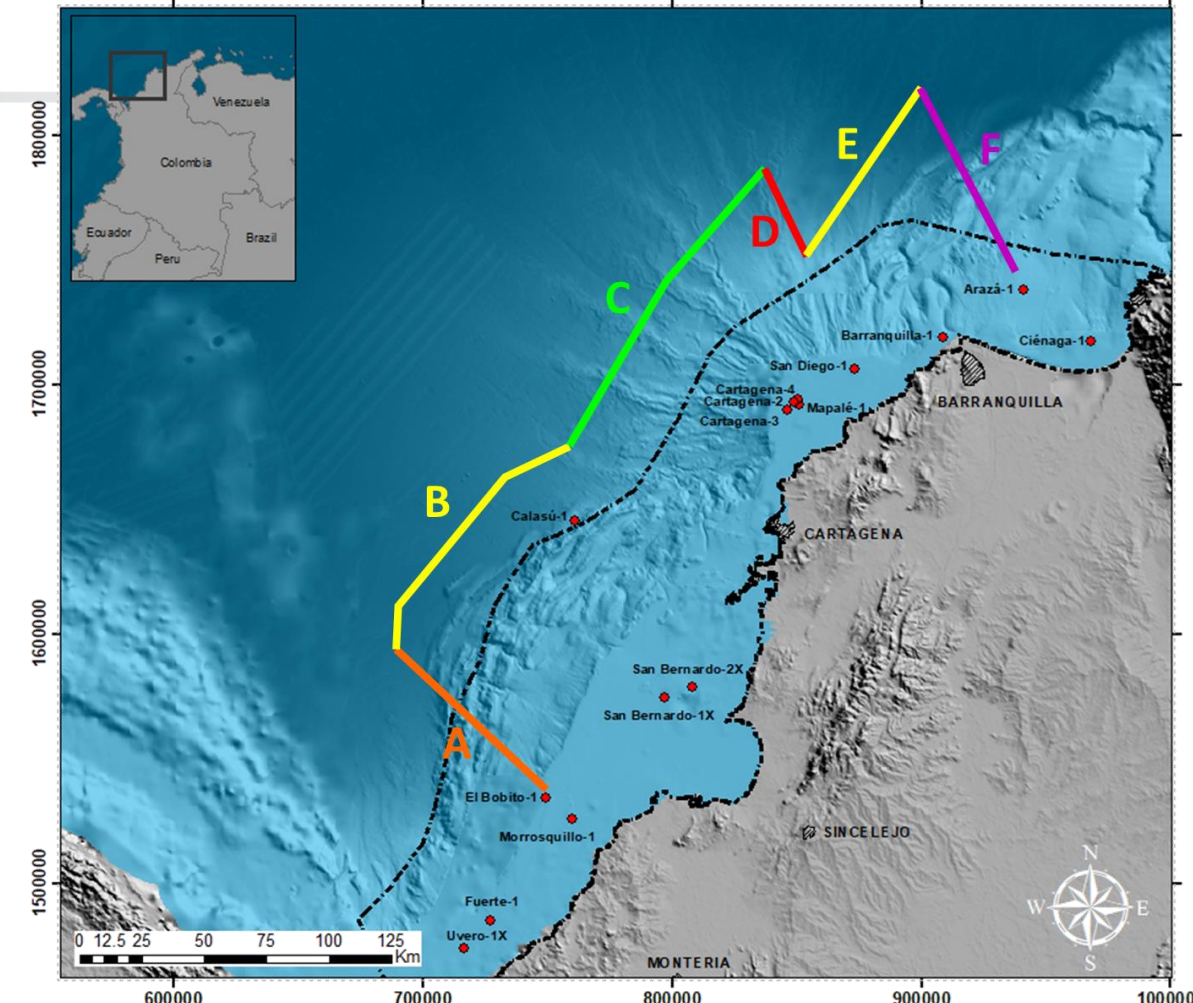
GEOMETRY, EXPRESSION AND MAIN STRUCTURAL BEHAVIOR ALONG THE BASIN



Regional cross section indicating the seismic character of the Sinu Offshore basin reflectors.

GEOLOGICAL PROVINCES IN THE SINU OFFSHORE BASIN

GEOMETRY, EXPRESSION AND MAIN STRUCTURAL BEHAVIOR ALONG THE BASIN

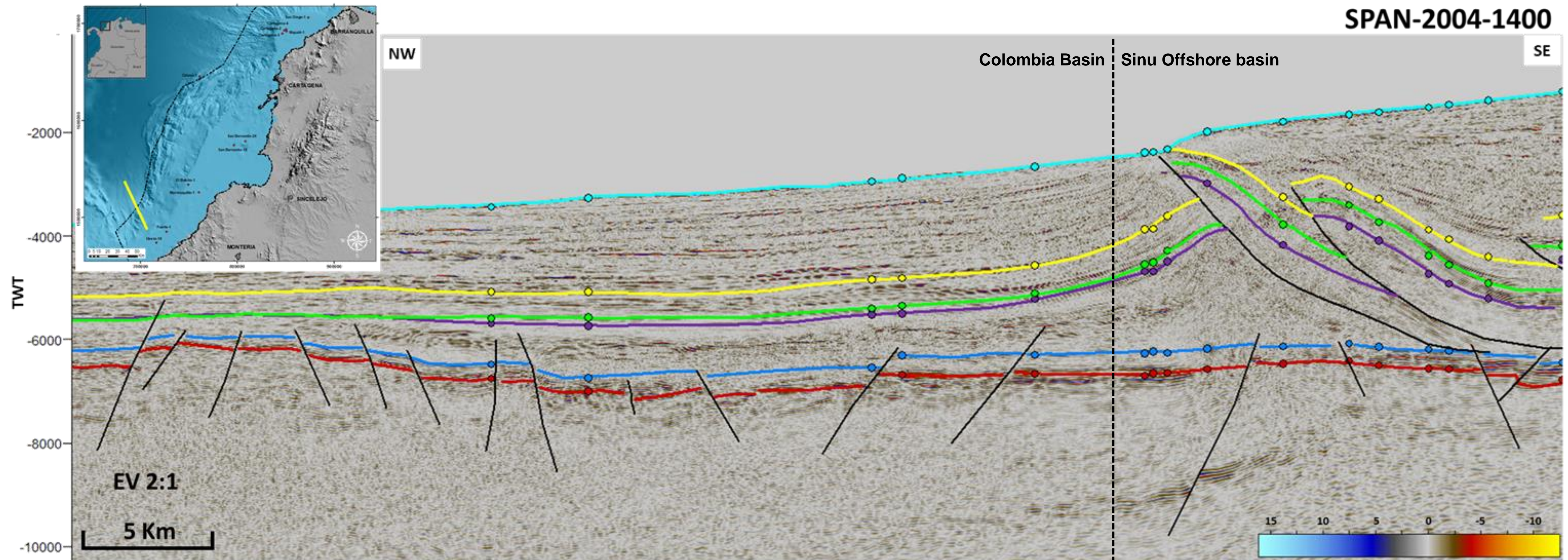


Basamento — Oligoceno Tardío — Mioceno Tardío — Plioceno Temprano-1 — Plioceno Temprano-2 — Base MTC — Fondo Marino

Regional cross section showing the main geological features of the Sinu Offshore basin.

GEOLOGICAL PROVINCES IN THE SINU OFFSHORE BASIN

GEOLOGICAL PROVINCES: ABYSSAL PLAIN

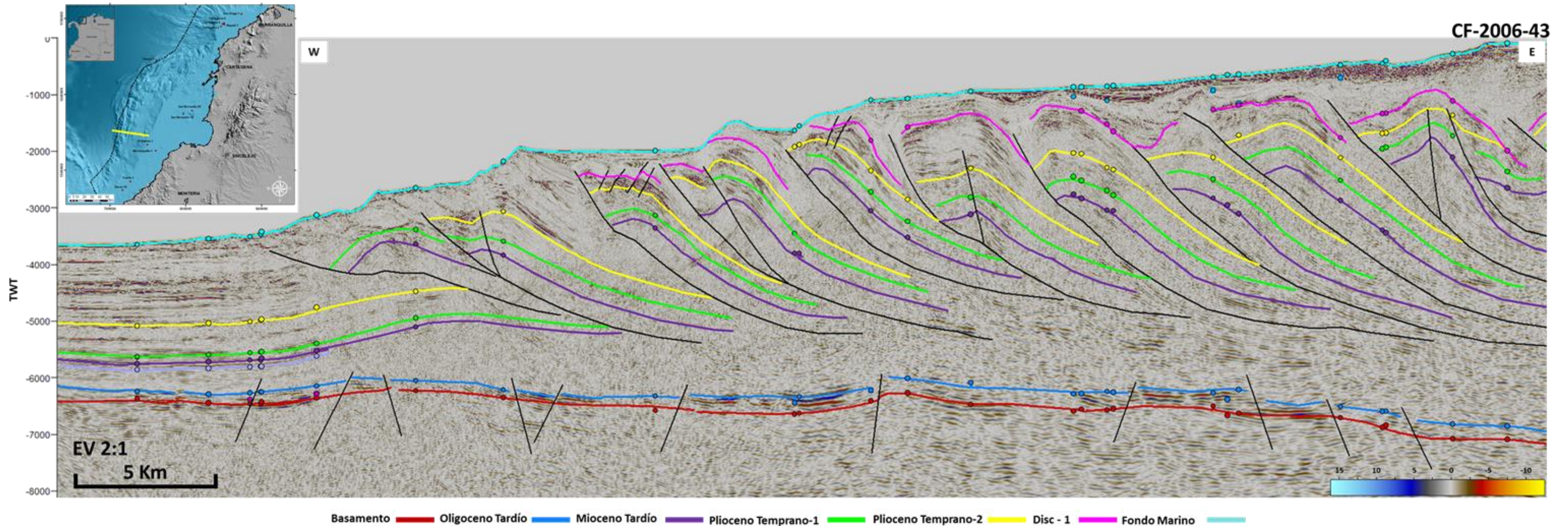


Basamento ■ Oligoceno Tardío ■ Mioceno Tardío ■ Plioceno Temprano-1 ■ Plioceno Temprano-2 ■ Fondo Marino ■

SPAN-2004-1400 line showing the structural configuration of the abyssal plain province where normal faults identified on the Basement.

GEOLOGICAL PROVINCES IN THE SINU OFFSHORE BASIN

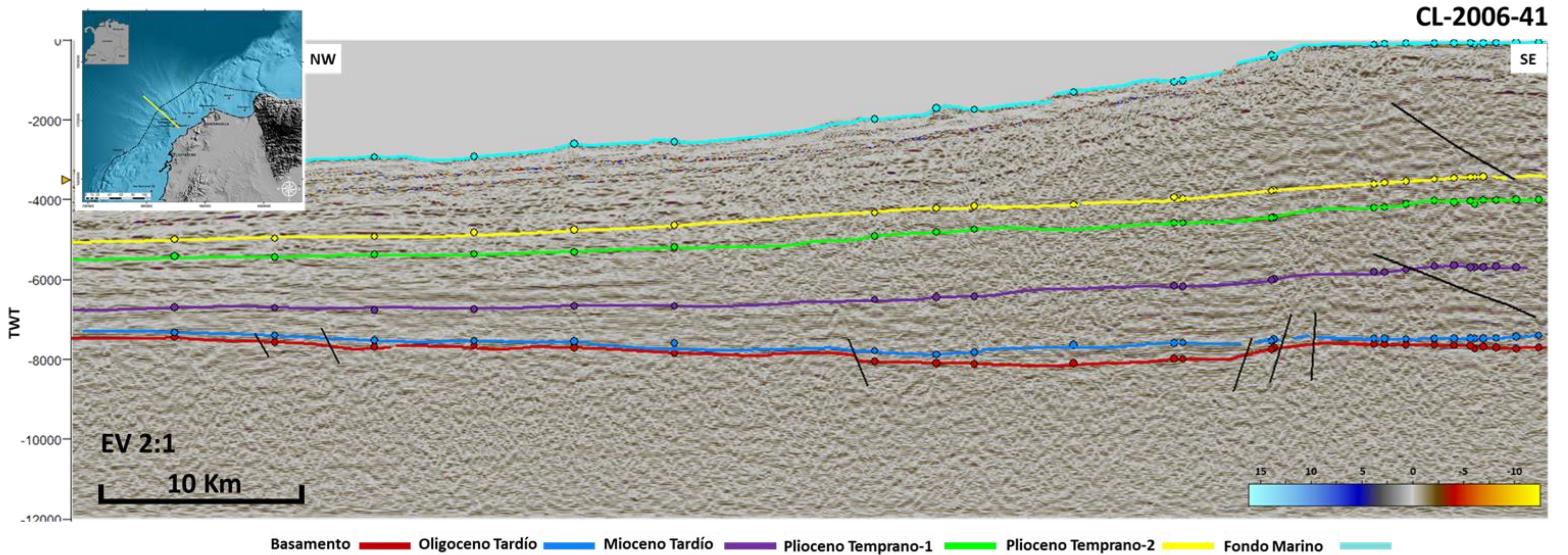
GEOLOGICAL PROVINCES: SINU OFFSHORE THRUST BELT (SOTB)



Line CF-2006-43. A series of folds generated by stacked faults is observed, interpreted as a succession of imbricated faults with deformation towards the front (offshore). In this line, it is possible to identify that the level of detachment of the deformation occurs above the Oligocene sequence.

GEOLOGICAL PROVINCES IN THE SINU OFFSHORE BASIN

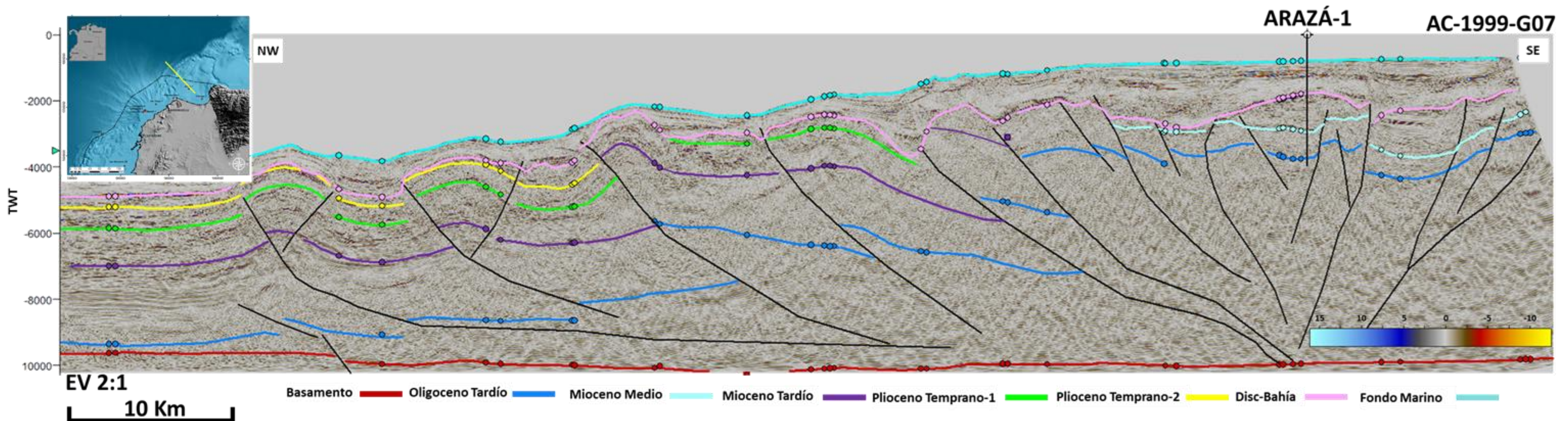
GEOLOGICAL PROVINCES: MAGDALENA DELTA



Line CL-2006-41 where is possible to observe a grater domain of the sediment contribution of the Magdalena Delta, as well as little or no deformation in this province.

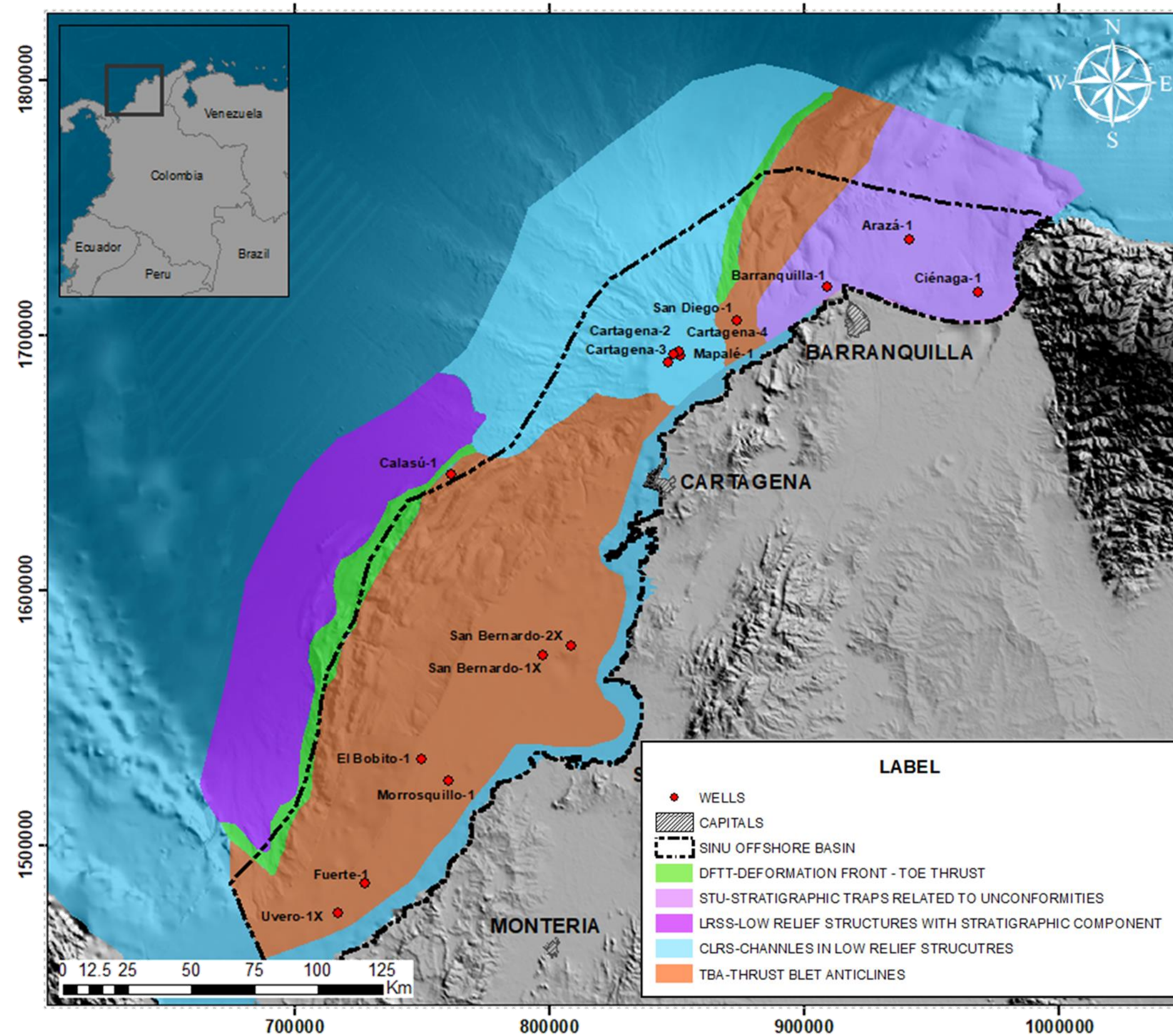
GEOLOGICAL PROVINCES IN THE SINU OFFSHORE BASIN

GEOLOGICAL PROVINCES: BAHIA AREA



Line AC-1999-G07 showing the two structural styles present in the Bahia sector. To the NW the deformed belt (compressive) and to the SW flower structures (transpressive).

AREAS OF EXPLORATORY INTEREST



DFTT – Deformation Front – Toe Thrust

LRSS – Low Relief Structures with Stratigraphic component

TBA – Thrust Belt Anticlines

ISB – Intraslope Basins

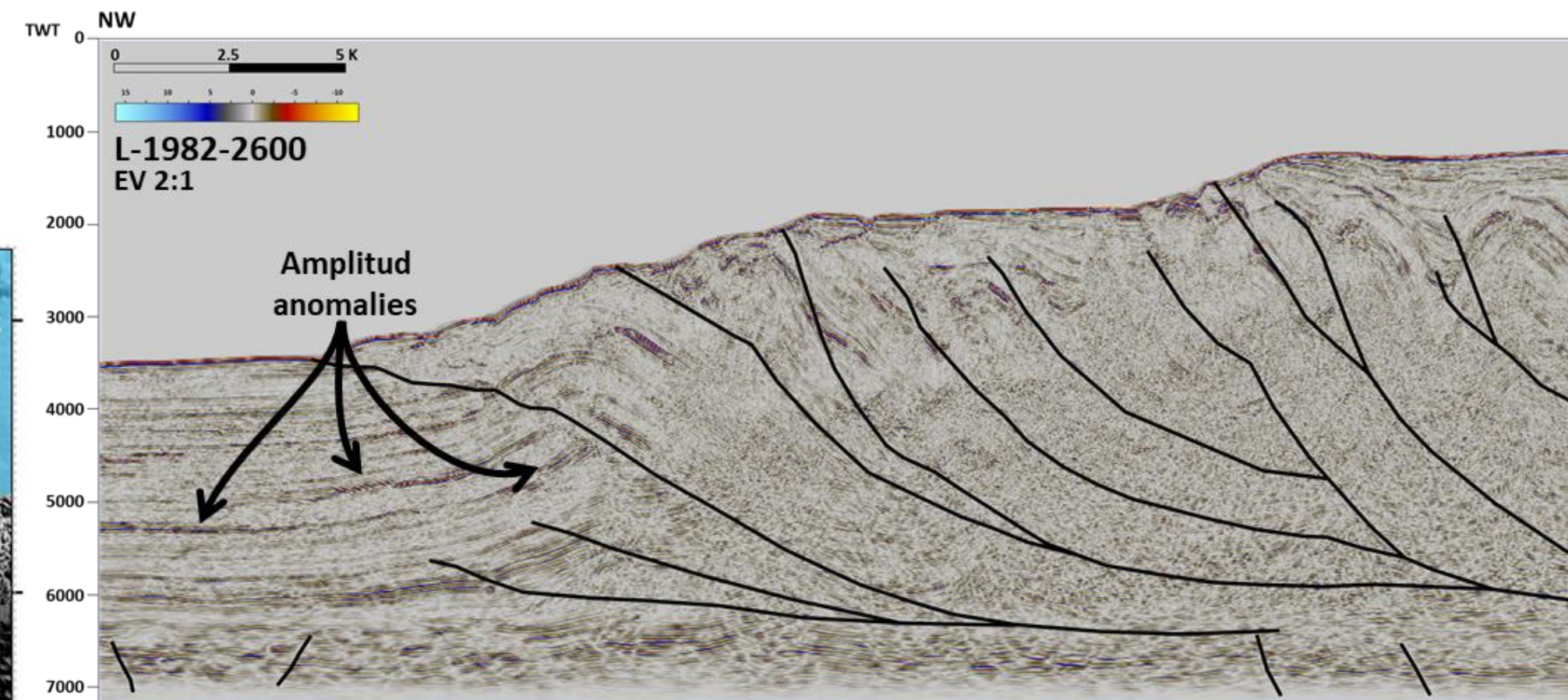
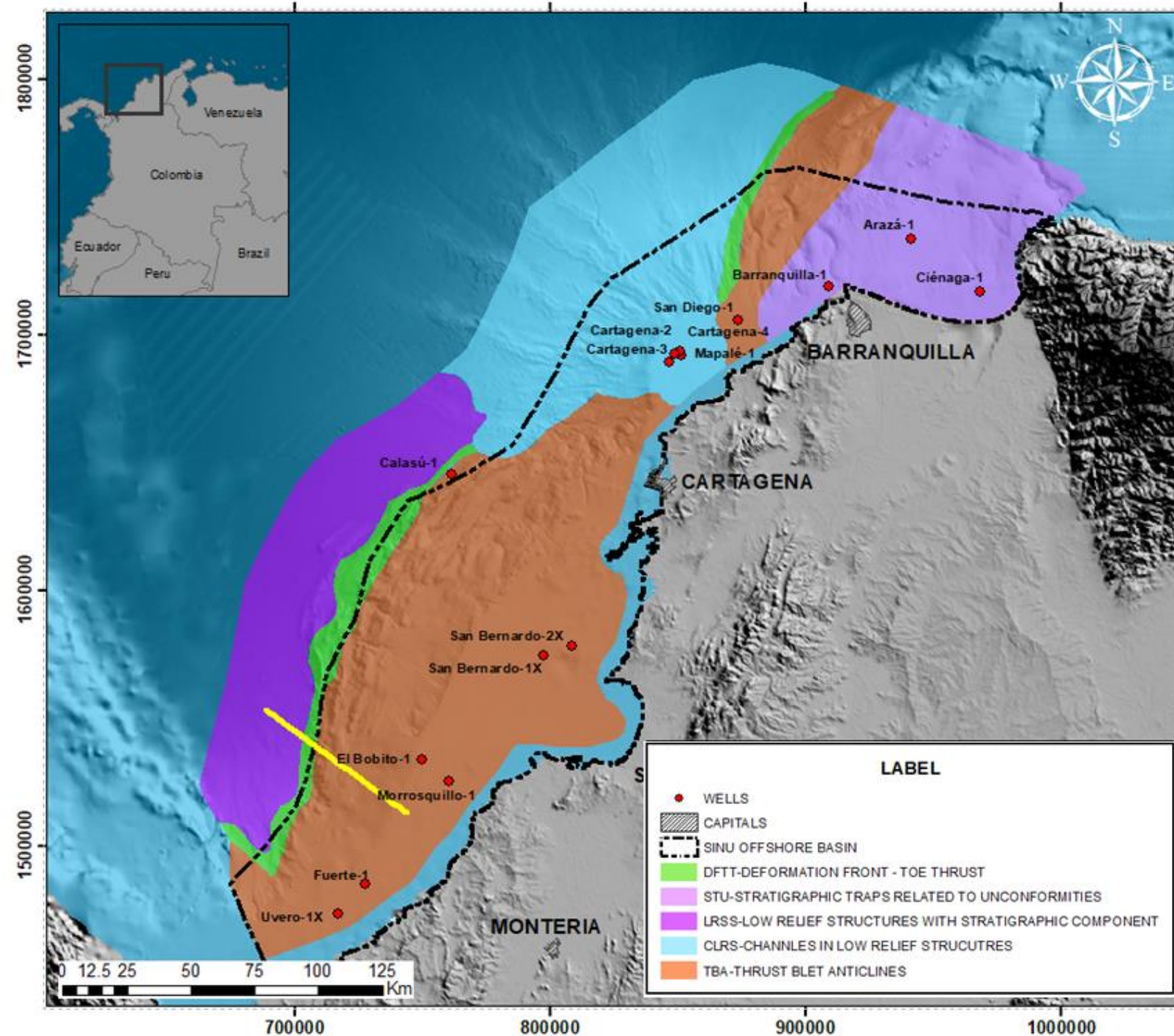
SMT – Shale Mobile related Traps

CLRS – Channels in Low Relief Structures

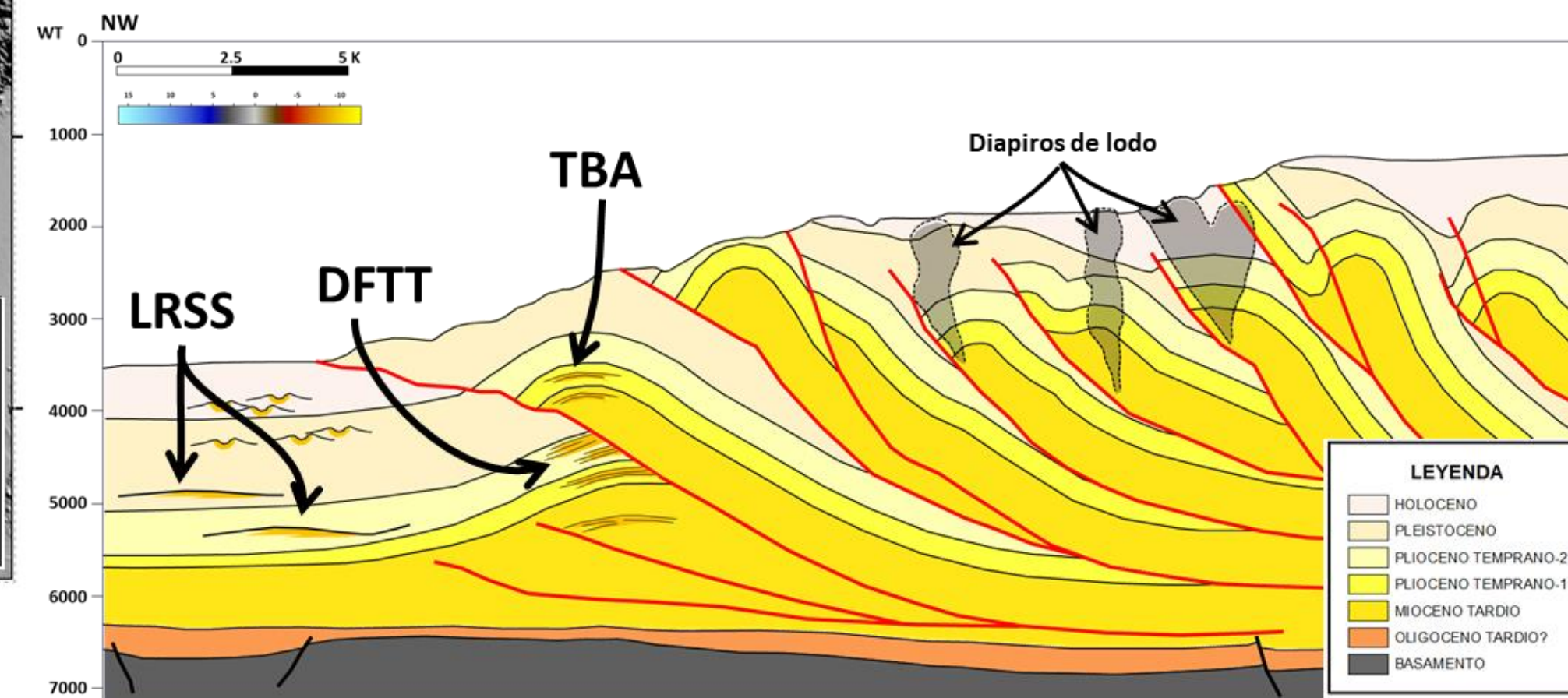
STU – Stratigraphic Traps related to Unconformities

AREAS OF EXPLORATORY INTEREST

PLAY: DEFORMATION FRONT – TOE THRUST - DFTT



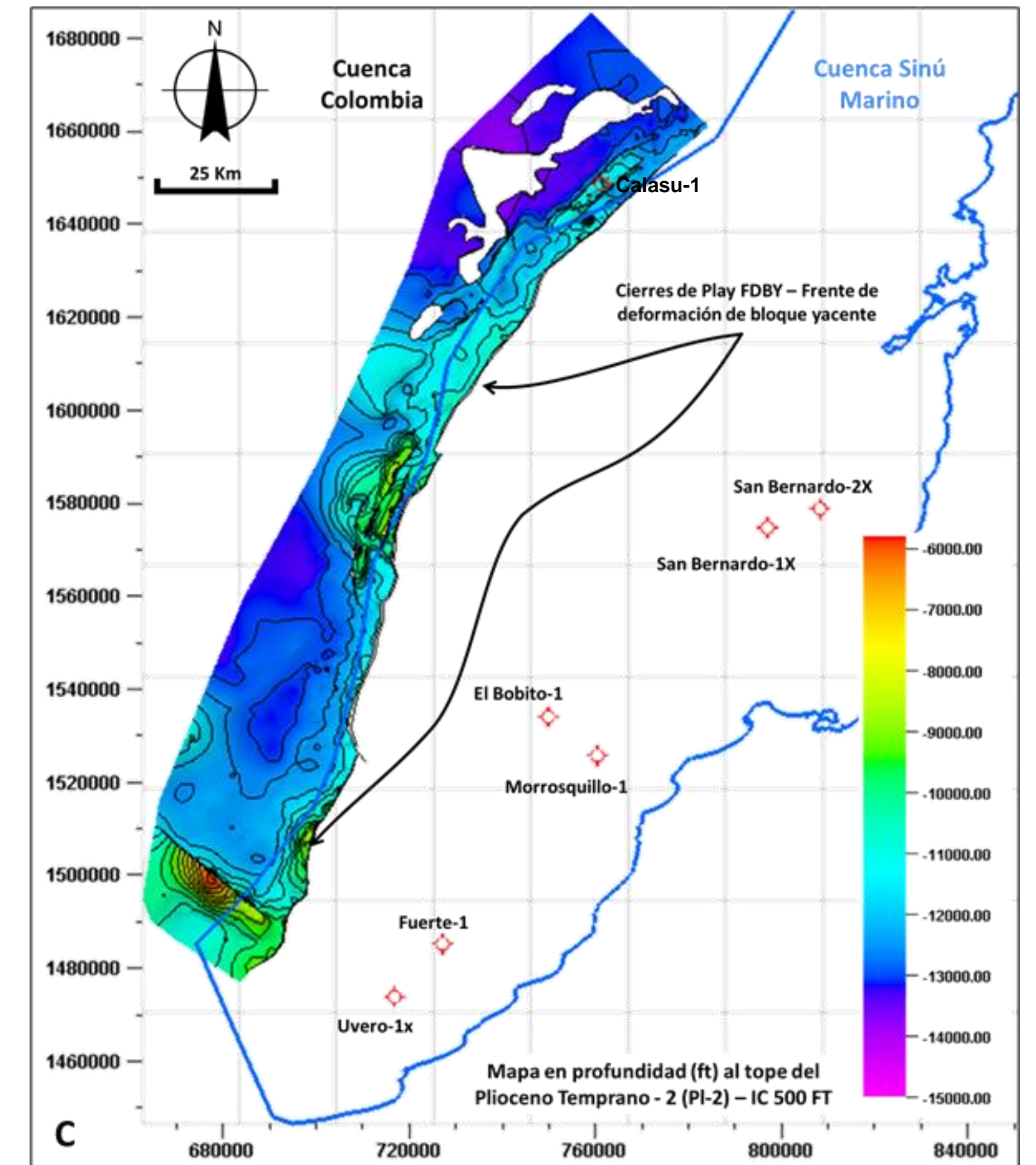
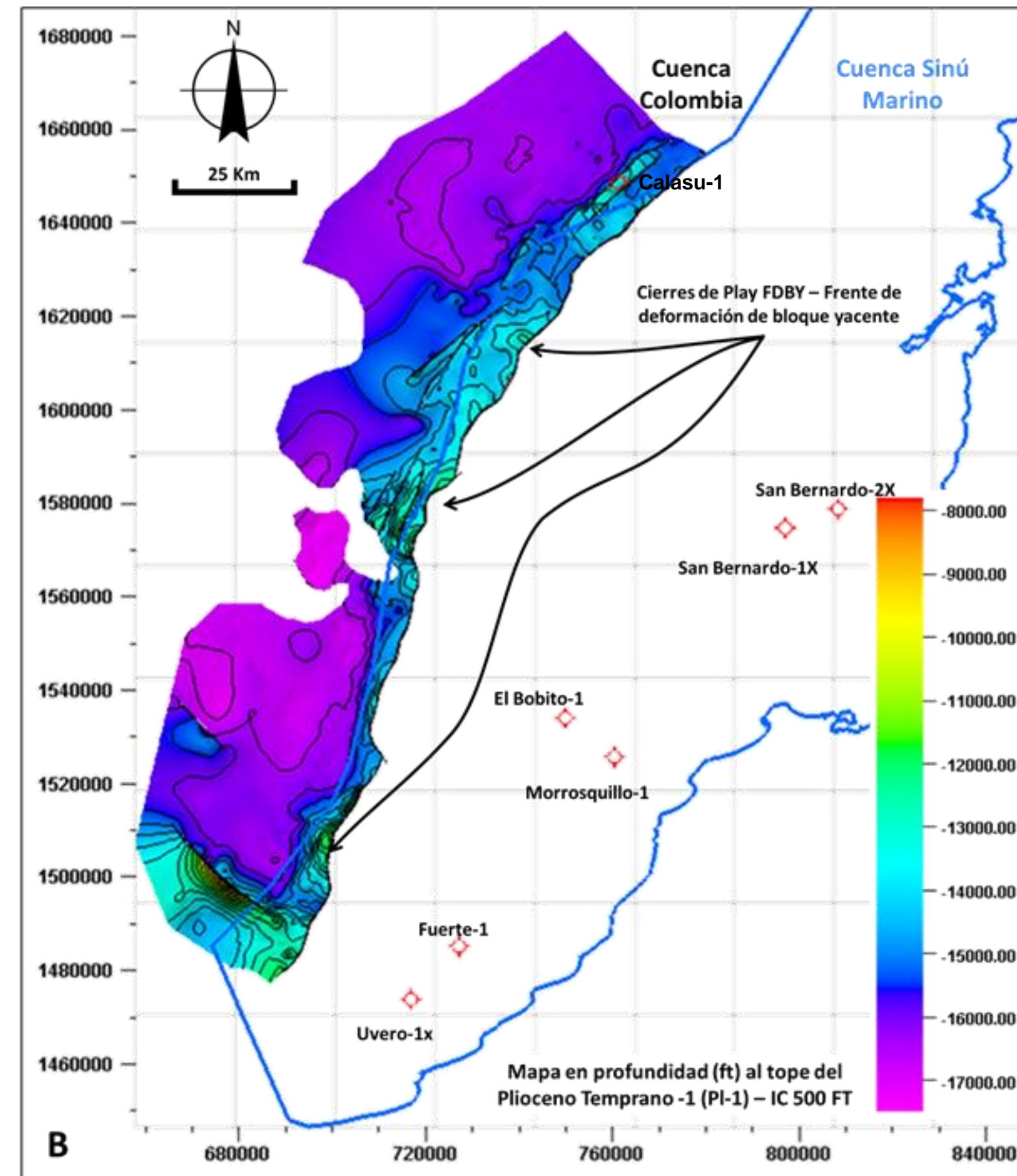
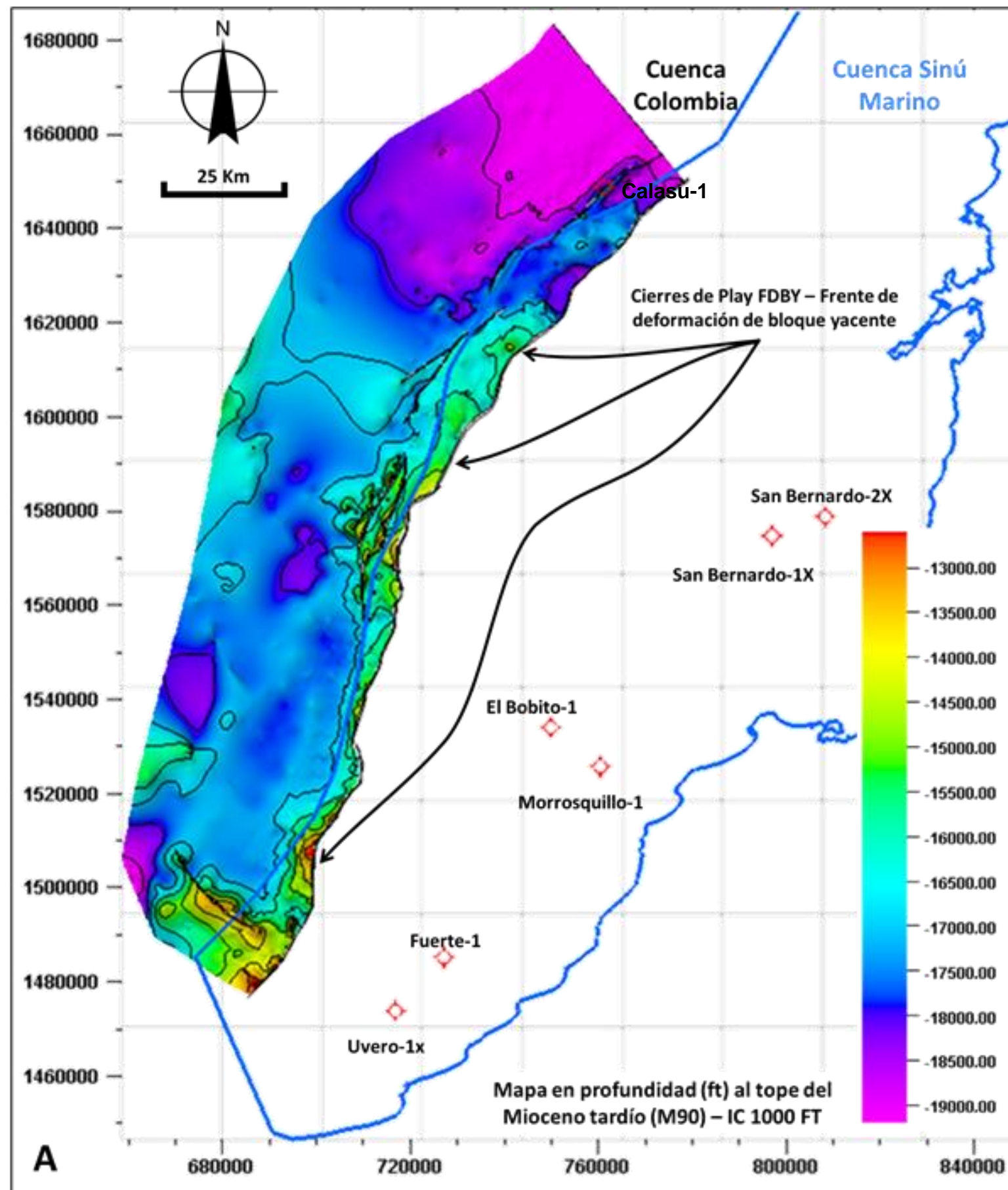
- ✓ Located at the front of the SOTB –Toe Thrust
 - ✓ 3 way closure
 - ✓ Closures with large dimensions
 - ✓ Numerous of anomalies associates
 - ✓ Higher probability for thermogenic charge
- The closures are between the Colombia basin and the Sinu Offshore basin



Sketch of the some plays in the Sinu Offshore basin. Play DFTT – Deformation front toe thrust. Play TBA Thrust Belt Anticlines. Play LRSS- Low relief structures with stratigraphic component.

AREAS OF EXPLORATORY INTEREST

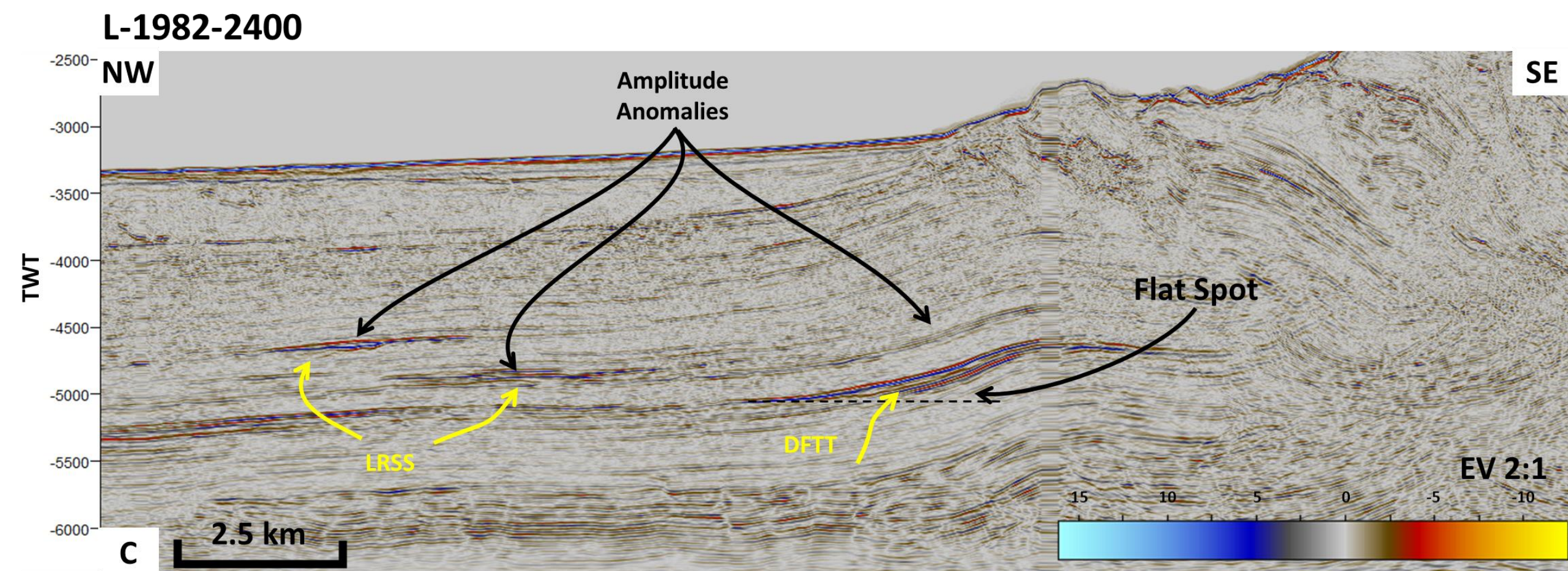
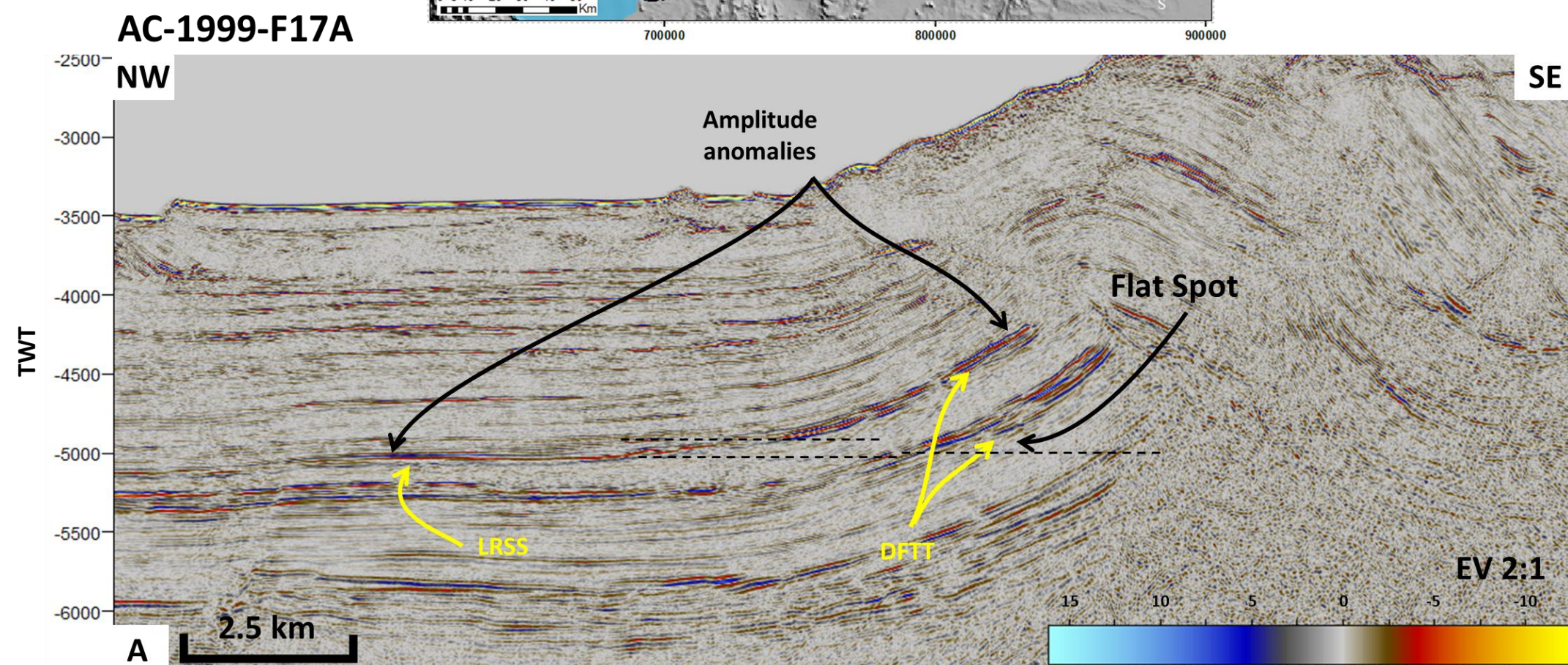
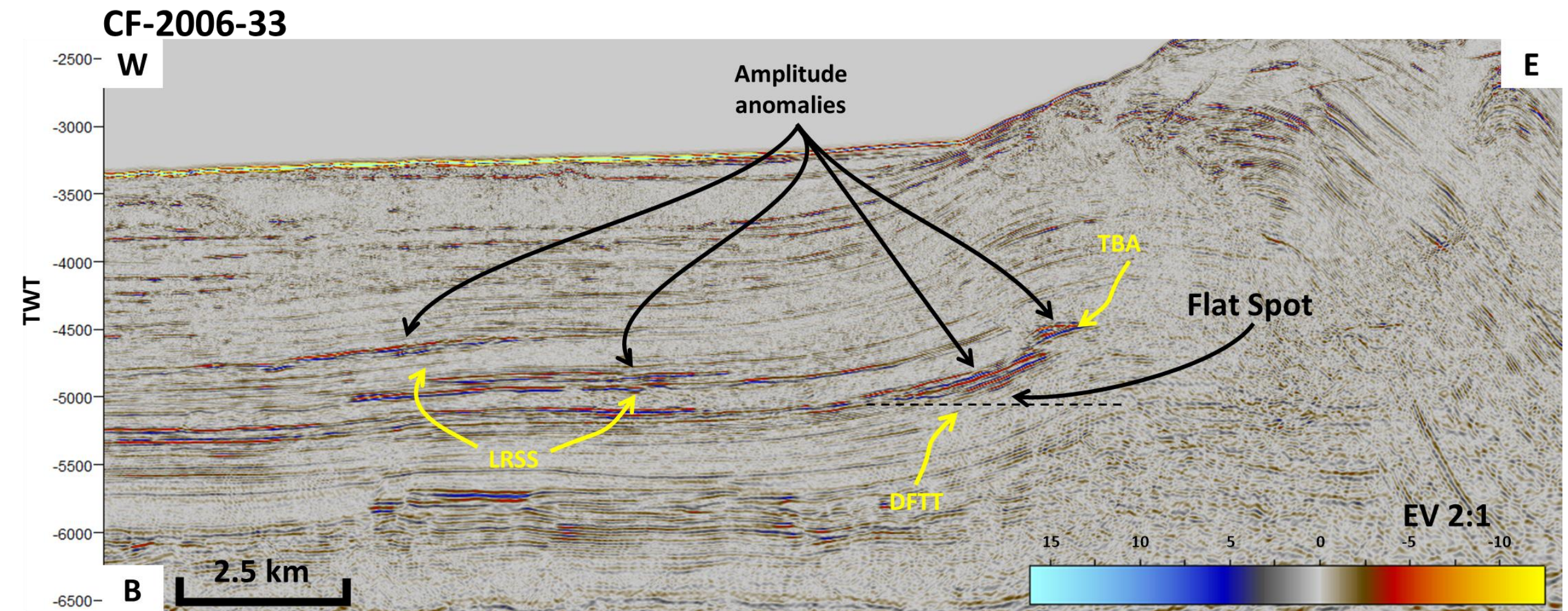
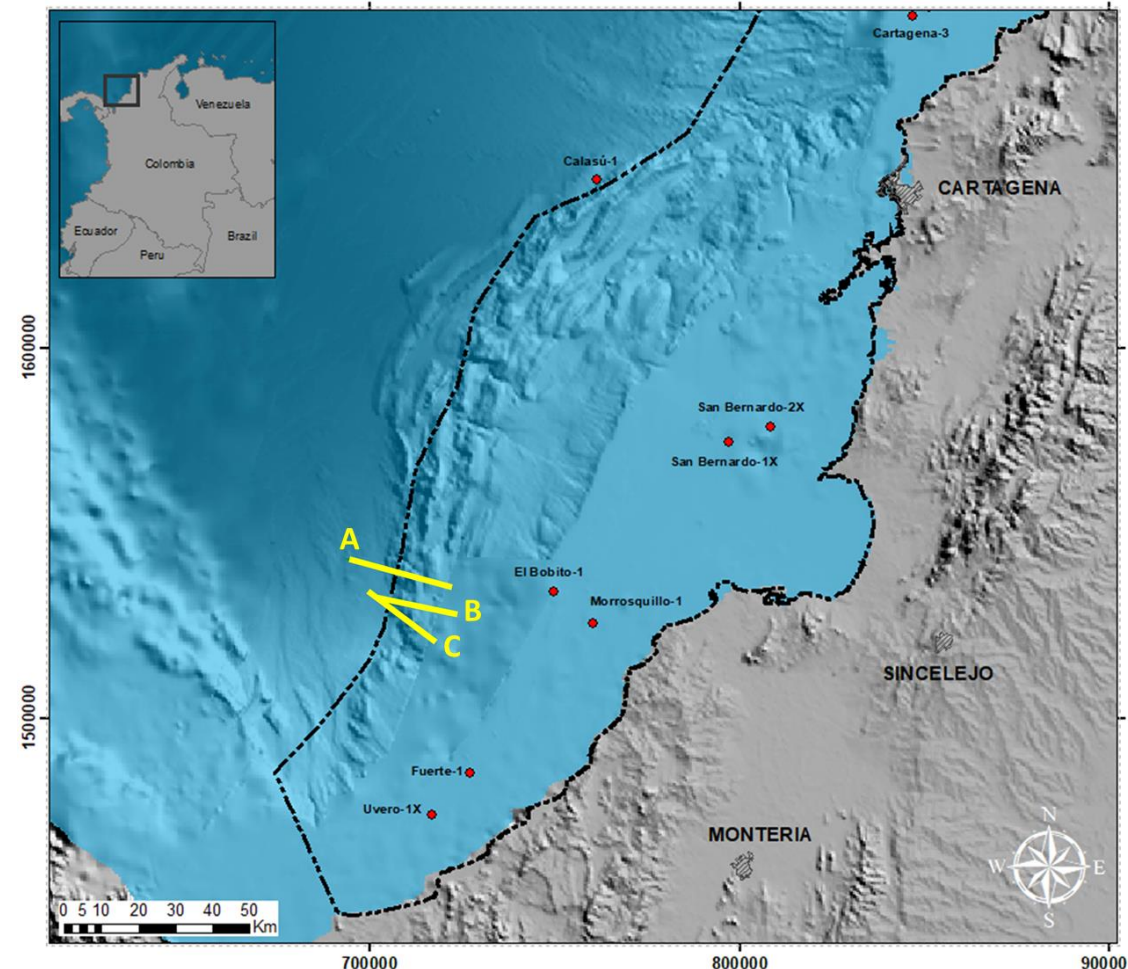
PLAY: DEFORMATION FRONT – TOE THRUST - DFTT



Structural maps in depth at the Upper Miocene, Pliocene-1, and Pliocene-2 tops of the foot wall of SOTB showing closures as potential traps for DFTT play.

AREAS OF EXPLORATORY INTEREST

PLAY: DEFORMATION FRONT – TOE THRUST - DFTT

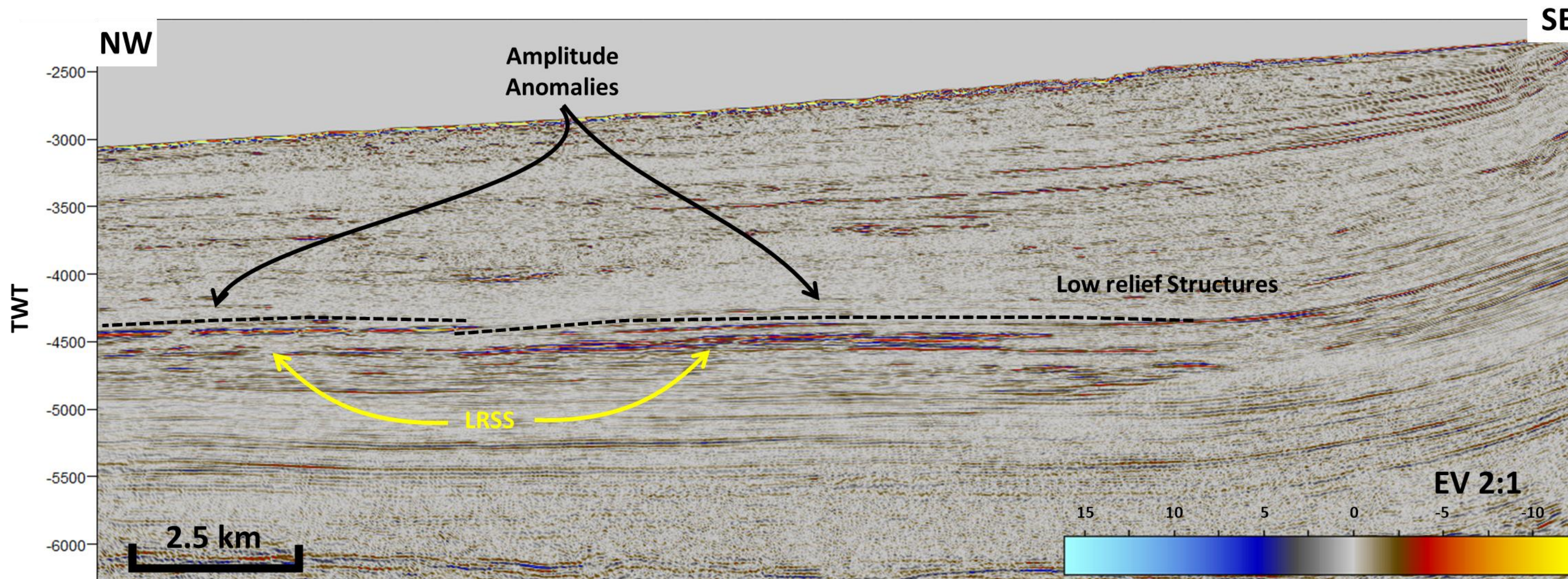


Examples of amplitude anomalies observed in the DFTT, LRSS, TBA plays that may be related not only to the presence of a reservoir but also the presence of fluids

AREAS OF EXPLORATORY INTEREST

PLAY: LOW RELIEF STRUCTURES WITH STRATIGRAPHIC COMPONENT- LRSS

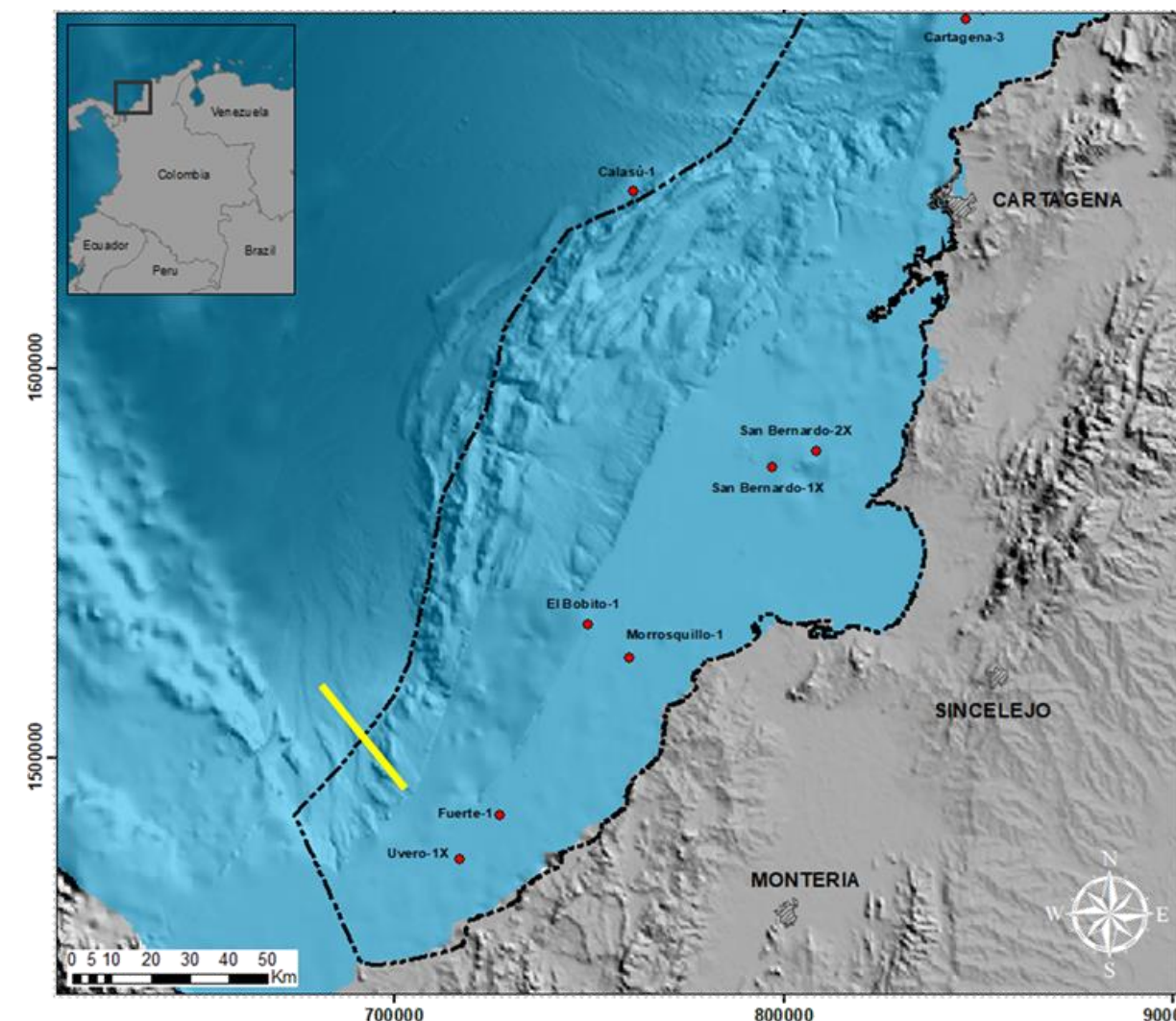
AC-1999-F21



Seismic expression of the LRSS play (low relief structure with stratigraphic component) in which amplitude anomalies at different levels and a wide low relief folding can be observed.

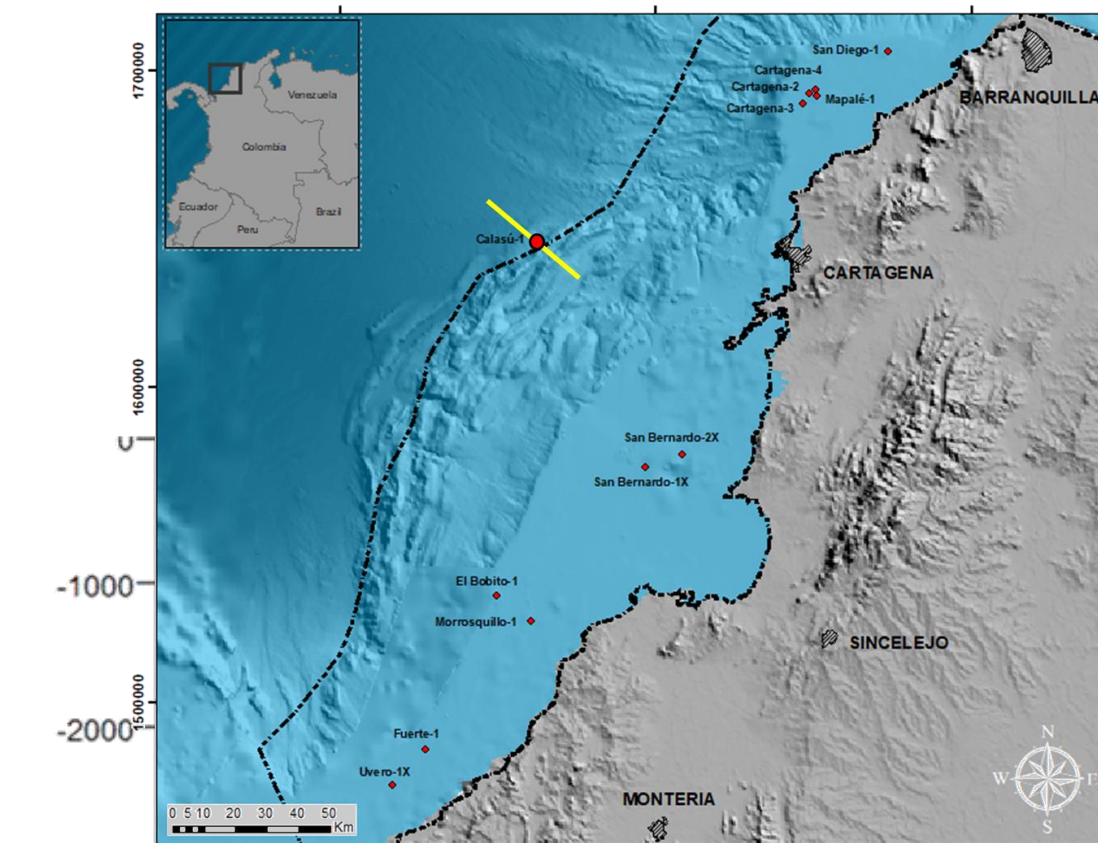
- ✓ Located in the abyssal plain
- ✓ Four way closure
- ✓ Closures with large dimensions
- ✓ Amplitude anomalies associates
- ✓ They can have multiple contacts

○ The closures are in the Colombia basin



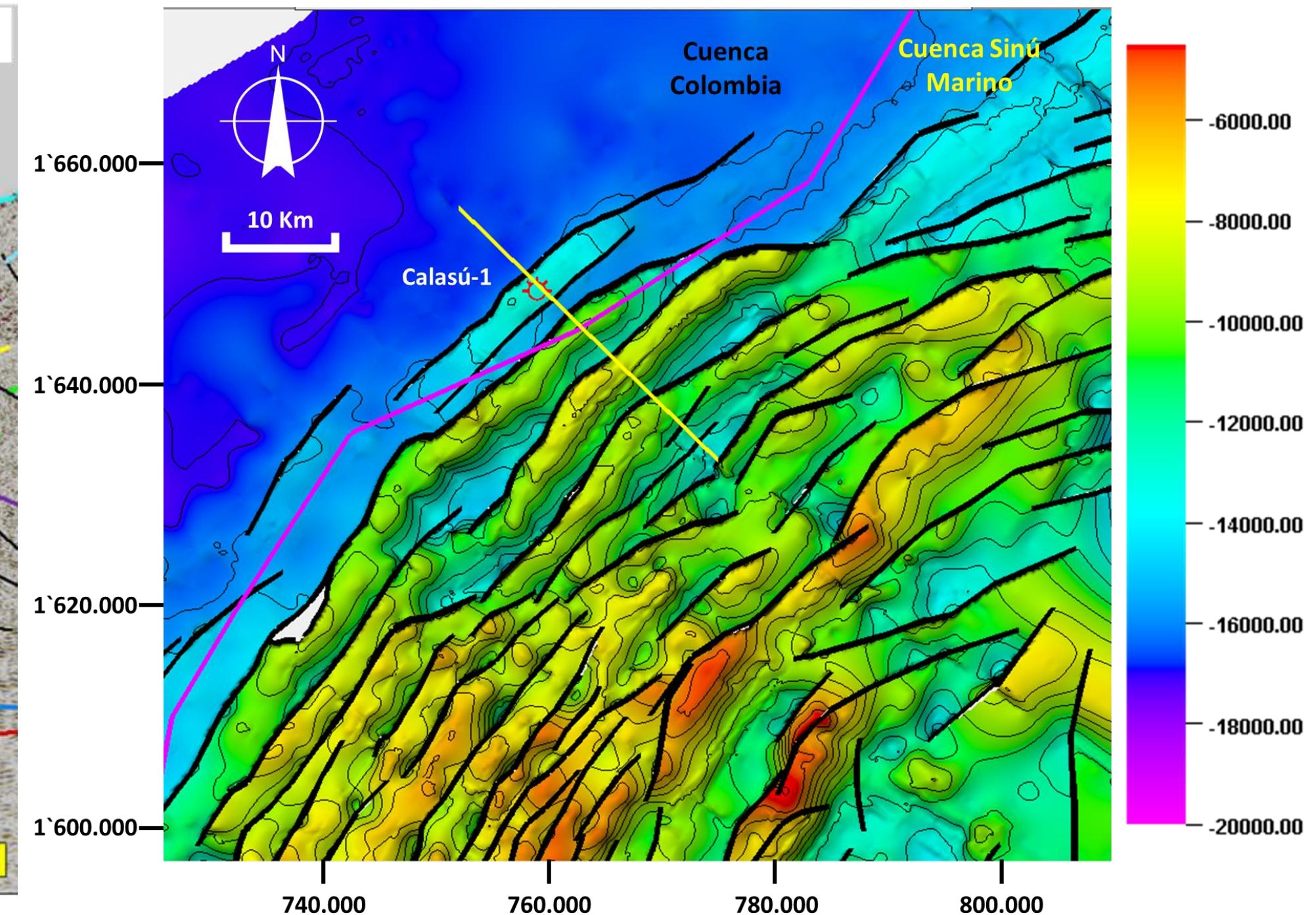
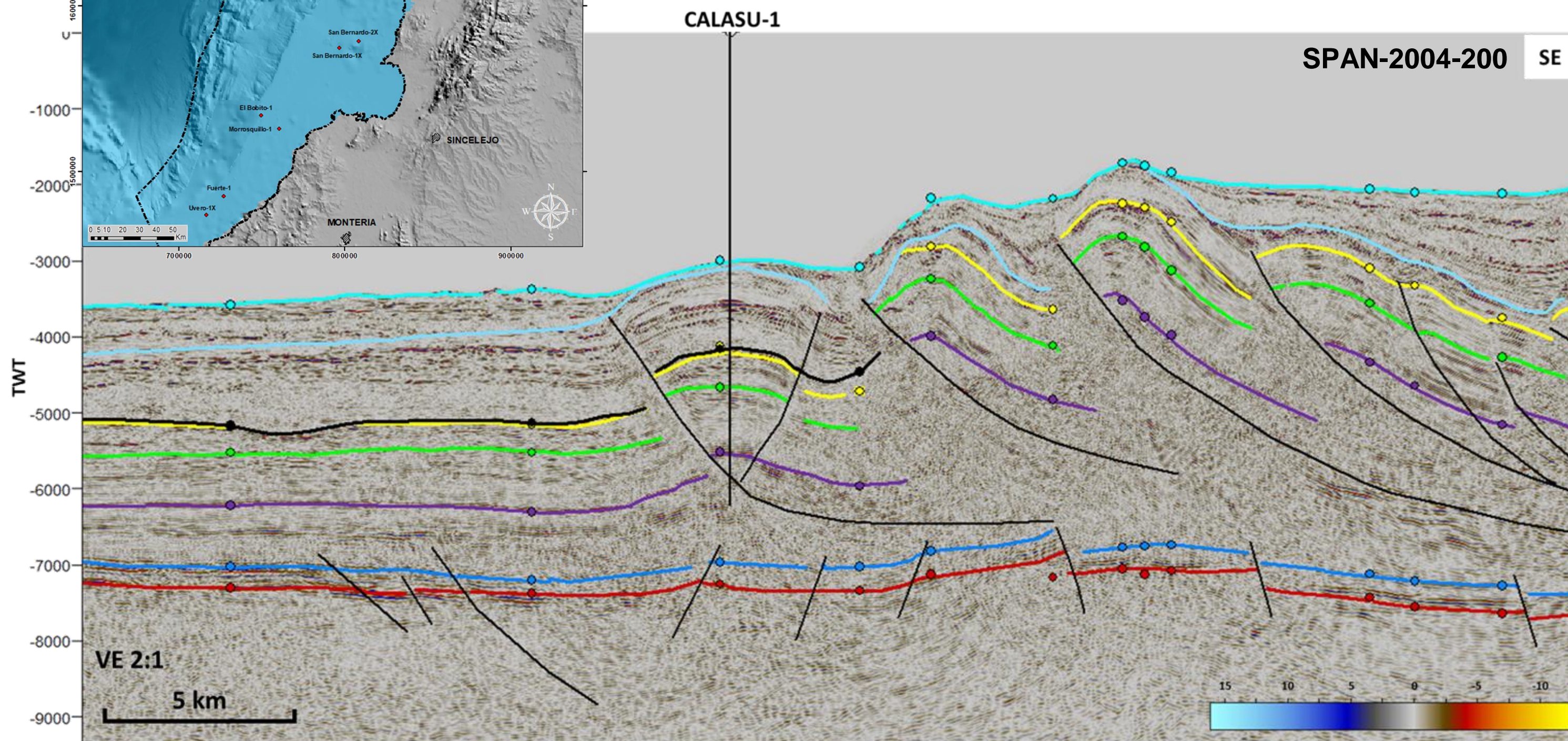
AREAS OF EXPLORATORY INTEREST

PLAY: THRUST BELT ANTICLINES – TBA



- ✓ Greater distribution in the basin
- ✓ Four way closures, 3 way closures
- ✓ Some associated amplitude anomalies

- Increase in relief and decrease in closing area towards the rear of the SOTB
- Risk due to retention in structures of greater relief
- Closure size
- Thermogenic Charge
- Retention due to rupture of structures – shale diapirism

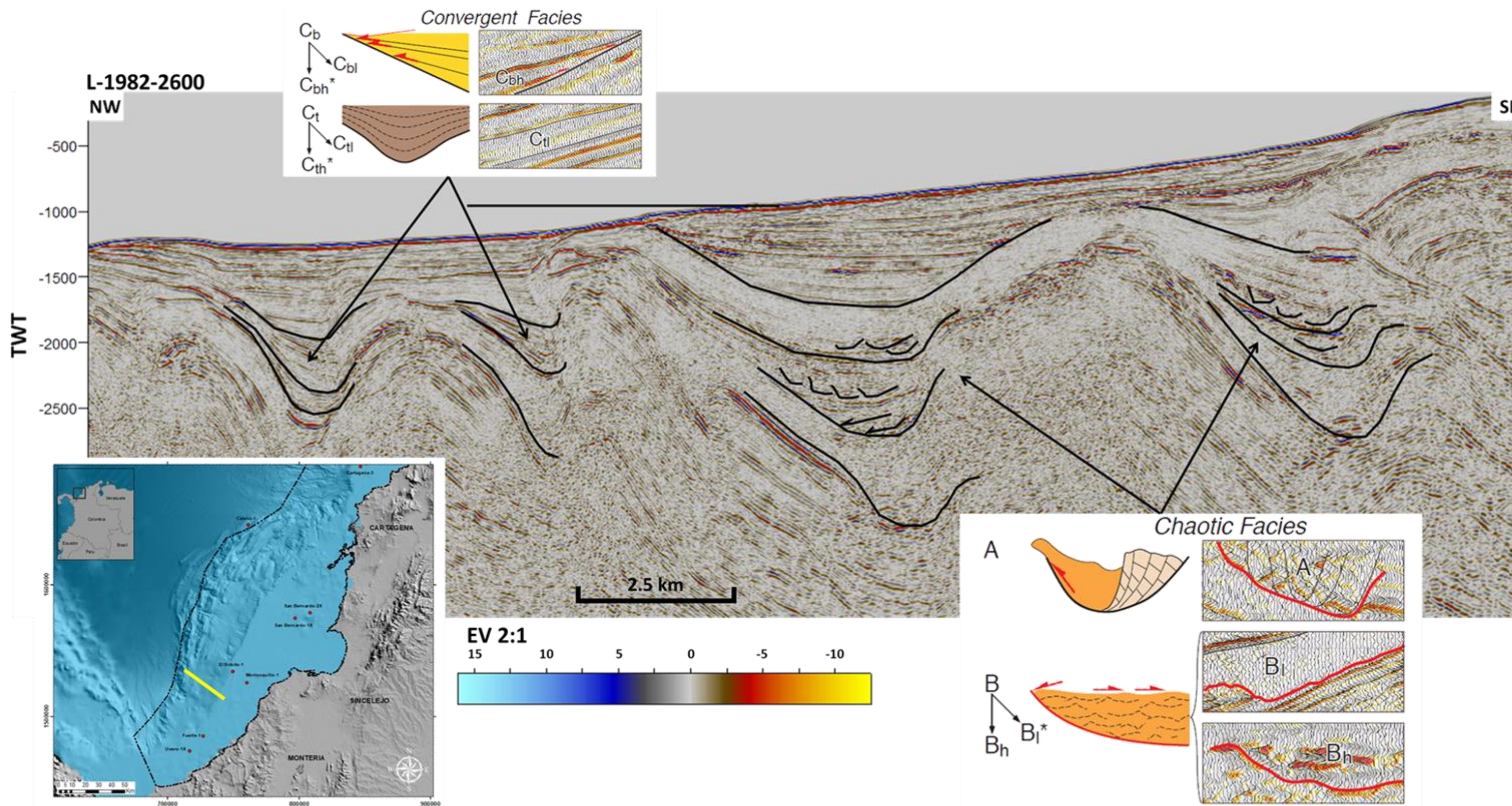


Basamento — Oligoceno Tardío? — Mioceno Tardío — Plioceno Temprano-1 — Plioceno Temprano-2 — Disc - 1 — Fondo Marino

Structural map in depth at the top of the Pliocene-1 showing the characteristic closures of the TBA play. Seismic section TWT of the SPAN-2004-2000 line show the geometry of the structures.

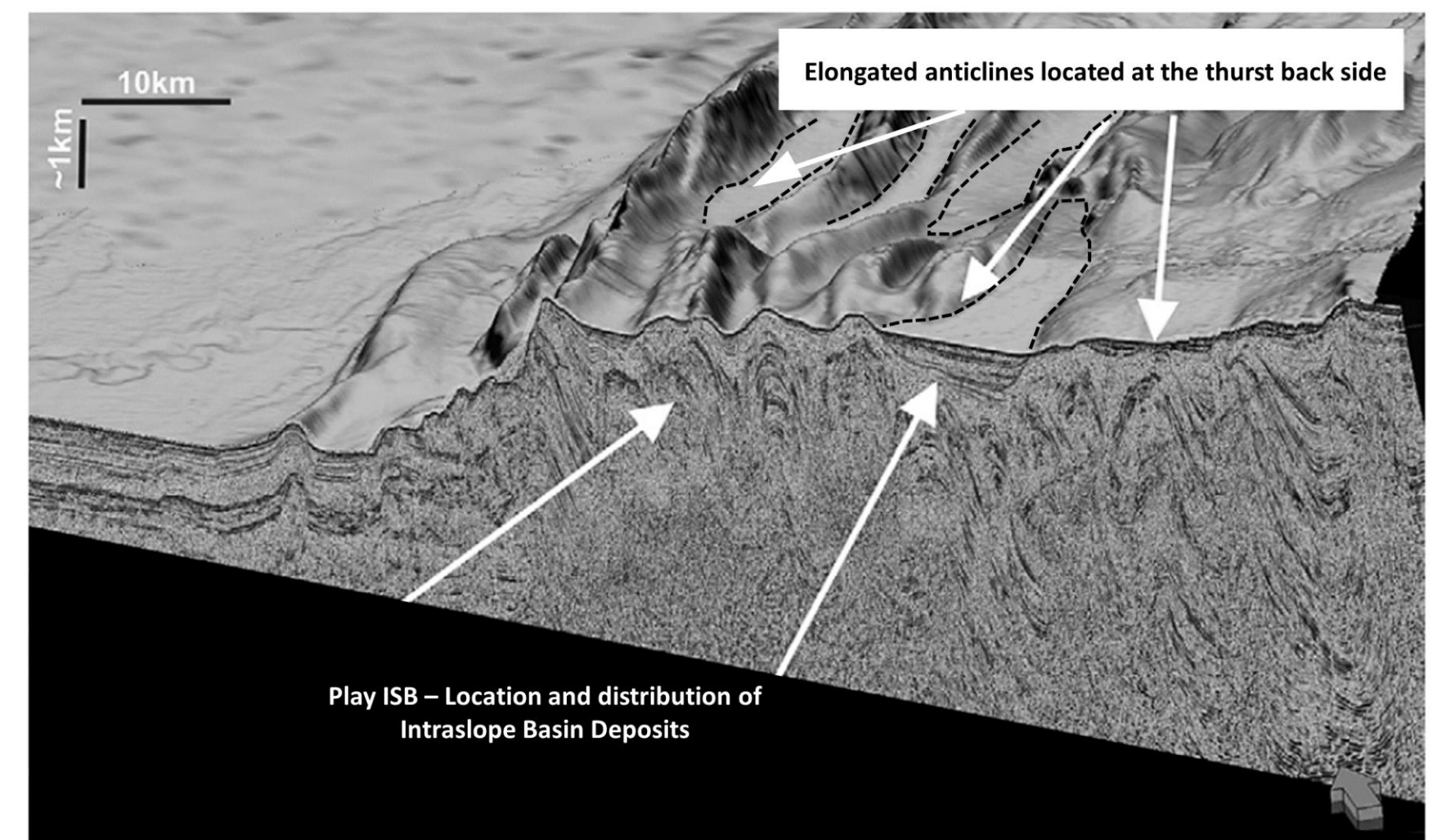
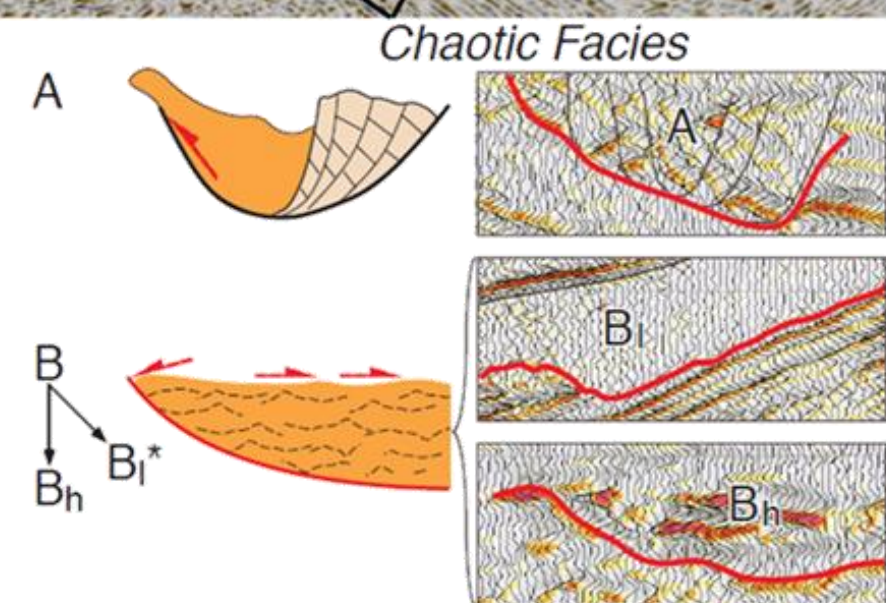
AREAS OF EXPLORATORY INTEREST

PLAY: INTRASLOPE BASINS - ISB



- ✓ Greater distribution in the basin
- ✓ Stratigraphic traps/Combine traps
- ✓ Amplitude anomalies associated
- ✓ Considerable sizes
- ✓ Biogenic preferential charge

- Stratigraphic trap
- Quality, distribution and continuity of possible reservoirs
- Anomalies associated to wedge effect?



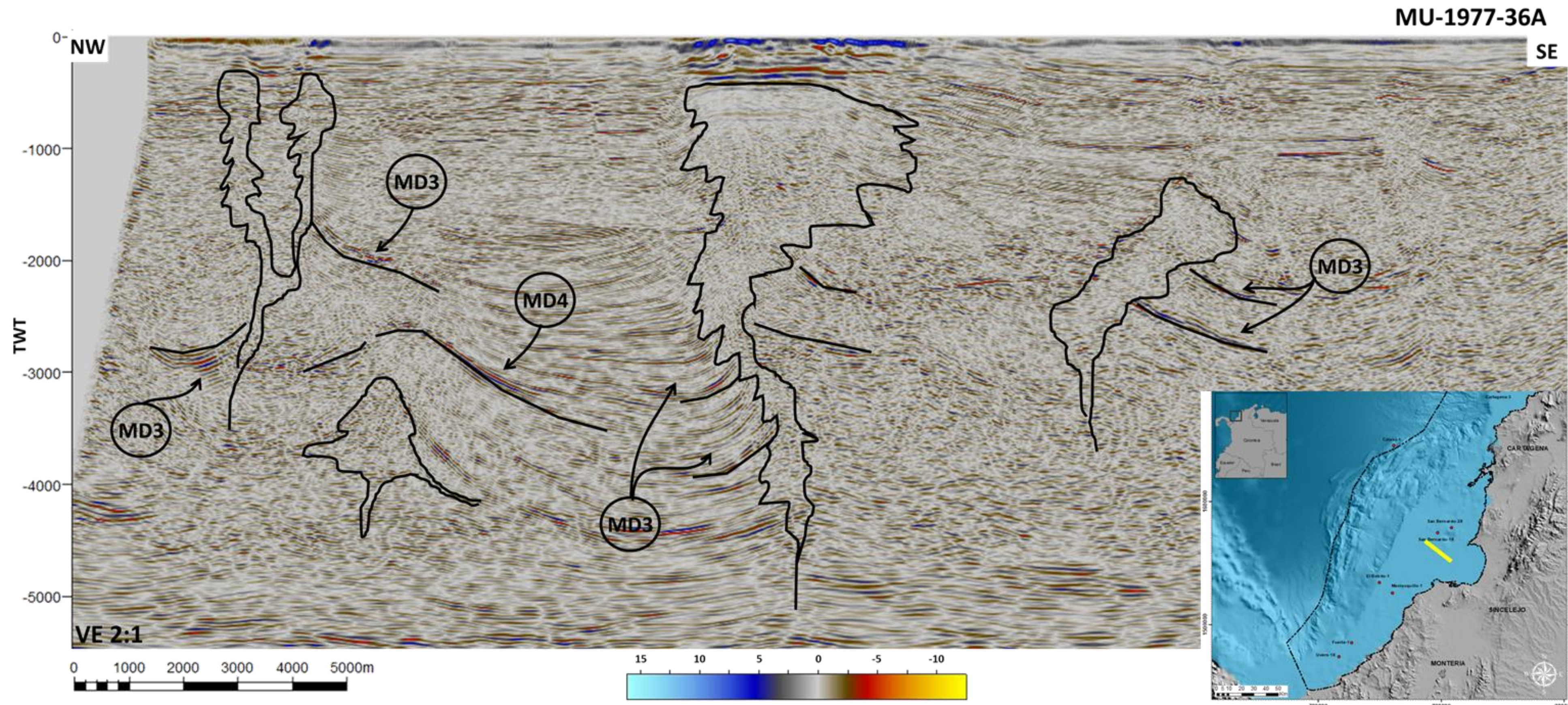
ISB play and its location within the deformed folds of the SOTB, seismic facies related to different types of deposits. Examples of facies taken from Prather (1998). B. location and distribution within the folded belt of the Sinu Offshore - SOTB. General morphology and expression in current bathymetry (Modified from Vinnels, 2010).

AREAS OF EXPLORATORY INTEREST

PLAY: SHALE MOBILE RELATED TRAPS - SMT

- ✓ Greater distribution in the basin
- ✓ Stratigraphic traps/Combine traps
- ✓ Amplitude anomalies associated
- ✓ Considerable sizes
- ✓ Shallow targets

- Stratigraphic trap
- Retention related shale mobility
- Age of trap
- Quality of seismic data

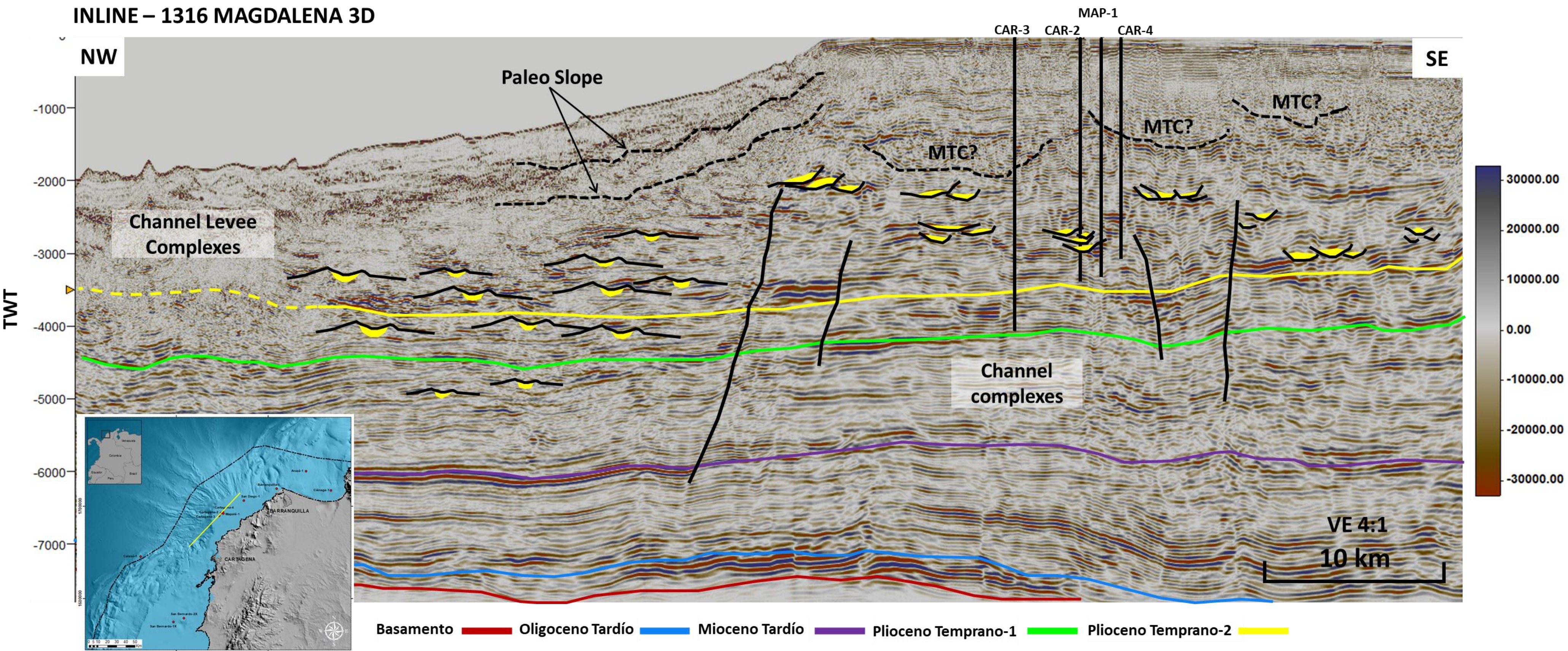


Seismic expression of the mud diapirs and their possible behavior as an SMT play trap.

AREAS OF EXPLORATORY INTEREST

PLAY: CHANNELS IN LOW RELIEF STRUCTURES – CLRS

INLINE – 1316 MAGDALENA 3D



- ✓ Combine traps (stratigraphic dominance)
- ✓ Amplitude anomalies associated
- ✓ Proven play – Reservoir and HC present in drilled wells
- ✓ Shallow water depth

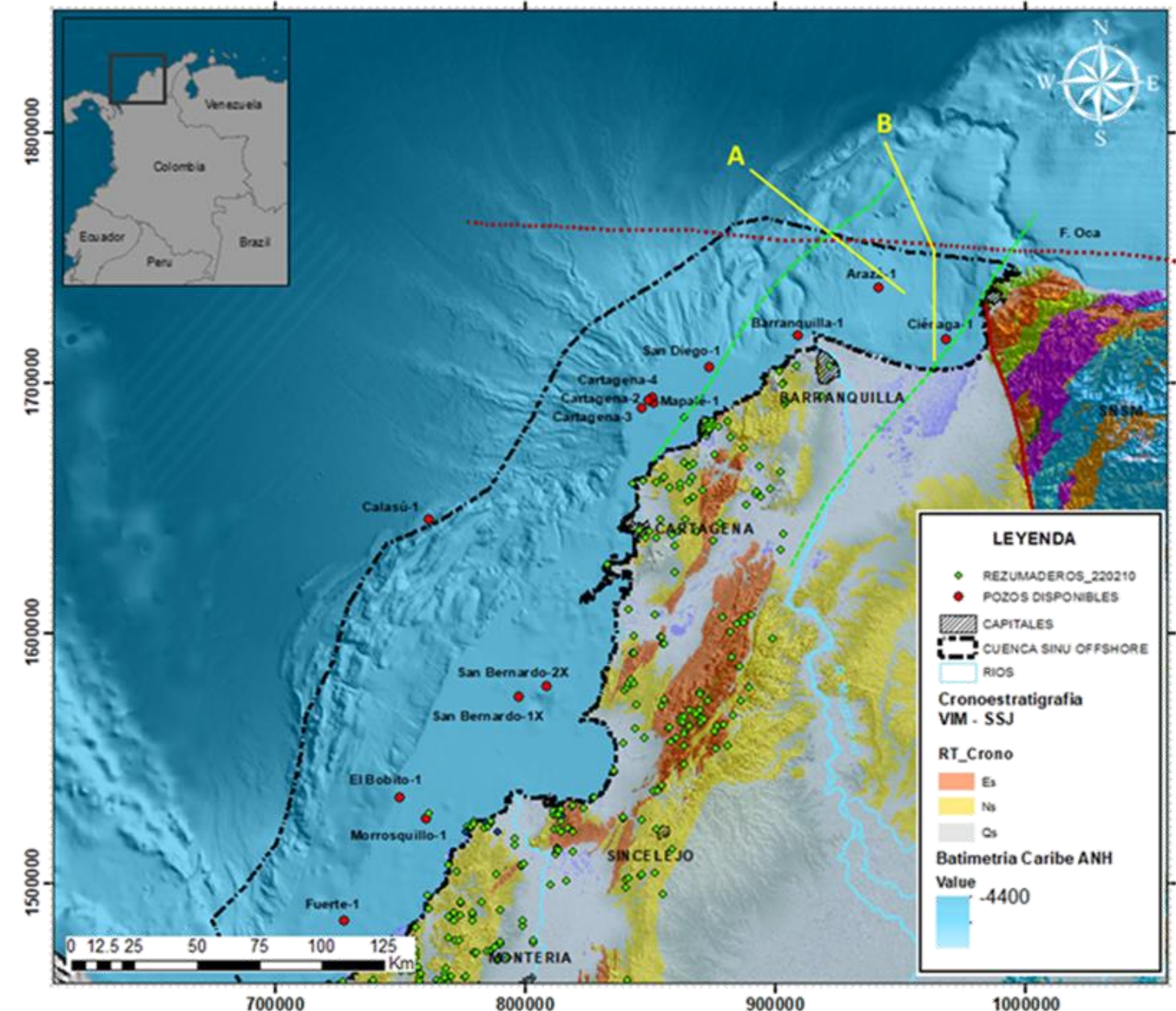
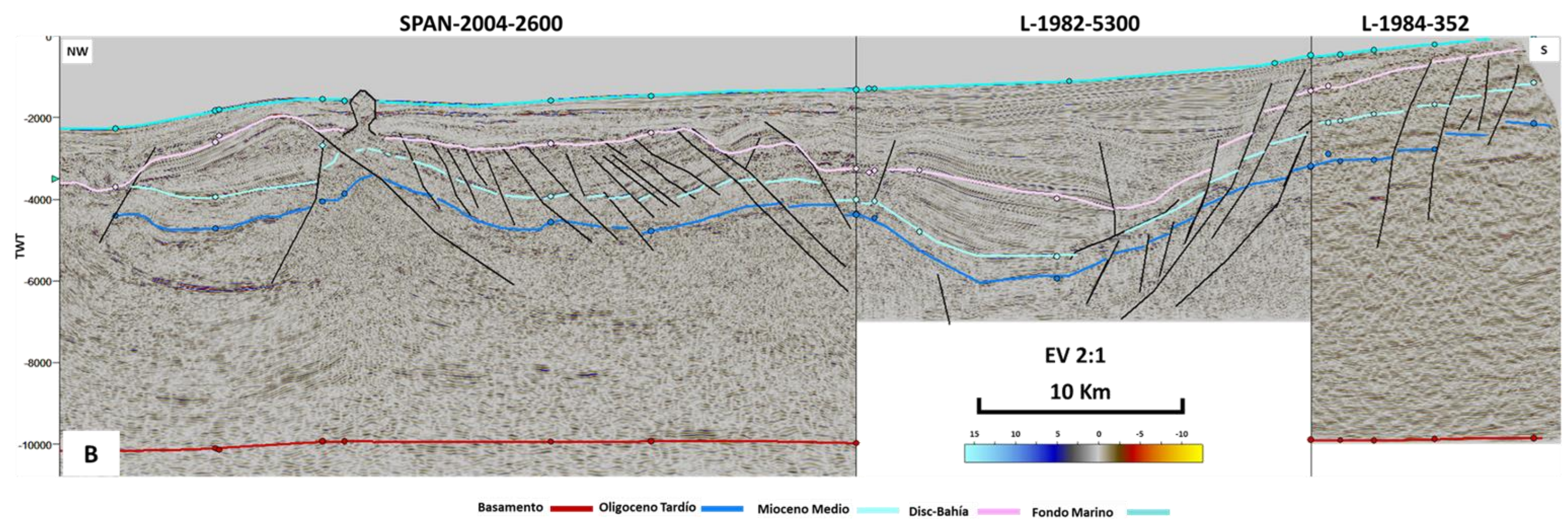
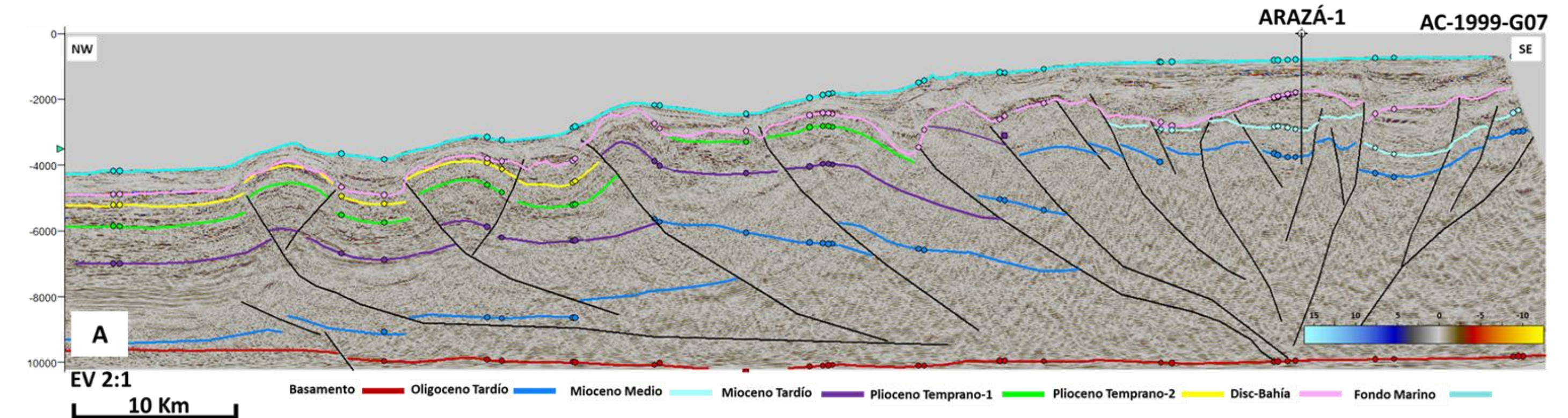
- Continuity of reservoir
- Size of traps/accumulations

CLRS Play. Possible behavior of the Magdalena Delta related to depositional systems, showing a possible channel complex domain developed mainly during the Plio-Pleistocene.

AREAS OF EXPLORATORY INTEREST

PLAY: STRATIGRAPHIC TRAPS RELATED TO UNCONFORMITIES - STU

- ✓ Stratigraphic traps
- ✓ Amplitude anomalies associated
- ✓ Older units at shallower depths
- ✓ Petroleum system similar to SSJO?
- Complexity of traps
- Seal and retention risk
- Negative result in well



Proposal for the extension of the Sinu San Jacinto towards the Bahia area, exhibit the seepage corridors and the potential of this sector.

Seismic lines revealing the structural complexity of the Bahia sector where positive and negative flower structures converge with the intervention of important erosions that truncate older deposits (Middle Miocene, Late Oligocene) which could generate stratigraphic or combined traps in the area.

CONCLUSIONS

4 GEOLOGICAL PROVINCES IN THE SINU OFFSHORE BASIN

ABYSSAL PLAIN

SINU OFFSHORE THRUST BELT (SOTB)

MAGDALENA DELTA

BAHIA AREA

7 PLAY TYPES

DEFORMATION FRONT – TOE THRUST

LOW RELIEF STRUCTURES WITH STRATIGRAPHIC COMPONENT

THRUST BELT ANTICLINES

INTRASLOPE BASINS

SHALE MOBILE RELATED TRAPS

CHANNELS IN LOW RELIEF STRUCTURES

STRATIGRAPHIC TRAPS RELATED TO UNCONFORMITIES

Thanks

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