Deep Water Aptian Turbidite System in Punta Del Este Basin, A New Play Offshore Uruguay*

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Abstract

The exploratory interest for gravity flow deposits, located in deep marine environments, has grown substantially in the last decades. The discoveries made in turbidites deposits in the Atlantic basins, particularly in Brazil, French Guiana and West Africa (Congo, Angola, etc.), generated a growing interest in the Uruguayan Atlantic Margin for the exploration of this particular type of play. In the last six years, product of two bidding rounds, an intense exploratory activity was developed offshore Uruguay, including the acquisition of nearly 41,000 km^2 of 3D seismic and an ultra-deep exploration well. In this context, a great amount of turbiditic systems were identified. These marine turbidite systems in the offshore basins of Uruguay are mostly located in deep waters and develop in Upper Cretaceous (Conician-Santonian, Maastrichtian) and Cenozoic (Paleocene, Eocene and Oligocene) sequences. The turbidites, and associated channels, shows roughly a NW-SE trend, suggesting that the paleoshelf and paleoslope for Upper Cretaceous and Cenozoic times presented an orientation similar to the current margin. Despite the great amount of marine turbidites identified for the Upper Cretaceous and Cenozoic sequences, these systems have not been described for the Lower Cretaceous. The objective of this work is the characterization of a turbidite system that develops in the Aptian-Albian sequence of Punta del Este Basin and assess its hydrocarbon potential. This finding is particularly important to better comprehend the evolution of the basin, since the turbidite has a perpendicular orientation (NE-SW) in relation to the younger turbidites, which suggest a different geometry of the basin for that moment. Additionally, from an exploration perspective, this prospect has an important potential (with estimated mean prospective resources of 3147 MMBOE), for being in direct contact with the main source rock of the offshore (Aptian) in an area with the greatest thickness of the basin, and because it shows Direct Hydrocarbon Indicators (Bright spots, AVO, etc.). On the other hand, this region, although not directly associated with the turbidite, has an important concentration of gas chimneys that develops from the Aptian source rock, spreading until the upper cretaceous. The above mentioned not only make the Punta del Este basin especially attractive, but also opens a new play for the offshore of Uruguay.

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Creaser, A., Hernández-Molina, F., Badalini, G., Thompson, P., Walker, R., Soto, M., Conti, B. 2017. A Late Cretaceous mixed (turbidite-contourite) system along the Uruguayan Margin: Sedimentary and palaeoceanographic implications. Marine Geology. p.234-253.

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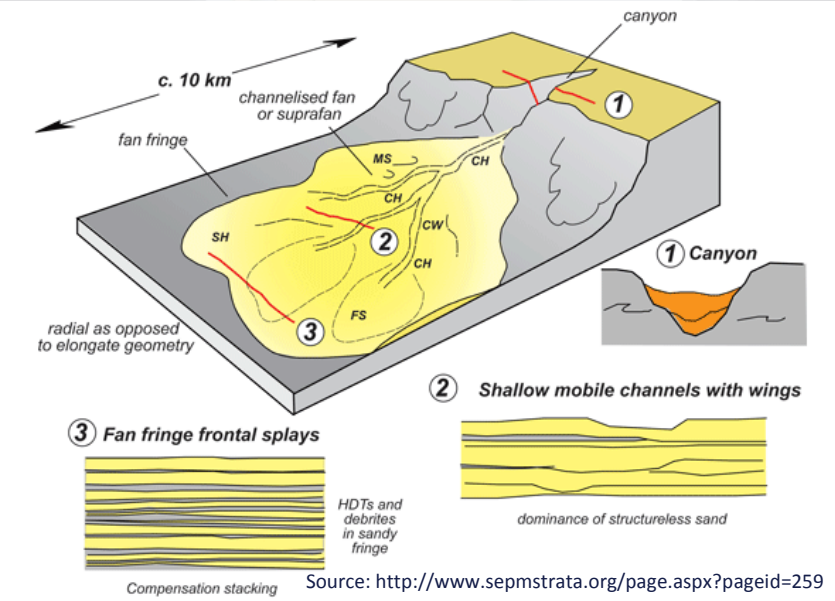
Importance of turbidites in Atlantic basins

The exploratory interest for gravity flow deposits, located in deep marine environments, has grown substantially in the last decades. Recent discoveries made in submarine fans in Atlantic basins of South America (Guyana, French Guiana) and West Africa (Ghana, Liberia, Sierra Leone) encourage the exploration of other frontier areas.

Geological model for gravity flow deposits



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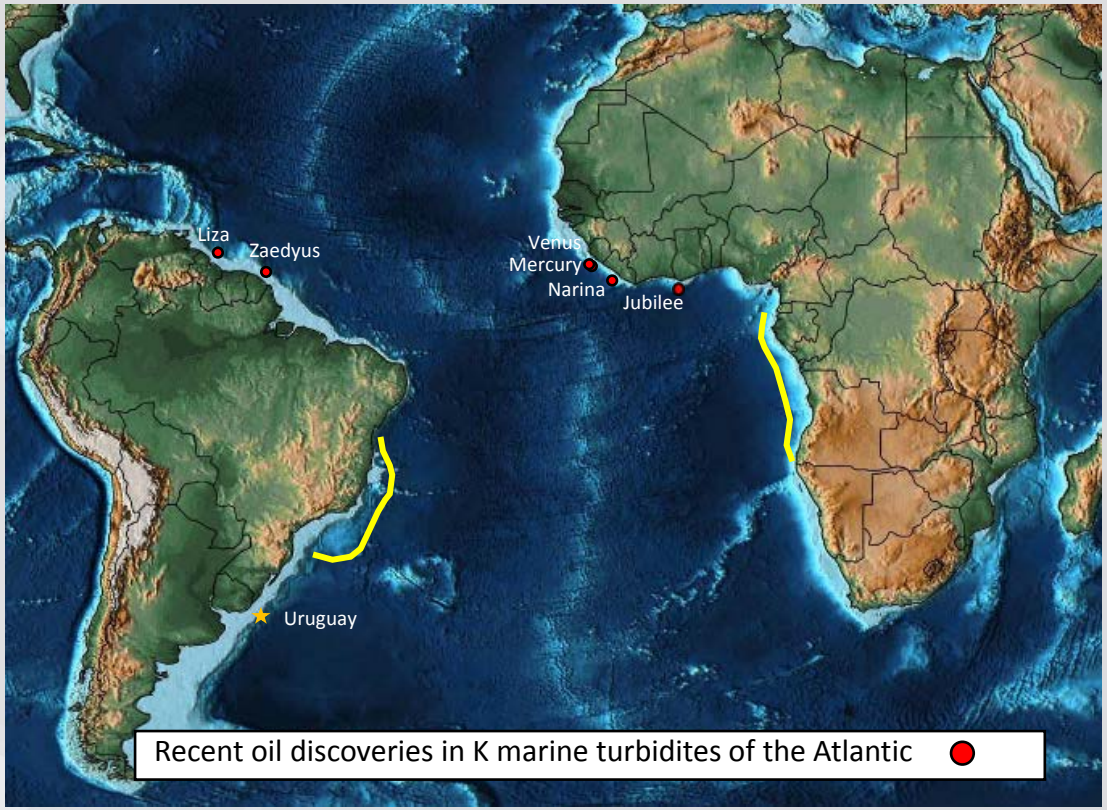


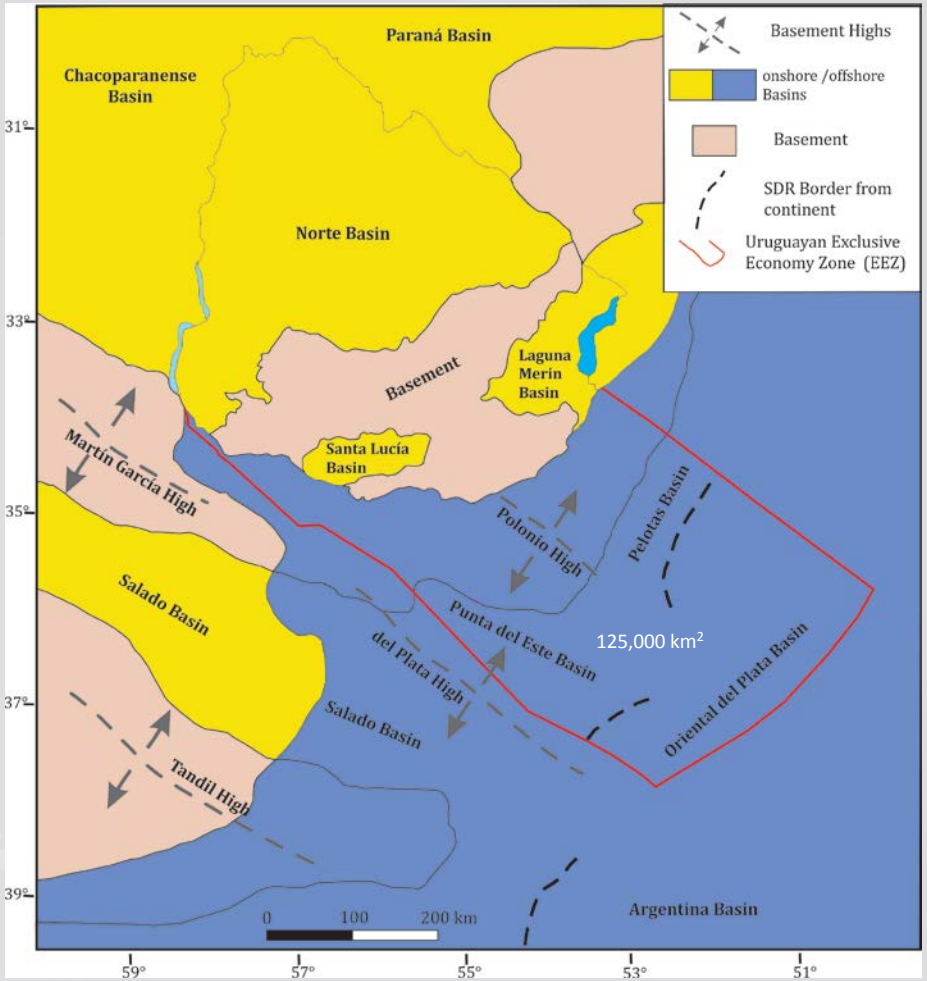
Modified from Scotese (2014)

The success of this type of play led to an intense exploration activity in offshore Uruguay (a frontier area with no hydrocarbons discoveries)

These plays:

- Are located in the Atlantic
- In areas with no salt deformation
- In stratigraphic traps
- In Cretaceous fan systems
- In deep waters
- With a Cretaceous source rock

Source Scotese (2014)



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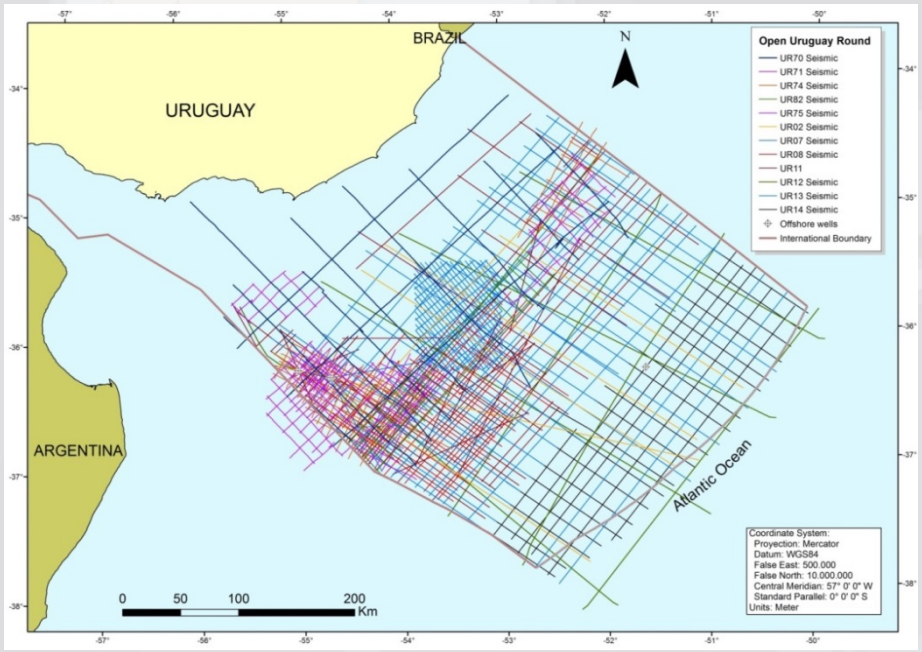
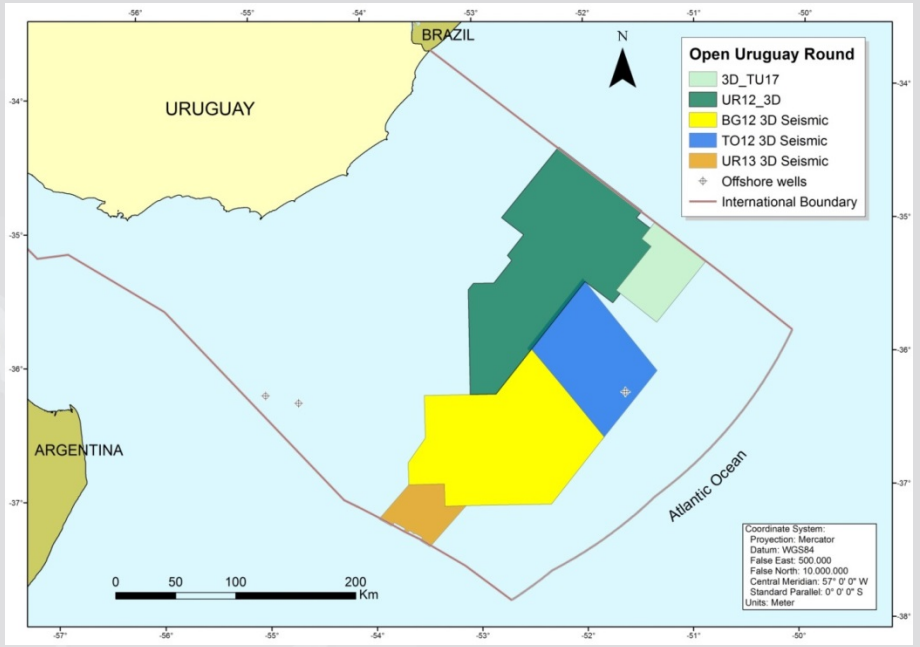
Present day seismic data

In the last eight years, as a result of two bidding rounds, an intense exploratory activity was developed offshore Uruguay, including the acquisition of 41,000 km of 2D seismic, 43,600 km² of 3D seismic and the drilling of an ultra-deep exploratory well (after 40 years).



41,000 Km of 2D seismic covering shallow to deep waters



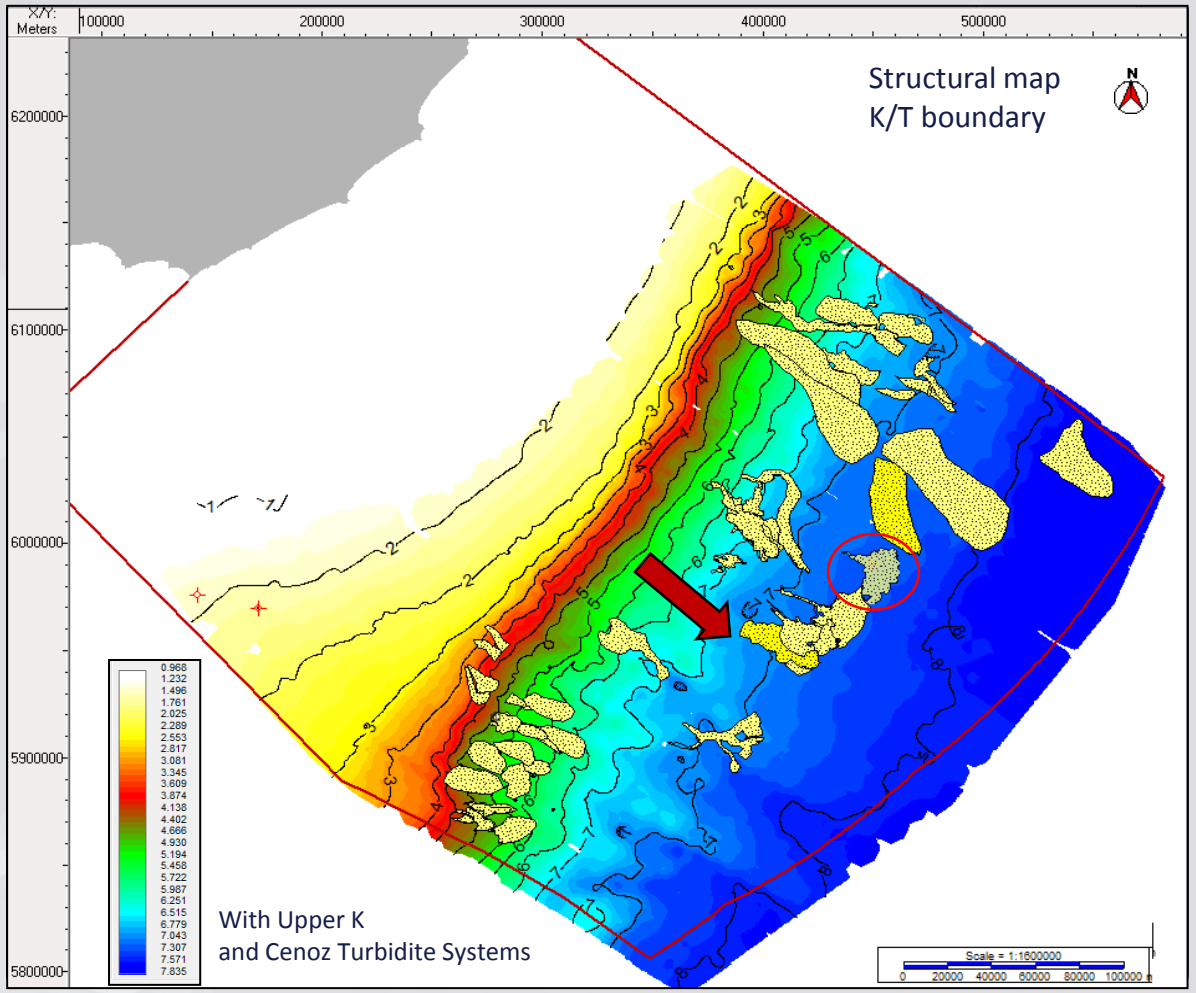
43,600 Km² of 3D seismic covering mostly deep waters

In this context, a great amount of Upper Cretaceous and Cenozoic turbiditic systems were identified with 3D seismic (more than 40 bodies).

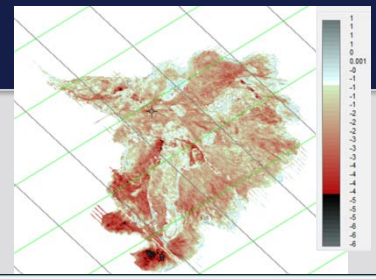
- The marine turbidite systems or submarine fans in the offshore basins of Uruguay are mostly located in deep waters and develop in Upper Cretaceous (Conician-Santonian, Maastrichtian) and Cenozoic (Paleocene, Eocene and Oligocene) sequences.

- The turbidites, and associated channels, shows roughly a NW-SE trend, suggesting that the paleoshelf and paleoslope for Upper Cretaceous and Cenozoic times presented an orientation similar to the current margin.

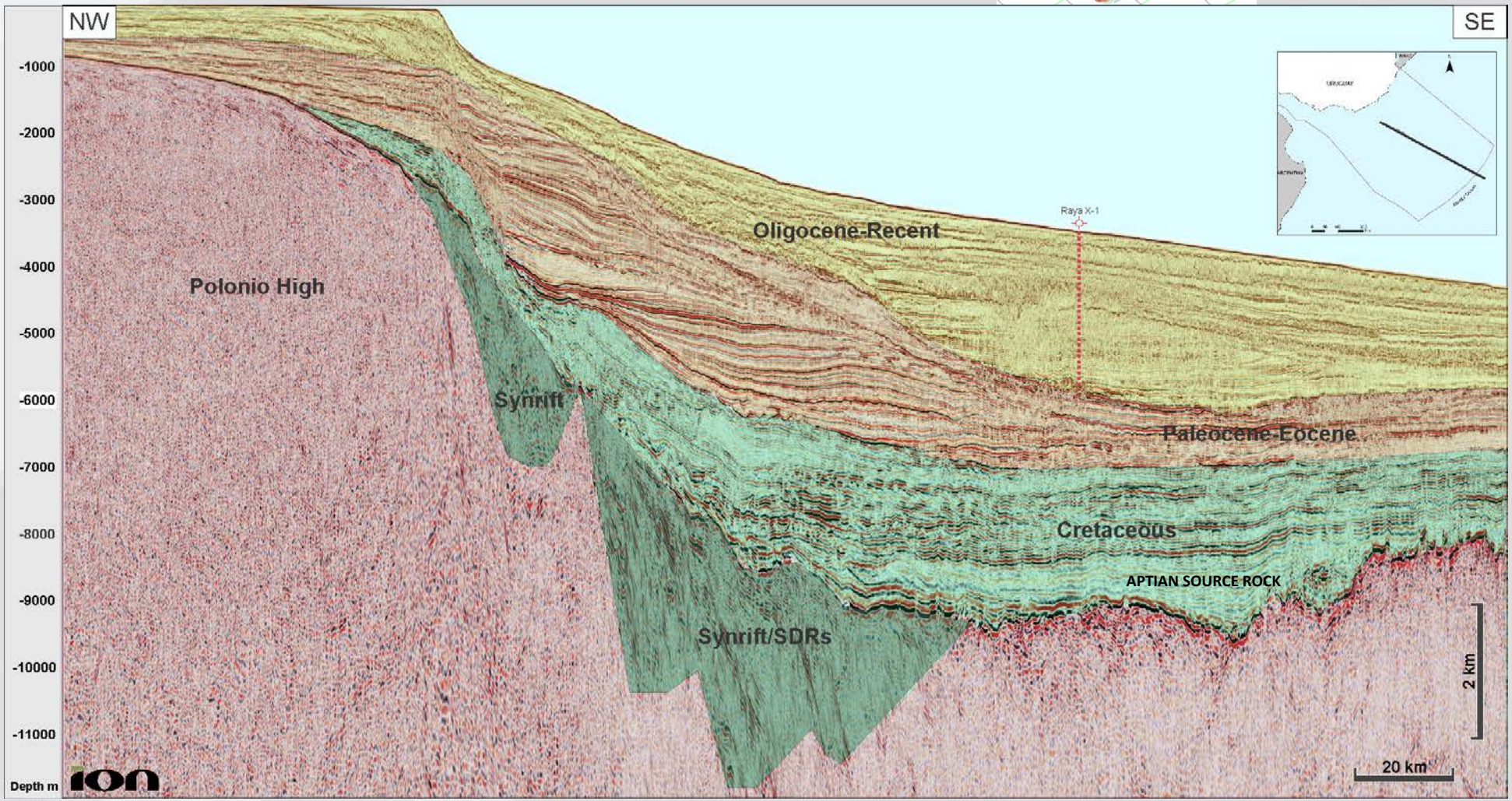
- One Oligocene turbidite was drilled in 2016



Raya well tested an Oligocene turbidite



- WD: 3,404 m
- Sediment depth: 2,452 m
- Reservoir of good quality but water bearing (135 m thick turbidite fan with a 24% average porosity)
- Dry well
- Distance between main source rock and reservoir is around 2,500 m
- 3D seismic show no clear migration pathways between Aptian source rock and this reservoir



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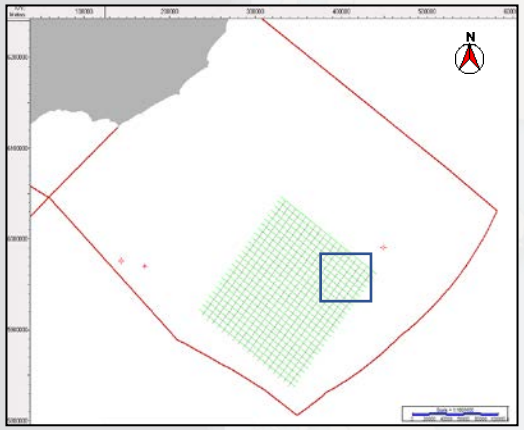
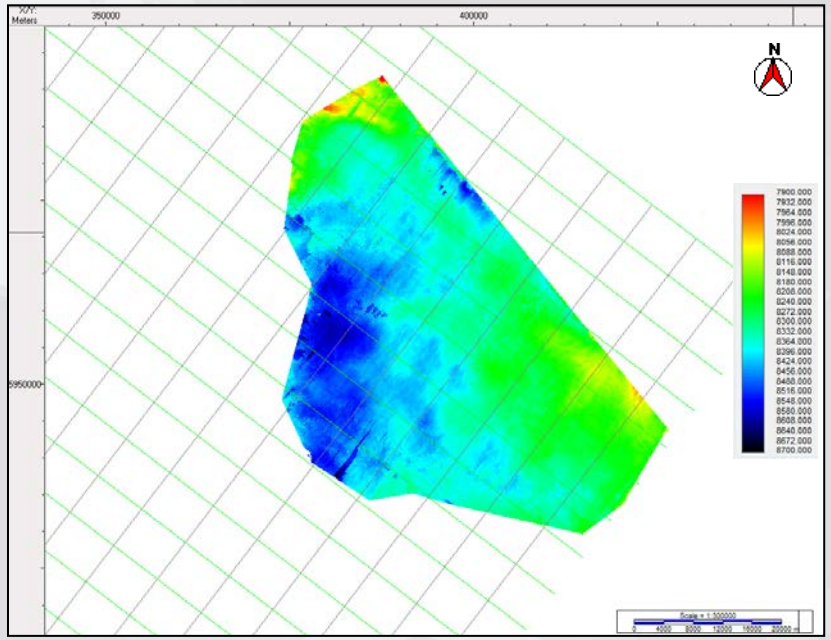
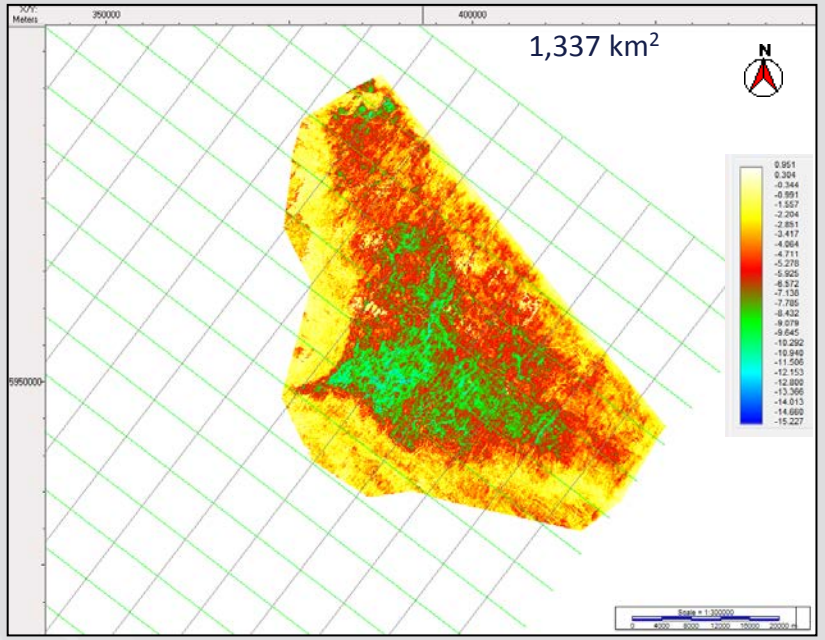
3D seismic used in this work (13,000 km^2) allowed the interpretation of a Late Aptian marine Fan



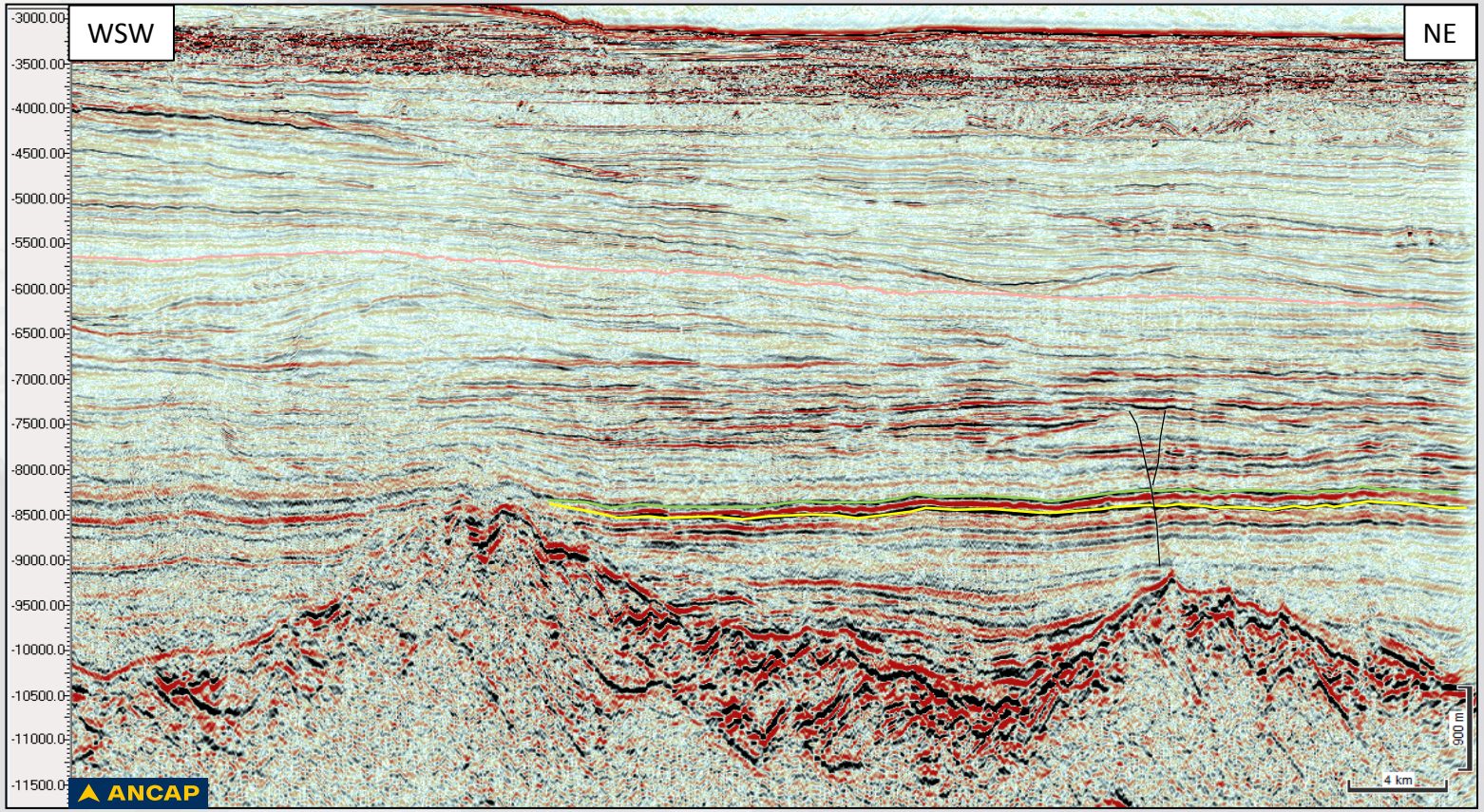
Structural map (top horizon)

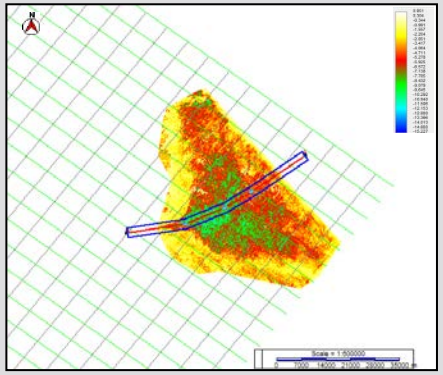


Amplitude anomaly map (showing fan geometry)

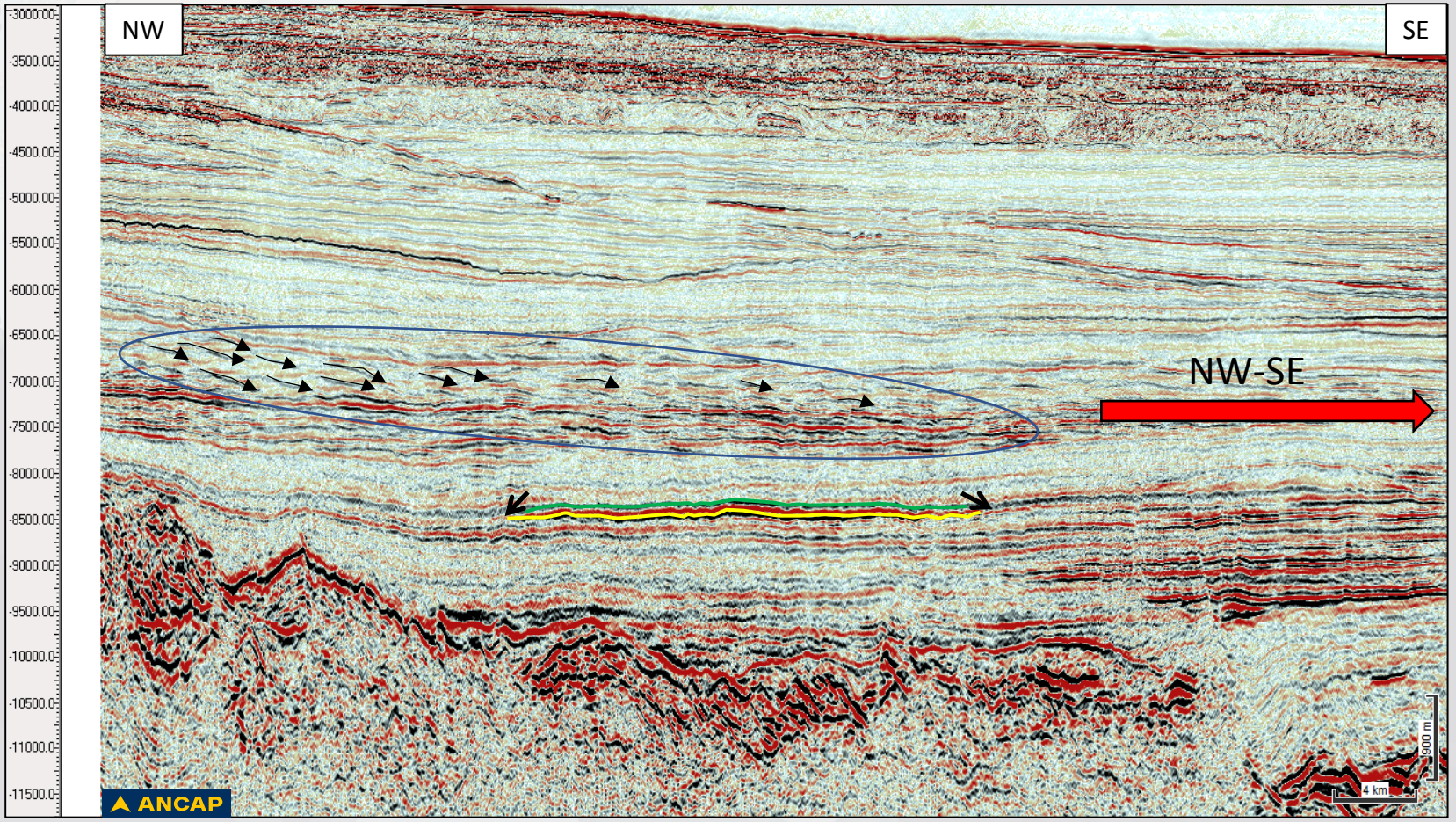


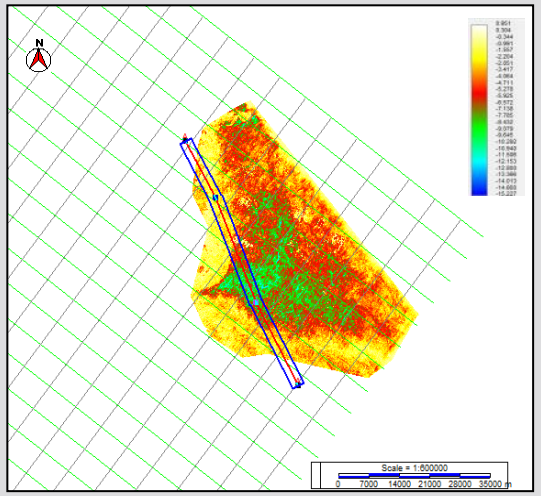
- Despite the great amount of marine turbidites identified for the Upper Cretaceous and Cenozoic, these systems have not been described for the Lower Cretaceous sequences, that mostly show retrogradational stacking patterns.
- However, a big deep water Late Aptian-Early Albian fan system was interpreted



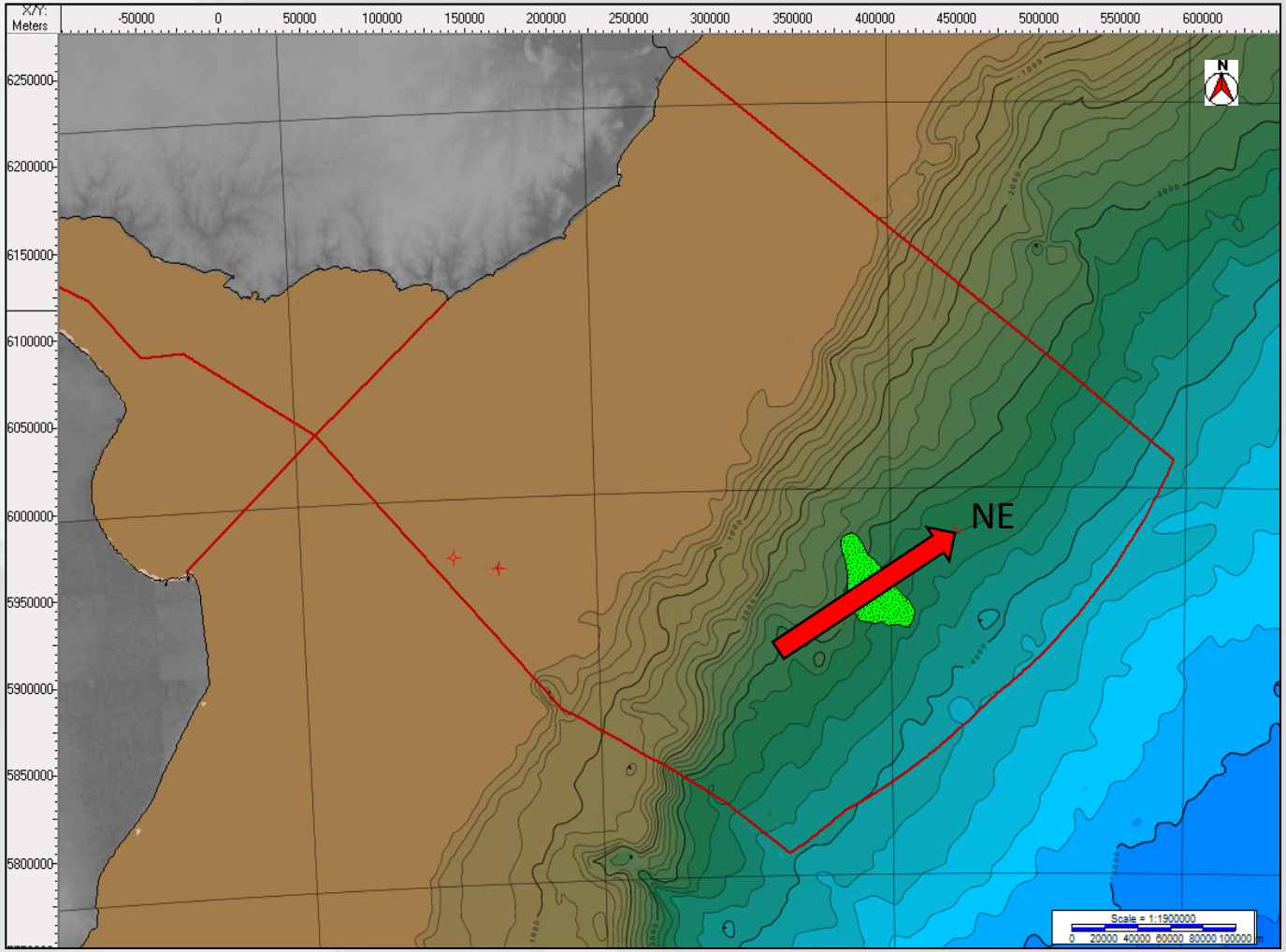


Aptian-Albian Fan in a NW-SE seismic line showing double downlap

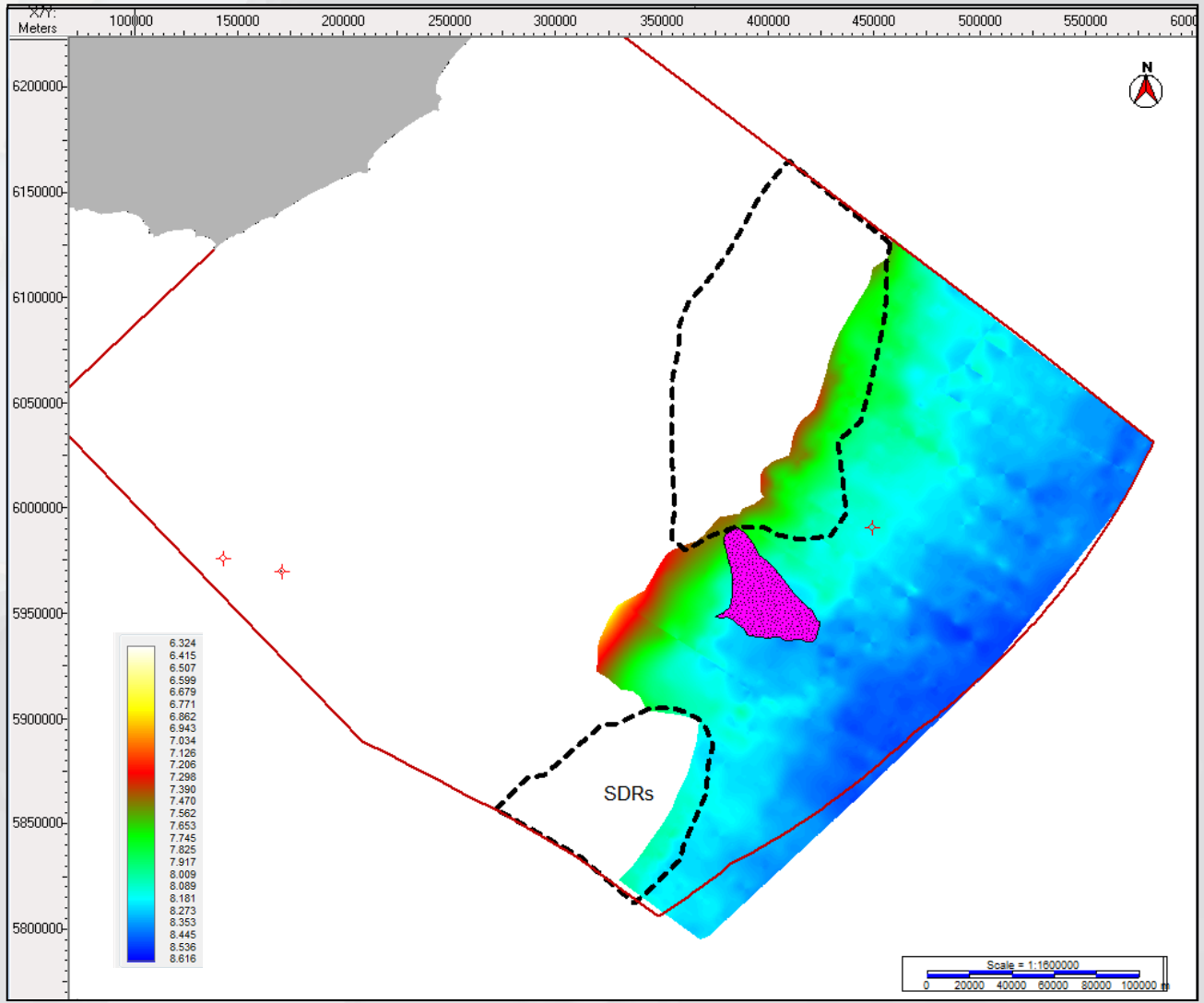




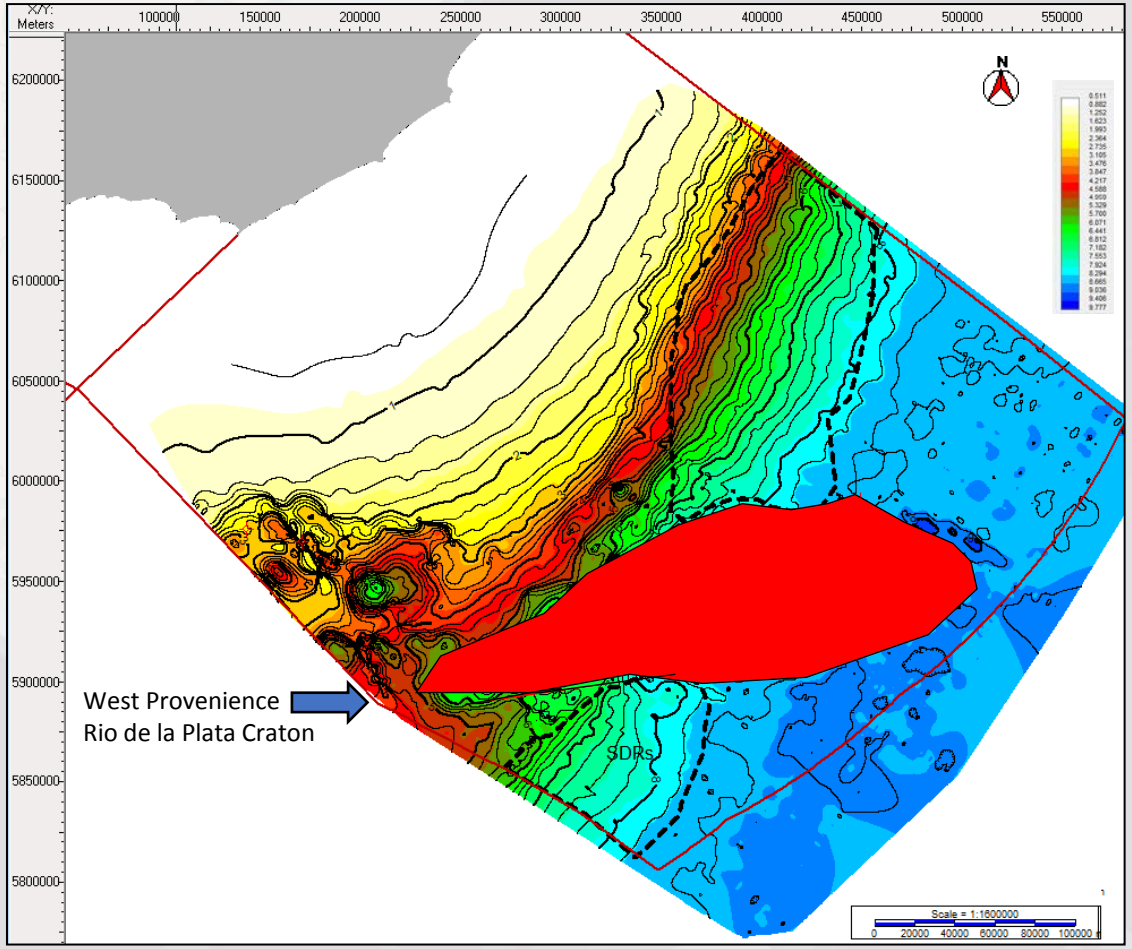
This finding is particularly important to better comprehend the evolution of the basin, since the turbidite has a perpendicular orientation (NE-SW) in relation to the younger turbidites, which suggest a different geometry of the basin for that moment



Marine Aptian distribution with SDRs location

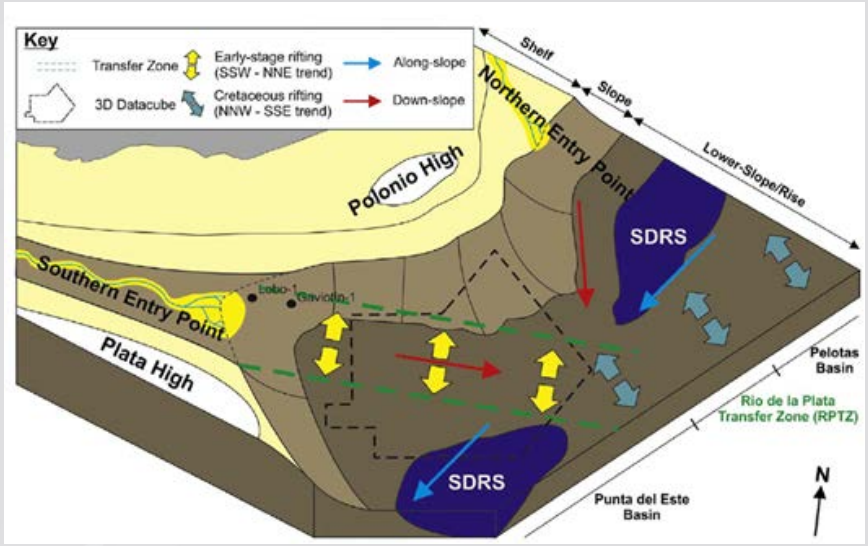


Top basement structural map with 2D data



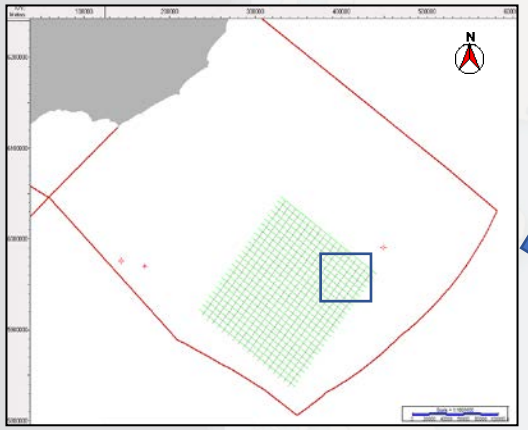
Channels and fans of this age probably restricted to this area of influence of the Rio de la Plata Transfer System

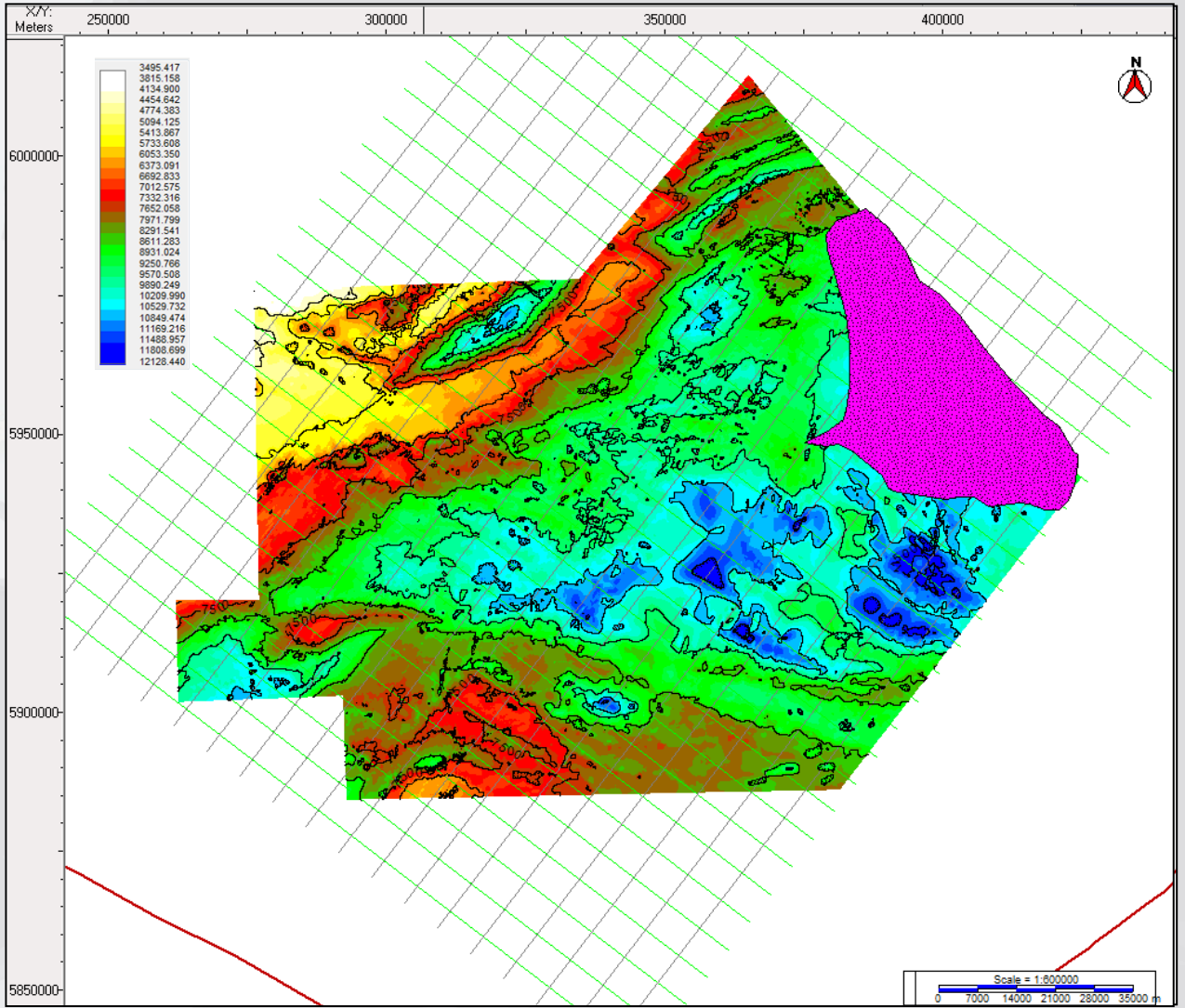
Paleorestoration of the area for the Early K



Creaser et al. (2017)

Detailed top basement structural map of the area with 3D seismic





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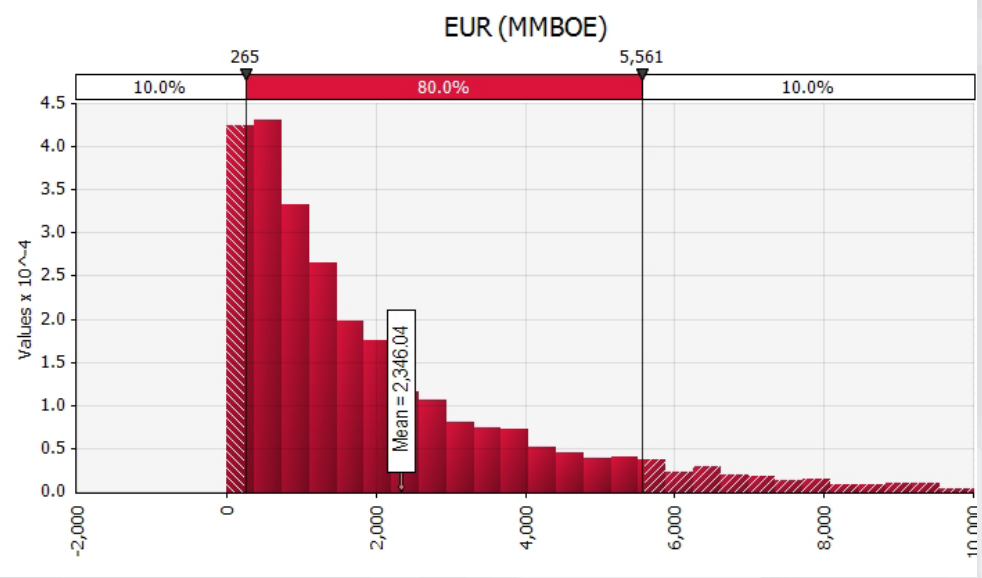
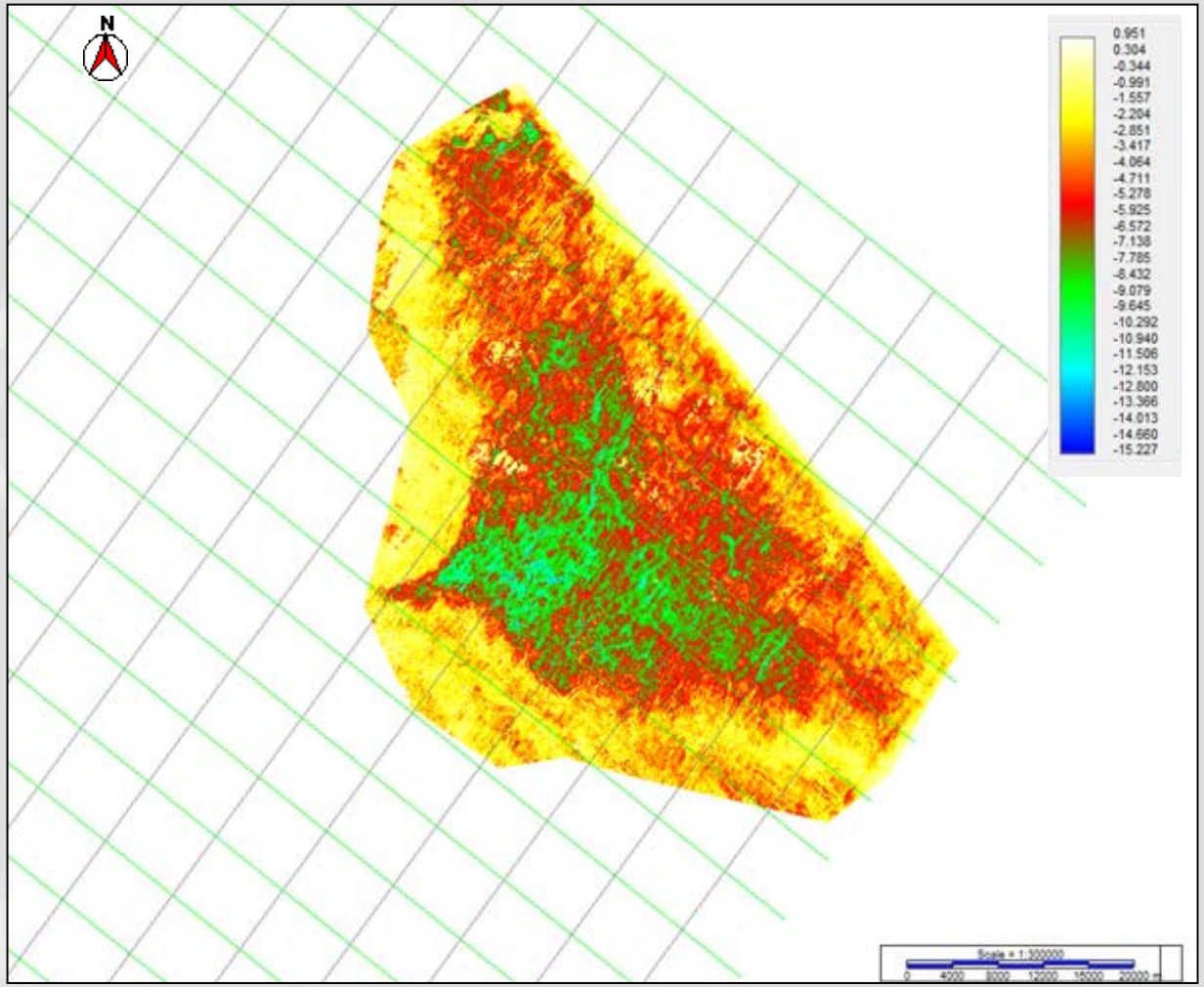
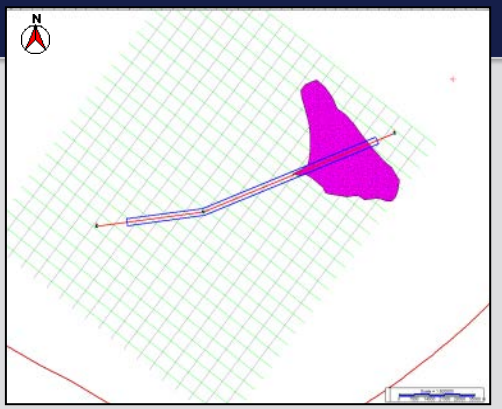
Volumetric assessment

- Age: Late Aptian - Early Albian
- Bathymetry: 3100 m
- Sediment depth: 5100 m
- Area: 110-486-1337 km^2
- Depositional system: Marine fan
- Estimated mean prospective resources: 2364 MMBOE
- Exceeds by far the Minimum Economic Field Size

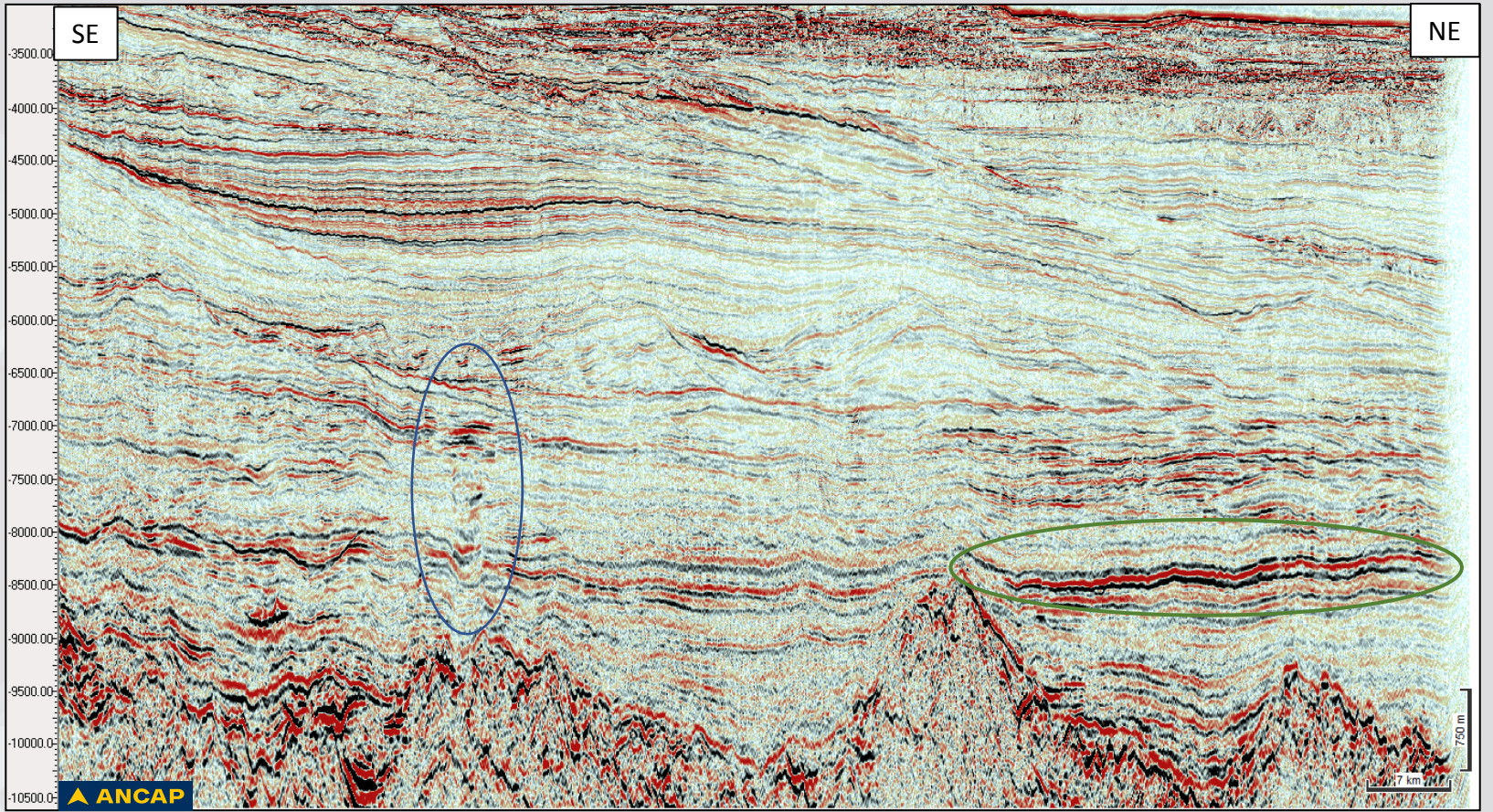




Prospectivity and hydrocarbon evidences



- ✓ Direct contact with Aptian source rock
- ✓ Inverse polarity with respect to seabed
- ✓ Abrupt increase in seismic amplitude (bright spot)
- ✓ AVO anomalies associated with the fan
- ✓ Gas chimneys coming from Aptian source rock feeding Upper cretaceous reservoirs



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Conclusions

- More than 40 Upper Cretaceous and Cenozoic turbidite systems were identified offshore Uruguay in the last 10 years.
- In this work 3D seismic analysis allowed the identification of a deep water Aptian turbidite system in a transition area between Punta del Este and Pelotas basins.
- It has a perpendicular trend with respect to the Upper K and Cenozoic turbidites. The later were generated in a passive margin phase, while the Aptian Fan System was developed in a transitional phase with a different geometry of the basin
- Provenience of sediments are from the Rio de la Plata craton (good reservoir quality is expected)
- There are DHI on the seismic that confirm the prospectivity of the prospect (amplitude anomalies, AVO anomalies, inverse polarity, gas chimneys).
- The fan is in direct contact with the Aptian source rock, which is a world class source rock, reducing migration risks.

These conclusions make offshore Uruguay attractive and also opens a new play type for hydrocarbon exploration.

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Acknowledgment

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