

The Early Cretaceous Rift and Sag Phases in the Offshore Basins of Brazil and Uruguay: How Much in Common?*

Oscar R. Lopez-Gamundi¹, Eduardo A. Rossello², and Héctor de Santa Ana³

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¹Hess Corporation, Houston, TX, USA (olopezgamundi@hess.com)

²University of Buenos Aires, Buenos Aires, Argentina.

³ANCAP, Montevideo, Uruguay.

Abstract

The South Atlantic opening is characterized by an initial (Early Cretaceous) diachronous, extensional phase dominated by asymmetric half-grabens (Conceição et al., 1988). The East African Rift System (EARS) has been invoked as a close analog for this early stage in the evolution of the South Atlantic (Crossley and Cripps, 1999). Furthermore, recent discoveries in the EARS have renewed the interest in this type of oil and gas habitats (Logan et al., 2009), reinforced lately by the exploratory success in the South Atlantic, particularly in the Cretaceous pre-salt (sag fill) section of the Santos, Campos and Espirito Santo basins ([Figures 1](#) and [2](#)) in offshore Brazil, an emerging world-class oil province. The structural asymmetry of these half-grabens is mainly due to differential, tectonically induced subsidence that created optimal conditions for the potential development of lacustrine to brackish source rocks ([Figure 2](#)). Classic seismic signatures in the asymmetric half-grabens include fanning (strongly divergent internal configuration) on fault borders, thinning (convergent internal configuration) and onlap on flexural margins, and compaction synclines over basement footwall cut-off points (López-Gamundí and Barragan, 2008). This half-graben fill phase was followed by a sag phase dominated by thermal subsidence which expanded beyond the rift shoulders. The trap geometries and distribution of facies, particularly in the lower section of the sag fill, have been influenced by highs inherited from the underlying asymmetric half-grabens. New 2D seismic ([Figures 3](#) and [4](#)) acquired for ANCAP in offshore Uruguay (Pelotas and Punta del Este basins) allows investigators to draw significant analogies between the offshore basins in Brazil and their counterpart farther south in Uruguay. Four stages have been identified in the evolution of the offshore basins of Uruguay:

- a) pre-rift
- b) rift
- c) sag
- d) passive margin.

Both the Pelotas and Punta del Este basins show significant similarities in their latest phases of evolution (sag and passive margin stages), but they display drastically different characteristics during the pre-rift and rift phases (Rossello et al., 2009). The Punta del Este basin exhibits half-graben geometries at the rift stage followed by a laterally extensive sag fill ([Figures 4 and 5](#)). In contrast, the Pelotas basin in offshore Uruguay does not exhibit fully developed half-grabens ([Figure 4](#)). The rifts present in the Punta del Este basin have a Jurassic-Cretaceous fill and show dominant westward vergence, opposite to the present deepening of the continental margin. This configuration has the potential for onlap/pinchout traps at the sag level, indirectly controlled by pre-existing half-graben geometries, which tend to develop on the flexural margins or on shoulders inboard. Differential compaction at the half-graben border fault margin would be a critical factor to create counter-regional dips necessary to form structural (4-way) closures at the sag level. From the point of view of trap efficiency, the main difference between the rift and sag sections of offshore Brazil (Santos, Campos and Espirito Santo basins) and Punta del Este basin in Uruguay is the absence of an overlying salt in the latter. Marine shales in the drift section can be invoked as potential top seals in light of the absence of a regional salt layer. The potential presence of Paleozoic pre-rift source rocks in the Punta del Este basin is suggested by the recent finding of Permian sediments on the rift shoulders in the Gaviotin well (Veroslavsky et al., 2003). The presence of Permian confirms the heterogeneous nature of the pre-rift basement, principally made up of:

- a) Paleozoic sedimentary rocks, equivalent to those exposed in the Paraná (Brazil, Uruguay), the Sierras Australes of Buenos Aires (Argentina) and Karoo (South Africa)
- b) crystalline rocks as inferred by highs in the gravity maps.

The presence of Permian sediments provides appealing exploratory alternatives for sourcing of hydrocarbons in addition to the potential presence of rift and sag source rocks.

References

Conceição, J. C. J., P. V. Zalán, and S. Wolff, 1988, Mecanismo, evolução e cronologia do rifte Sul Atlântico: Boletim de Geociências da Petrobras, v. 2, p. 255–265.

Crossley, R. and D. Cripps, 1999, Templates from mainland Africa and the Red Sea for interpreting the early evolution of the South Atlantic, *in* Cameron, N. R., Bate, R. H. and Clure, V. S. (eds) The Oil and Gas Habitats of the South Atlantic: Geological Society, London, Special Publications, v. 153, p. 85-96.

Logan, P., S. Curd, B. Downie, J. Weston, and D. Shaw, 2009, Exploration on the frontier: Towards an understanding of the Albert Basin: Search and Discovery Article #10192 (2010) (<http://www.searchanddiscovery.net/documents/2009/10192logan/index.htm>).

López-Gamundí, O.R., and R. Barragan, 2008, Rift architecture and its control from pre-salt plays in the South Atlantic: Lessons from offshore Brazil (abstract) AAPG, International Conference and Exhibition, Cape Town, South Africa; Search and Discovery Article #90082 (2008) (http://www.searchanddiscovery.net/abstracts/html/2008/intl_capetown/abstracts/471102.htm).

Rossello, E.A., H. de Santa Ana, O. R. López-Gamundí, O, and G. Veroslavsky, 2009, Influencias de la tectónica Andina sobre la plataforma continental Atlántica (Uruguay-Argentina)?: Controles sobre su potencial exploratorio: X Simposio Bolivariano Exploración Petrolera en Cuencas Subandinas, Cartagena, Colombia. CD, 6 p.

Veroslavsky, G., G., Daners, and H. de Santa Ana, 2003, Rocas sedimentarias pérmicas en la plataforma continental uruguaya: el pre-rift de la Cuenca Punta del Este: Geogaceta, v. 34, p. 203-206.

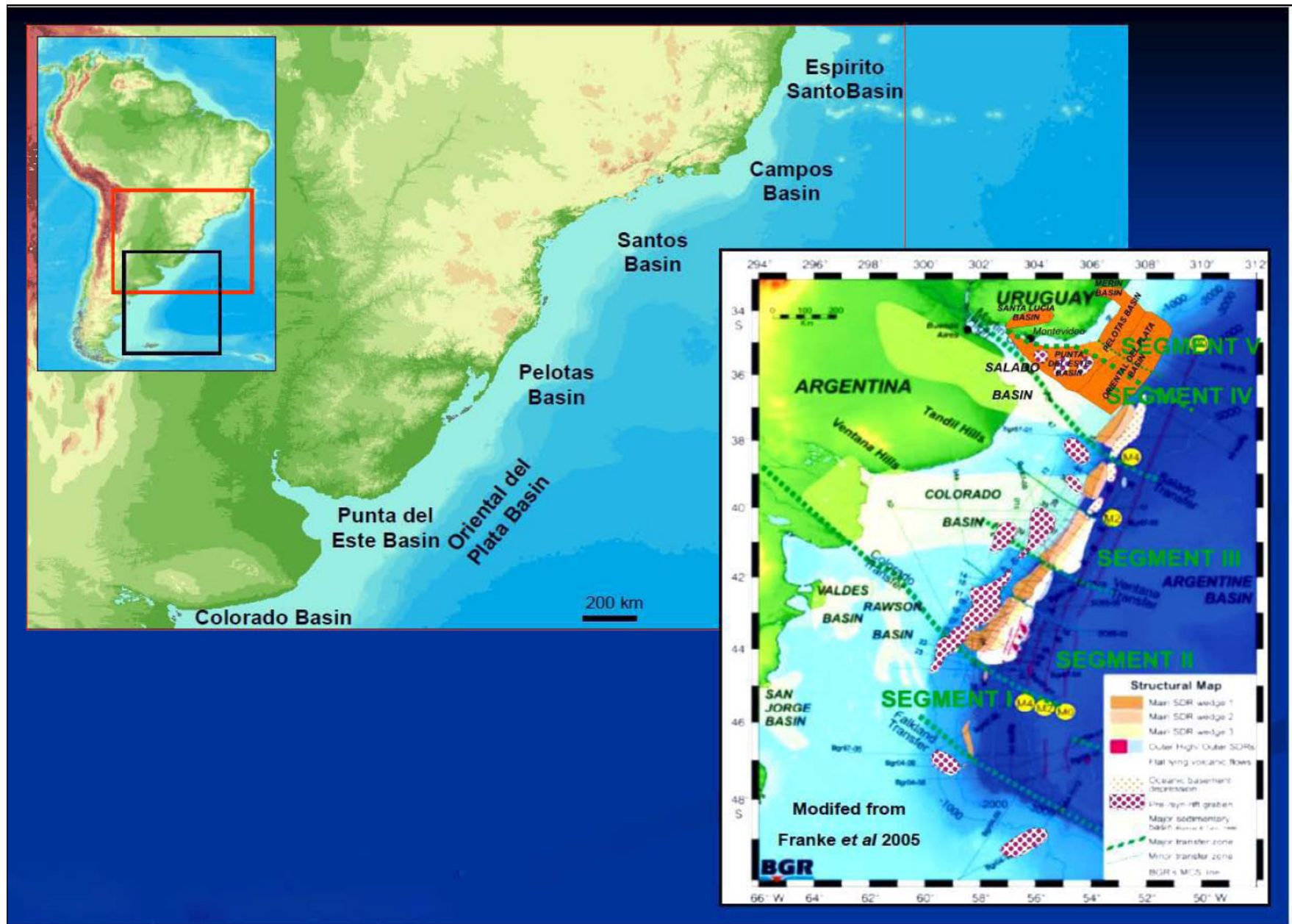
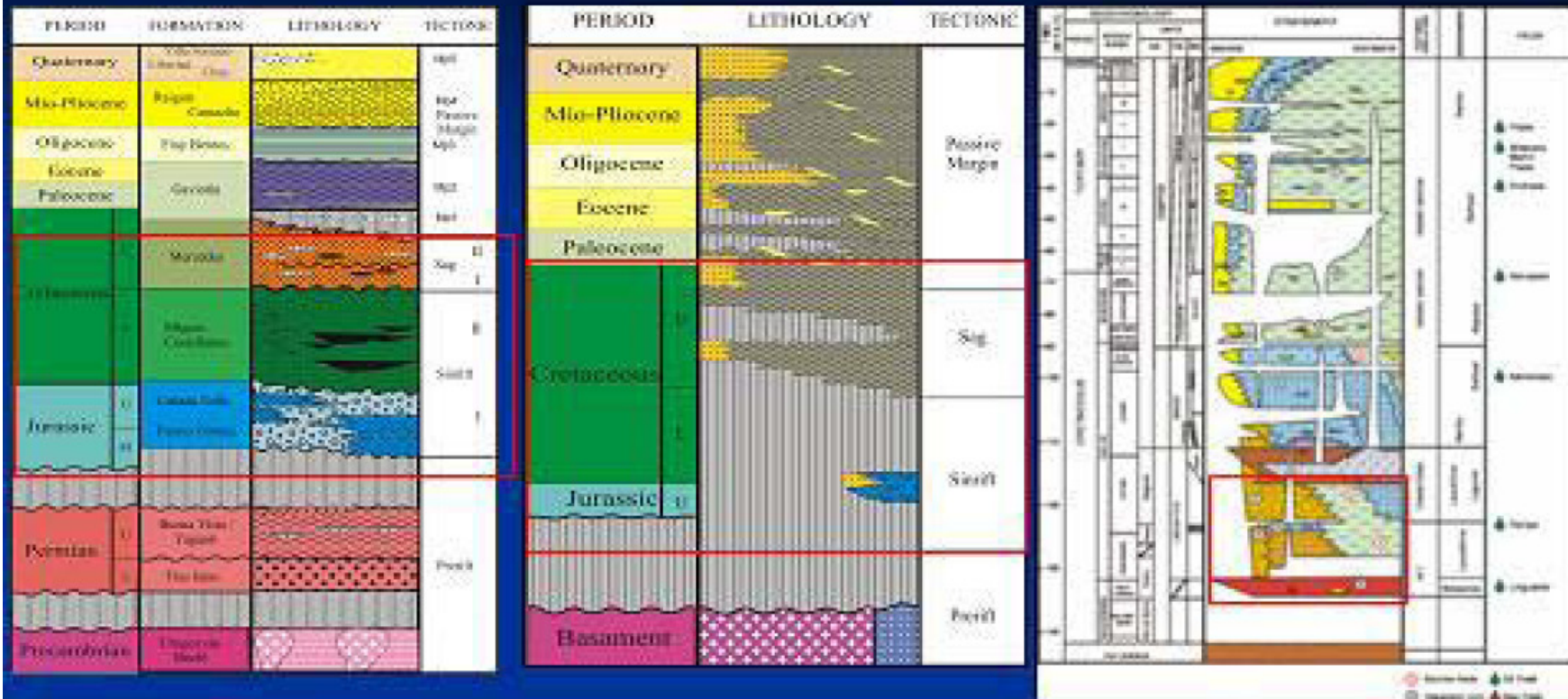


Figure 1. Location maps of coastal basins, south Brazil, Uruguay, and north Argentina.

Punta del Este basin

Pelotas basin

Santos-Campos basins



Break-up in the South Atlantic developed diachronously: rifting started in the south (Argentina) during the Jurassic and progressed towards the equatorial segment (Punta del Este basin in Uruguay, Pelotas basin in Uruguay and south Brazil, Santos, Campos and Espírito Santo basins in Brazil).

Figure 2. Stratigraphic columns for Punta del Este, Pelotas, and Santos-Campos basins.

Uruguay Offshore Basins

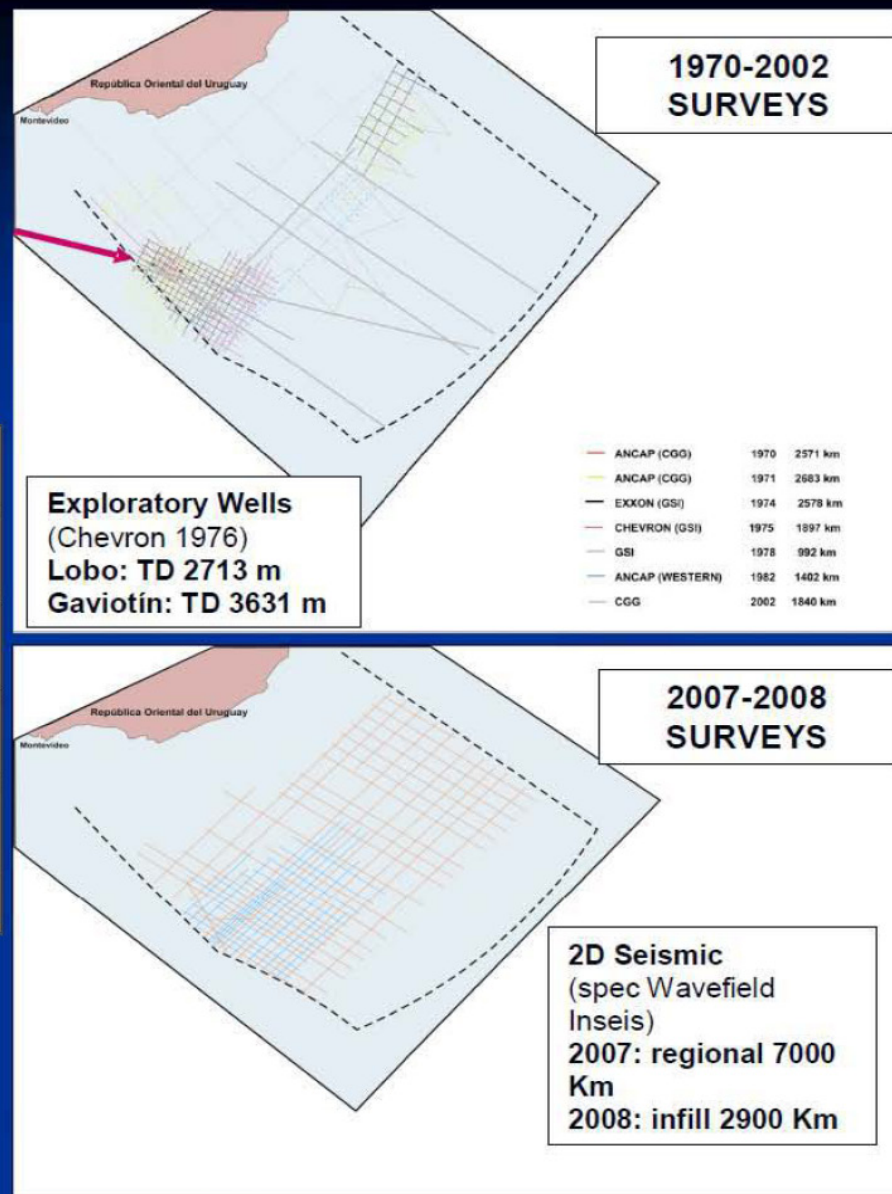


Figure 3. Maps of Uruguay offshore basins, with exploratory wells and seismic surveys.

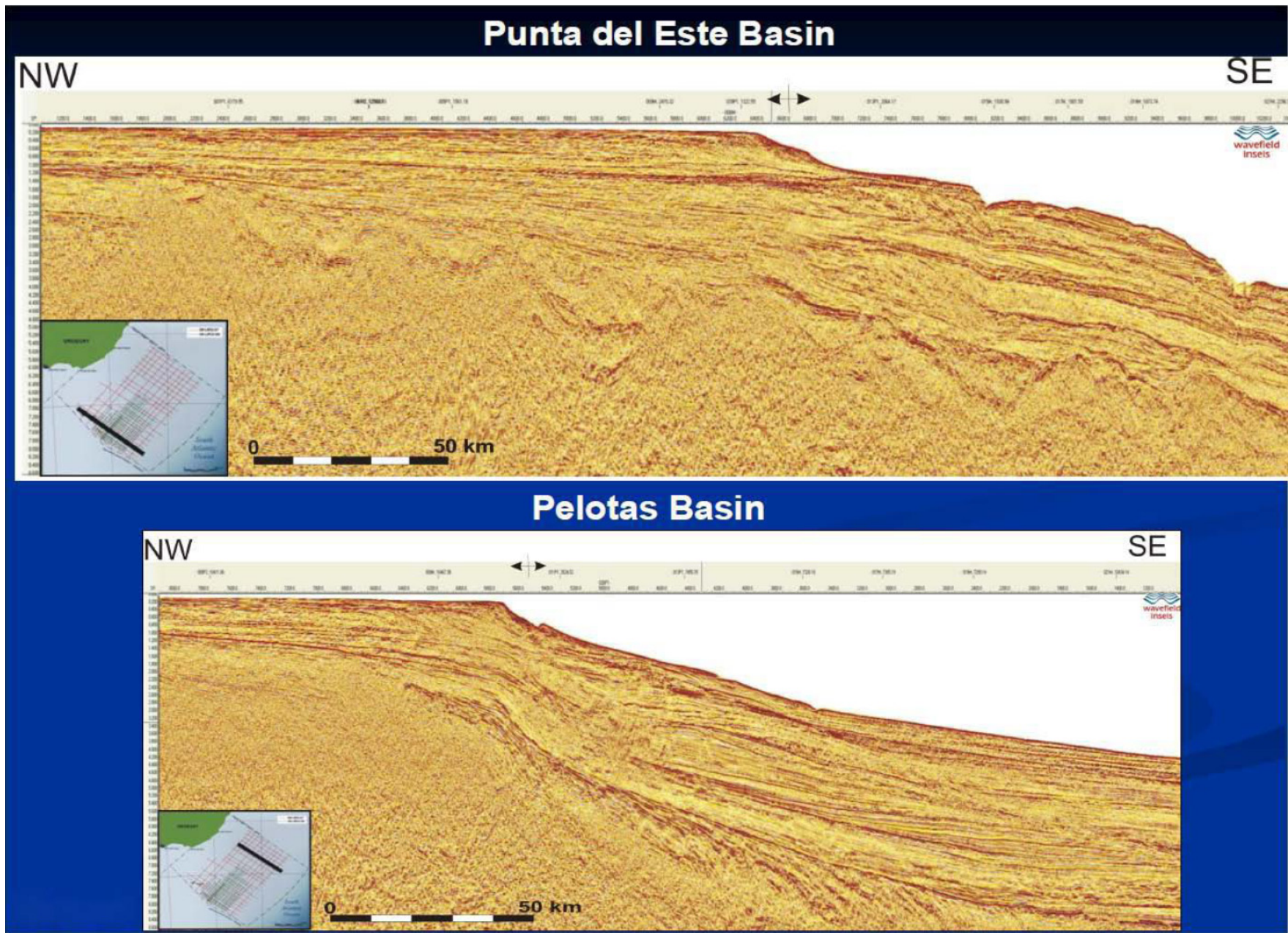


Figure 4. Regional seismic profiles (uninterpreted), Punta del Este and Pelotas basins.

Punta del Este Basin

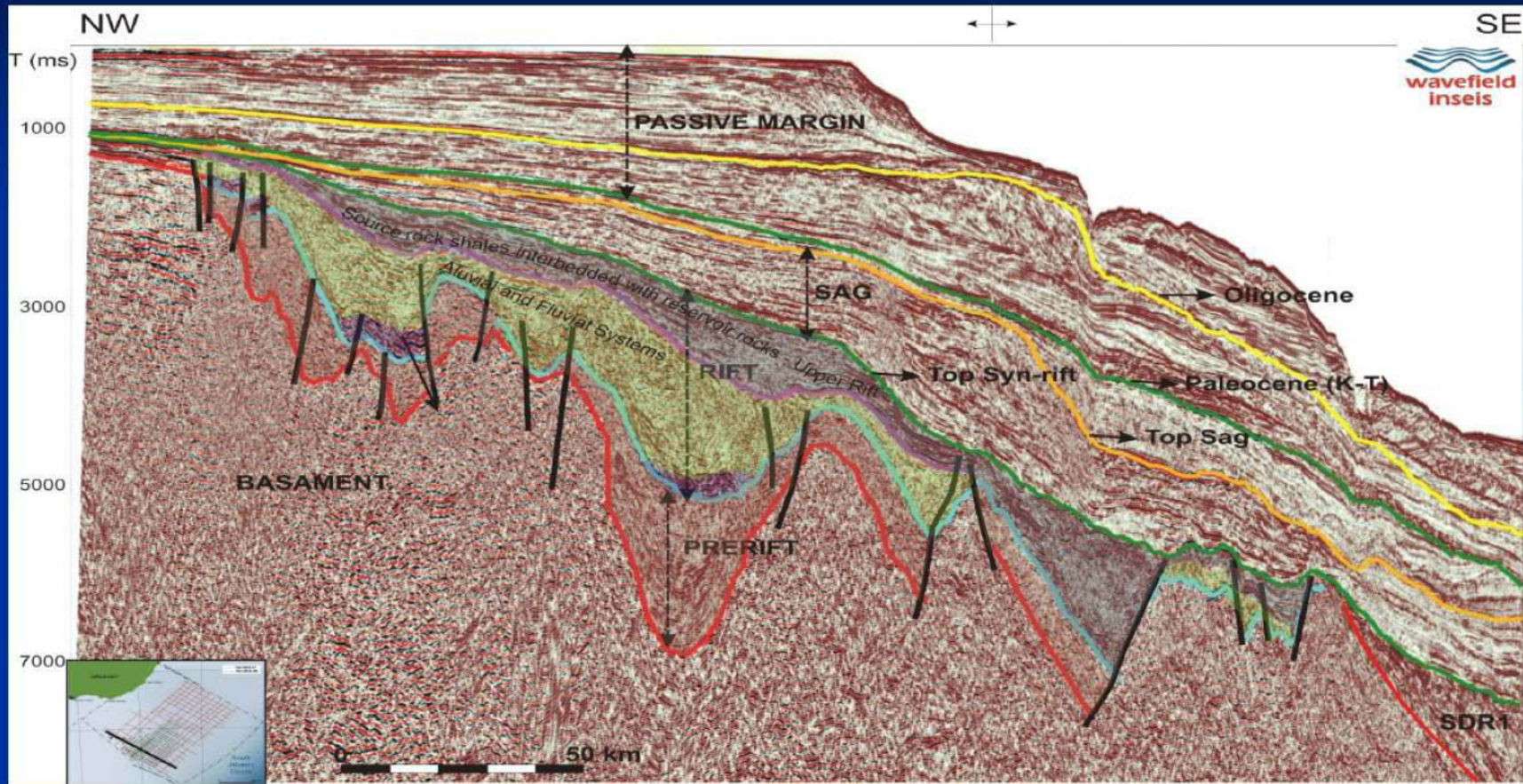


Figure 5. Regional interpreted seismic profile, Punta del Este basin.