[PS]Imaging and Imagining Transitional Sedimentary Environments: A Paleogeographic Reconstruction of Northern Colombia*

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Abstract

Predicting reservoir presence and quality in frontier basins is a challenging task due to the scarcity of wells and seismic data. Northern Colombia's Caribbean offshore basin is no exception to the rule, as available seismic data are mainly restricted to regional 2D lines, and wells are mostly confined to the continental shelf. In addition, the tectonically active nature of this continental margin hinders the application of depositional models from the world's best known analogs, such as the Gulf of Mexico and Brazil, developed on passive margins. To establish a working geologic framework for predicting Cenozoic reservoir distribution in the onshore Lower Magdalena and Guajira and offshore Caribbean (Sinu and Guajira) basins, we integrated onshore and offshore seismic, biostratigraphic, and geologic information onto a set of 5 paleogeographic maps spanning the late Oligocene through the early Pleistocene of northern Colombia. To cross-check the validity of intermediate versions of our maps, we resorted to seismic geomorphology analysis. This procedure allowed us to test whether features, such as channels, chaotic, clinoform and lobate seismic geoforms, were sitting on areas consistently mapped as paleo-canyons, debris flows, prograding deltas, areas of mass-transport complexes, etc. Moreover, tracking the migration of the shelf break on seismic data was particularly useful to constrain deep-water environments and the wandering edges of paleo-deltas. Our maps reveal the design of the paleo-shoreline, shelf break, and main emerged areas and record the birth and evolution of ancient and modern river deltas. Furthermore, our maps help us understand the geologic history of basin infill due to sediment delivery by the Sinu, Atrato, Magdalena and Rancheria rivers, implicitly displaying reservoir fairways. The dynamic nature of this project facilitates the constant inclusion of new seismic and well data as they become available, testing the validity of our maps and improving their quality.

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IMAGING AND IMAGINING TRANSITIONAL SEDIMENTARY ENVIRONMENTS: A PALEOGEOGRAPHIC RECONSTRUCTION OF NORTHERN COLOMBIA

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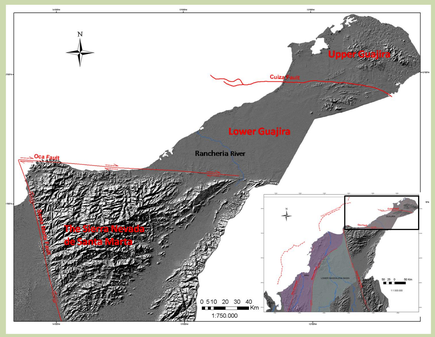
ABSTRACT 1

Predicting reservoir presence and quality in frontier basins is a challenging task due to the scarcity of wells and seismic data. Northern Colombia's Caribbean offshore basin is no exception to the rule, as available seismic data are mainly restricted to regional 2D lines, and wells are mostly confined to the continental shelf. In addition, the tectonically active nature of this continental margin hinders the application of depositional models from the world's best known analogs such as the Gulf of Mexico and Brazil, developed on passive margins. To establish a working geologic framework for predicting Cenozoic reservoir distribution in the onshore and offshore Guajira basins, we integrated onshore and offshore seismic, biostratigraphic, and geologic information onto a set of 5 paleogeographic maps spanning the late Oligocene through the early Pleistocene of northern Colombia. To cross-check the validity of intermediate versions of our maps, we resorted to seismic geomorphology analysis. This procedure allowed us to test whether features such as channels, chaotic, clinoform and lobate seismic geoforms were sitting on areas consistently mapped as paleo-canyons, debris flows, prograding deltas, areas of mass-transport complexes, etc. Moreover, tracking the migration of the shelf break on seismic data was particularly useful to constrain deep-water environments, and the wandering edges of paleo-deltas. Our maps reveal the location of the paleo-shoreline, shelf break and main emerged areas, and record the birth and evolution of ancient and modern river deltas. Furthermore, our maps help us understand the geologic history of basin infill due to sediment delivery by Rancheria and Upper Guajira rivers, implicitly displaying reservoir fairways. The dynamic nature of this project facilitates the constant inclusion of new seismic and well data as they become available, testing the validity of our maps and improving their quality.

LOCALIZATION 2



Localization of the study area. The image shows the main sedimentary provinces and tectonic features.

Modified from Barrero et al, 2007

METHODS 3

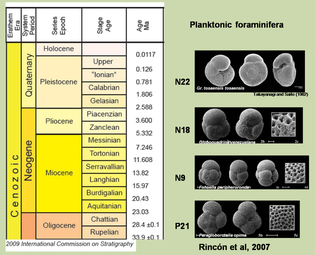
The paleoenvironmental maps were constructed for five time intervals, Late Oligocene, Middle Miocene, Late Miocene, Lower Pliocene and Lower Pleistocene.

Sedimentology

Outcrop-cores

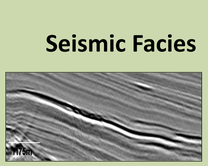
Upper Guajira outcrops

Biostratigraphy



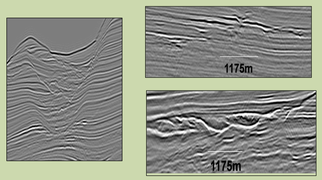
23 well –biostratigraphic data

Seismic Facies



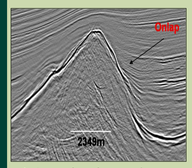
Olaya & Ramírez, 2003

Laterally continuous sheet-like reflections

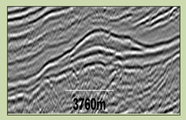


Shaughnessy & Walch, 2000

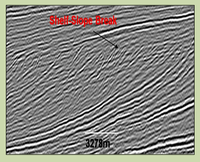
Channel and canyon features



Interval onlapped the basement



Carbonate mounds

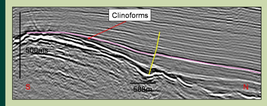


Clinoforms

Analysis of 40000 Km² of 2D seismic data

Diagram showing the different data type used in the paleoenvironmental-map constructions.

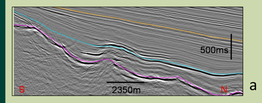
RESULTS 4



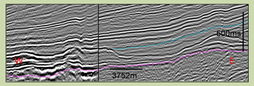
Late Oligocene

Late Oligocene seismic facies. The image shows Clinoforms in the Upper Guajira

Middle Miocene



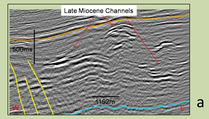
a



b

Middle Miocene seismic facies **a** Sheets sands **b** Carbonate mound

Late Miocene



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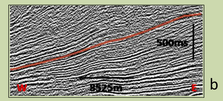
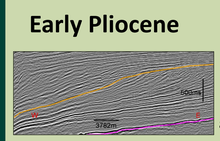


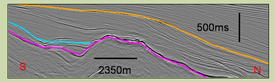
b

Late Miocene seismic facies. **a** Channel complex **b** Clinoforms of Ranchería Delta

Early Pliocene



a



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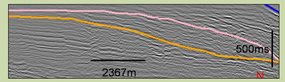
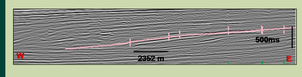


c

Early Pliocene seismic facies. Clinoforms of: **a** Rancherías **b** Carpintero **c** Upper Guajira

Early Pleistocene



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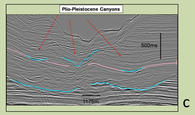
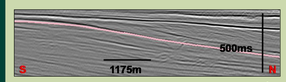


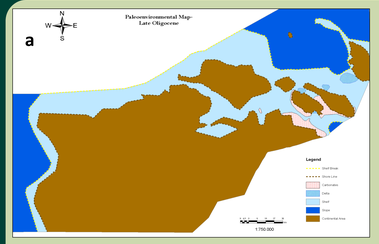
c

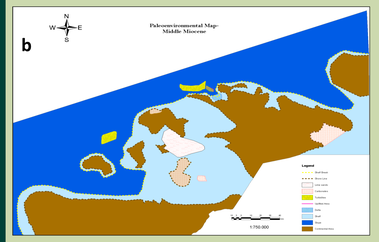


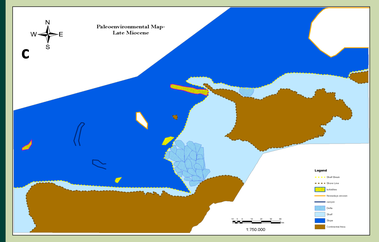
b

Early Pleistocene seismic facies. Clinoforms of: **a** Upper Guajira **b** Carpintero **c** Plio-Pleistocene Canyons

DISCUSSION-CONCLUSIONS 5



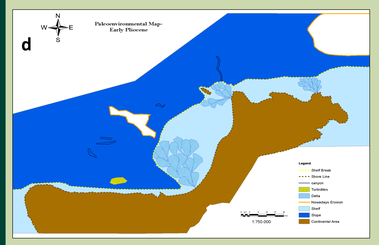




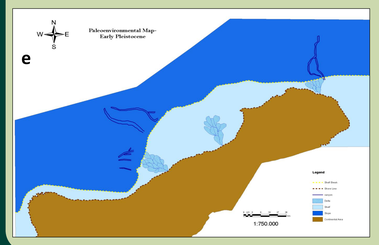
- Four river delta systems: (1) Rancherías (Late Miocene), (2) Carpintero (Late Miocene), (3) Chimare (Early Pliocene?). (4) Upper Guajira (Late Oligocene)

- Late Miocene increase in sedimentation rate in Lower Guajira, due to 0.33 Km/Ma SNSM exhumation rate (Cardona et al., 2008).

- Carbonate facies in Late Oligocene and Early Miocene.



- Three main sand-bearing reservoir elements: sheets, channels, and deltas.



Paleoenvironmental Reconstruction of Northern Colombia **a** Late Oligocene **b** Middle Miocene **c** Late Miocene **d** Early Pliocene **e** Early Pleistocene. Maps not palinspastically restored

REFERENCES 6

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