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Cenozoic Seismic Sequence Stratigraphic Analysis of the Suriname Margin, South America

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Introduction

Latest understanding has shown that application of conventional seismic sequence stratigraphic methods on shelf-to-slope transition environments is difficult. The Suriname margin of the equatorial Atlantic is the youngest post-rift margin of the Atlantic and should; therefore, be the least complex (Fig. 1). It is the objective of this study to apply latest sequence stratigraphic principals to data from this margin in an attempt to understand the relative roles of external forcing functions such as sea level, sediment input and tectonics to development of the margin

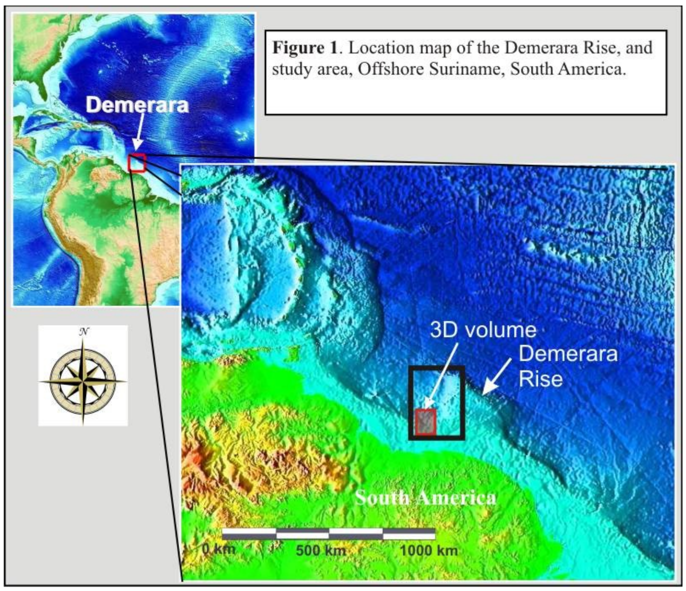

Figure 1. Location map of the Demerara Rise, and study area, Offshore Suriname, South America.

Methods

Regional 2D and a large 3D seismic volume span the shelf to slope transition zone offshore Suriname. With these data, Cenozoic strata were placed into a sequence stratigraphic framework using the method of accommodation succession, proposed by Neal and Abreu (2009) (Figs. 2 to 4). Seven key reflections (Fig. 3) were correlated to the North Coronie-1 industry well and Ocean Drilling Program Leg 207 Site 1257. These reflections date as approximately Early Oligocene, Early Miocene, lower Middle to Late Miocene, Early Pliocene, Late Pliocene, Early Pleistocene, and the present day sea-floor. Seismic reflection stacking geometries were interpreted into the context of lowstand, transgressive, and highstand systems tracts (ST) with associated maximum flooding surfaces based on facies descriptions and reflection geometries (Fig. 4).

Results and Discussion

Apparent pro-gradational followed by onlapping aggradational clinoforms are interpreted as lowstand systems tracts. Paleo-channel incision on the outer shelf and slope with linked, down-dip lower slope mass transport and turbidite deposits are interpreted as lowstand wedges. Generally, lowstand and highstand systems tracts are separated by an unconformable transgressive surface and packages of back-stepping transgressive reflections that onlap and aggrade the depositional profile. Transgressive systems tracts are then capped by the formation of the maximum flooding surface, marking the change to highstand systems tracts. Highstand tracts are generally recognized on the outer shelf and slope as clinoform packages with reflection geometries indicating aggradation followed by slow then rapid basinward progradation determined from the relative thickness of individual clinoforms. Degradational reflection stacking occurs during a drop in base level; recognized as clinoforms that rapidly prograde basinward with offlap breaks that step into the basin.

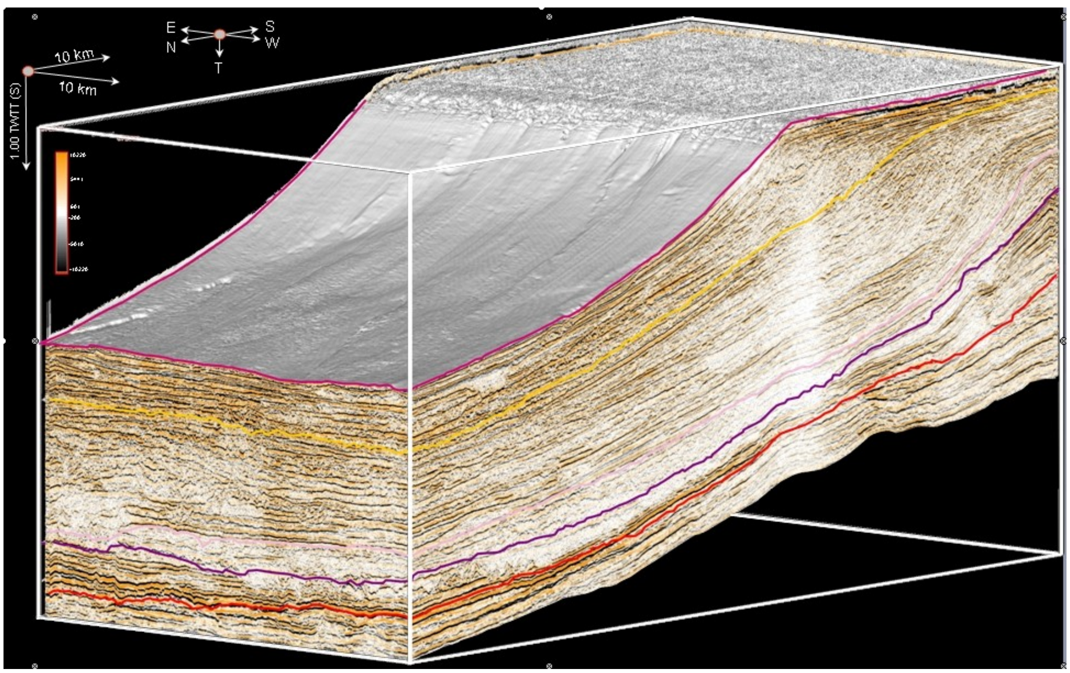

Figure 2. 3D perspective view of the seafloor and subsurface reflection patterns, offshore Suriname.

In the Middle Oligocene, Early-Middle Miocene, and Early-Late Miocene, significant erosion produced outer shelf and slope channels with minor gully incision. These are interpreted as sea level lowstands. Channel flow generally bypassed the upper to middle slope region, resulting in turbidite deposits accumulating in lowstand wedges. During the Late Oligocene, Middle Miocene and the middle Late Miocene, backfilled channel and gully incisions are associated with high sedimentation interpreted to result from periods of rising sea level and transgressive phases culminated in the formation of a maximum flooding surface. During the Latest Oligocene-Earliest Miocene, Middle to Late Miocene, and Latest Miocene, outer shelf deltas aggraded and sediments drape the outer shelf and upper slope with linked condensed sections in the lower slope regions. These patterns are believed to represent periods of high sea-level.

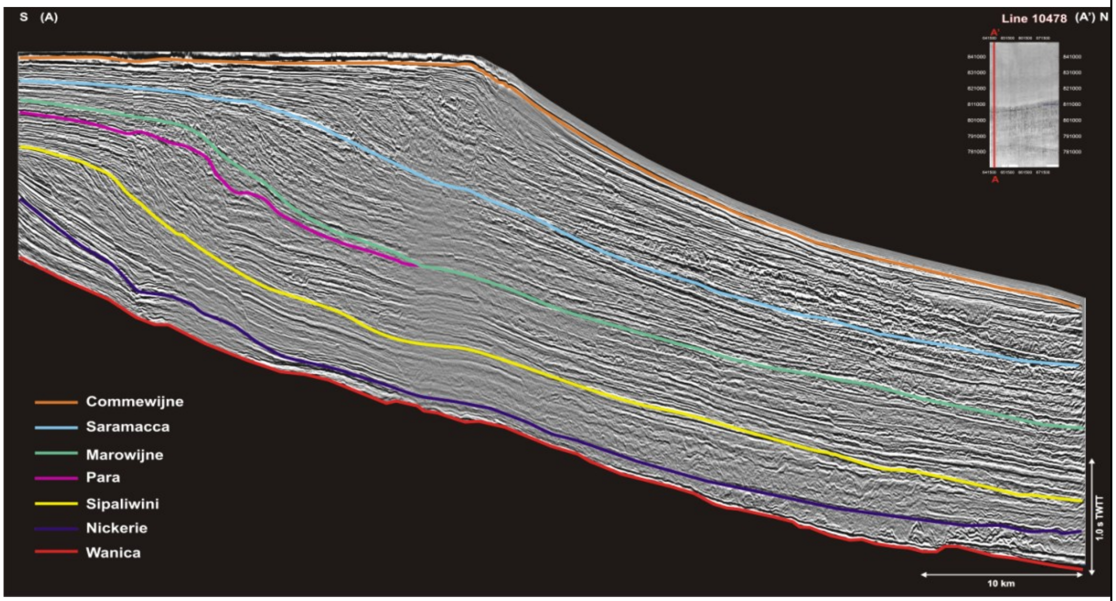

Figure 3. Dip profile showing major sequence boundaries.

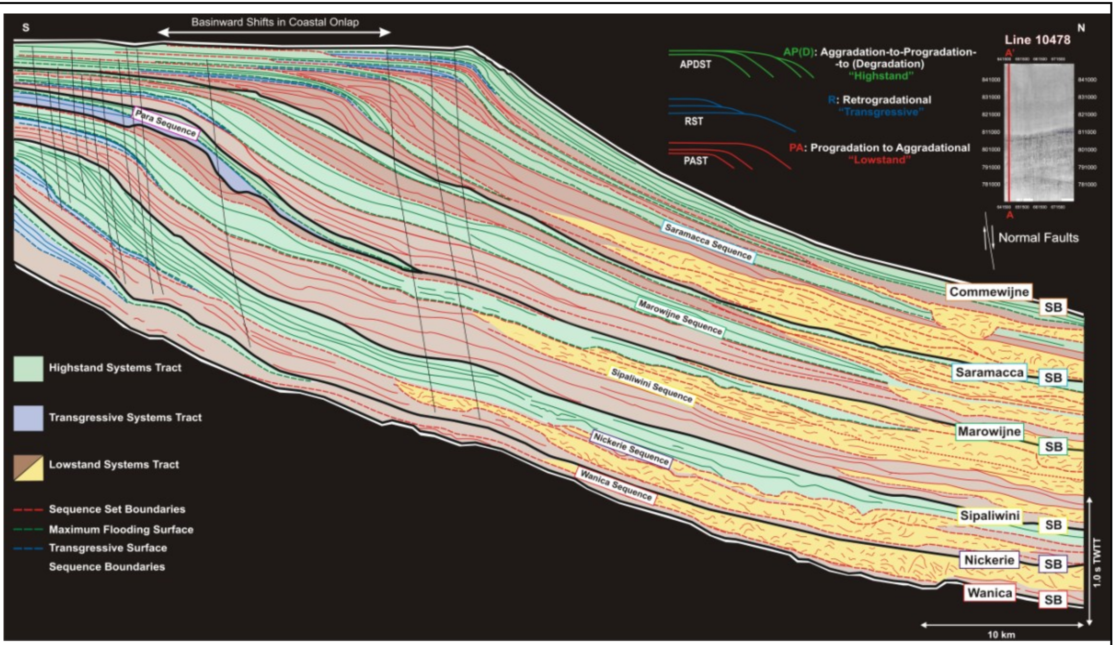

Figure 4. Seismic sequences identified in dip profile

Conclusions

The Suriname margin's Cenozoic sequence stratigraphic framework consists of six sequences that correlate to paleooceanographic sea-level changes. Within each sequence, high frequency systems tracts are identified. Overall the stratigraphic architecture of the Suriname margin is recognized as having; 1) stratigraphic development influenced by sea level changes, 2) minimal effects of tectonic activity since the Late Cretaceous, and 3) high sedimentation rates resulting in the overall progradation of the margin. Sea level cycles and sediment supply are the primary controls on the margin's evolution. Mass transport deposits in deep water and erosional unconformities in shallow water result during sea level low stands. Periods of transgression and sea level high stands are marked by shelf margin aggradation with minimal sedimentation on the slope. Short-lived sea level rises and falls predominate from the Late Miocene to end of the Pliocene, followed by even higher frequency shifts from the Late Pliocene to Recent. This latter time period is marked by high sedimentation rates, minor gully incision, lower slope infilling and rapid progradation of the shelf break. The shelf break advanced seaward by nearly ~ 20 km to its present day location during this time.

In terms of an exploration model, lower turbidite deposits may provide significant amounts of clean reservoir sands, with potential for being charged by Late Cretaceous source rocks. These deposits are the result of sea level lowering and channel and gully incision in the outer shelf providing sediment conduits to the deep water regions. These deposits are likely bound by marine sediments forming possible stratigraphic traps during periods of transgression and highstand.

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