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Evidences of a Shelfal Hyperpycnal Deposition in the Pliocene Sandstones in the Oilbird Field, SE Coast, Trinidad: Impact on Reservoir Distribution and Field Re-Development

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The Pliocene Sandstones in the Oilbird Field traditionally have been interpreted as deposited in wave-dominated prograding shoreface systems. Prograding shoreface consists of lower, middle, and upper shoreface facies deposited below sea level and within the zone of wave action and storm influence. Classical shoreface deposits are characterized by thin sandy layers with flaser and truncated wave ripples (Figure 1). Typically, these are heterolithic deposits, with a proportion of fine materials that depends on its position along the beach profile. Sedimentary structures like micro-hummocky are also common and are considered as a diagnostic feature of storm deposition in the shoreface (Walker, 1996). Wave diffusion processes can be easily recognized in the field by the widespread occurrence of truncated wave ripples of different orders and magnitudes. Detailed sedimentological interpretation of 10,157 ft of borehole image data previously integrated with 59 ft of core data has led to the development of a new depositional model for the area under study (Schlumberger, 2007). The core data did not show any diagnostic characteristics of a shoreface deposit. No wave ripples were interpreted in these sandstones.

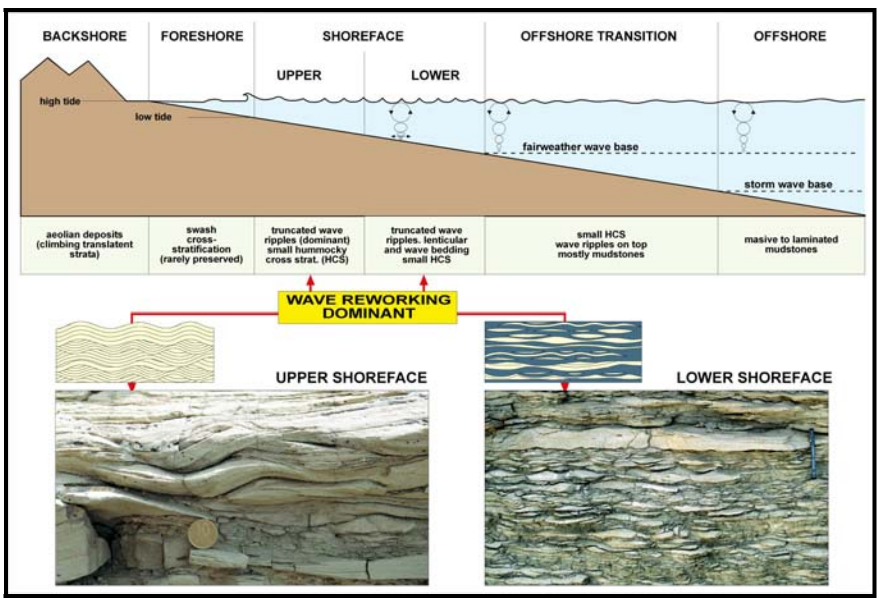
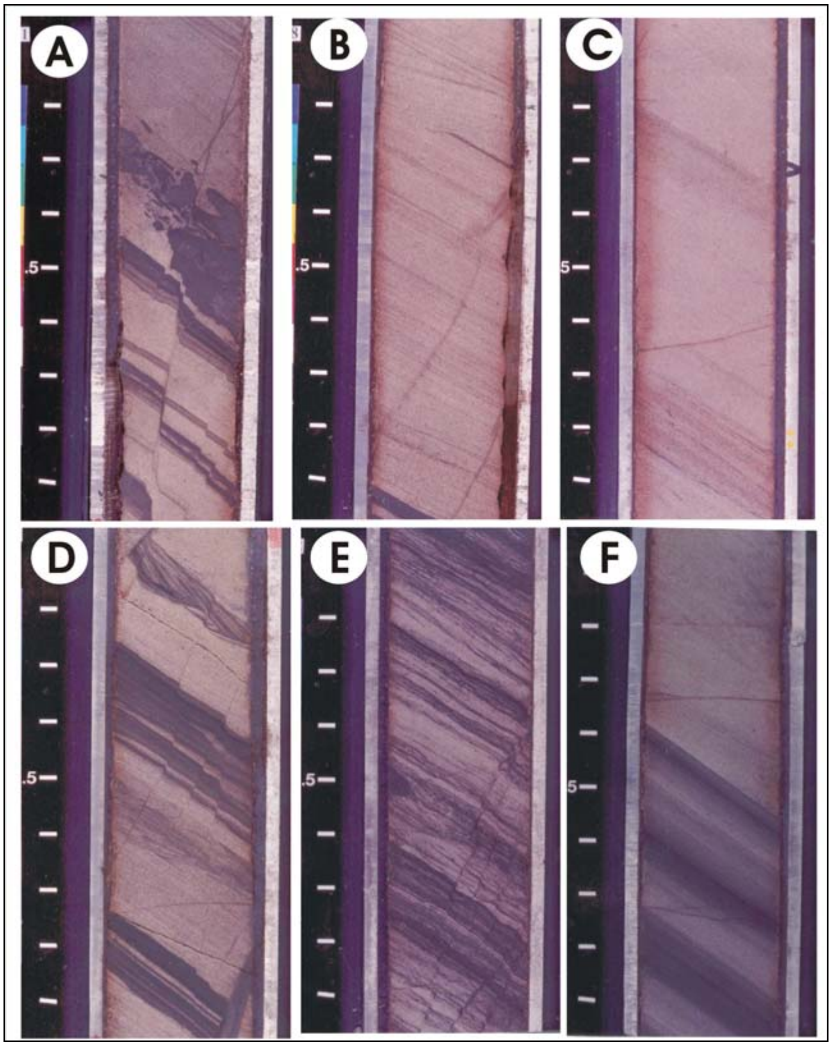


Figure1. This a typical shoreface profile, with examples of fossilized wave ripple structures both in upper and lower shoreface sequences.

A new image- and core-derived facies scheme was generated for the Pliocene Sandstones in the Oilbird Field based on the origin of the sedimentary structures. The Pliocene sandstones are characterized by rhythmic fine to very fine parallel laminated and massive sandstones, thick medium to fine grained sandstones with asymptotic cross stratification interbedded with fine grained sandstones with hummocky cross laminations and oscillatory ripple laminations, plant-derived carbonaceous material and thinly laminated sandstones and siltstones (Core photograph plate). The associated occurrence of moderate plant debris also favored the interpretation of a direct fluvial supply by rivers in flood. Lamination in massive sandstones is diffuse, and appears as a recurrent feature within the massive intervals. The core data show very little to no bioturbation. The recurrence of massive and parallel laminated sandstones without any break indicates a fluctuating overpassing sustained turbidite flow. The occurrence of hummocky cross laminations (S2h lithofacies) and oscillatory ripples (lithofacies S3w) could be indicative of shallow water conditions or a confined depocenter. The presence of some evidences of wave reworking at the top of major sandstone bodies is not frequently related to continuous wave diffusion processes, but rather a consequence of the final reworking by the oscillating component of a density flow. In most cases, the oscillating component can be induced in the receiving basin by the disturbance provoked by the volume of the incoming flow in shallow water bodies (Zavala et al., 2007). The shallow water condition for the deposition of the Pliocene Sandstones in the Oilbird Field is supported by the biostratigraphic results in the area. This study reported inner to outer neritic conditions for the deposition of the main OB40 and OB30 reservoir units. The Pliocene Sandstones (OB40, OB30 and OB20 reservoir sands) in the Oilbird Field have been interpreted as being deposited from an over-passing sustained turbulent flow or fluvial-derived hyperpycnal flows progressive filling of a fault-bounded depocenter. The evidence of plant material associated with silts and very fine grained sandstones are here related to lofting processes which are the diagnostic facies of hyperpycnal flows. Lofting deposits tend to predominate towards the flow laterals (levee) or the paleotopographic highs. Previous proposed depositional models from the available core data are: (1) A line-sourced slope fan deposition filling in a normal fault related basin (Core Lab 2004) and (2) Deposition from a fluvially-dominated braided delta system (OMNI Laboratories, 2004). The term slope fan, according to Wood (2000), describes the turbiditic sand deposits on the lower parts of the down-dropped side of a growth fault. The Core Lab study, based on the sedimentary structures, indicated an episodic dumping of sand rather than a sustained current deposition. We believe that the presence of composite beds (Zavala et al., 2007) or the recurrence of massive and parallel laminated sands indicates, instead, evidence of a sustained or near-continuous deposition from a quasi-steady turbulent flow. The OB40 and OB30 reservoir sands show a progradational pattern reflecting the filling of a fault-controlled depocenter. The paleoflow data evidences an axial transport parallel to the fault system, indicating that these faults were active, creating progressively an accommodation space. The upper sand represents the final stage of sand accumulation, evidenced by a change on paleotransport direction towards the east. Figure 2 shows a schematic model of the axial transport of these channelized flows filling up the lows. Laterally, the lofting facies can be interpreted either as a topographic high or a lateral position of the channelized flow. Unfortunately, the seismic data was not available to support this model.

Zavala (*in press*) developed a model about the evolution of a hyperpycnal discharge in a basin dominated by extensional tectonics. This model shows how hyperpycnal flows could fill the accommodation space created during the extensive tectonics in the Columbus Basin resulting in NW-SE oriented elongated sand bodies that have been traditionally interpreted as shoreface or strand plain deposits (Wood, 2000; Leonard, 1989; among others). It is very important to understand the evolution of the structures in Oilbird Field and its relationship with the creation of accommodation space. This will help to predict the accumulation of sands and its distribution for future prospects.



Core photograph plate. **A**. Thin bed, clay clast conglomerate within a massive to laminated, fine grained sandstone, interbedded with organic-rich silty laminations. **B**. Parallel laminated fine grained sandstones and hummocky cross stratification towards the top. **C**. Massive fine grained sandstones are usually associated with parallel laminated, fine grained sandstones. These are most frequency facies in the field. **D**. Presence of oscillatory ripples towards the top of the photograph, interbedded with thinly laminated carbonaceous rich siltstones and very fine grained sandstones. Very scarce bioturbation is found along the core. **E**. Heterolithic facies that consists of thinly laminated carbonaceous rich siltstones and very fine grained sandstones interbedded with parallel and ripple laminated, very fine grained sandstones. **F**. Massive, fine grained sandstones underlain by thinly laminated, carbonaceous rich, siltstones and very fine grained sandstones. No bioturbation effect is observed.

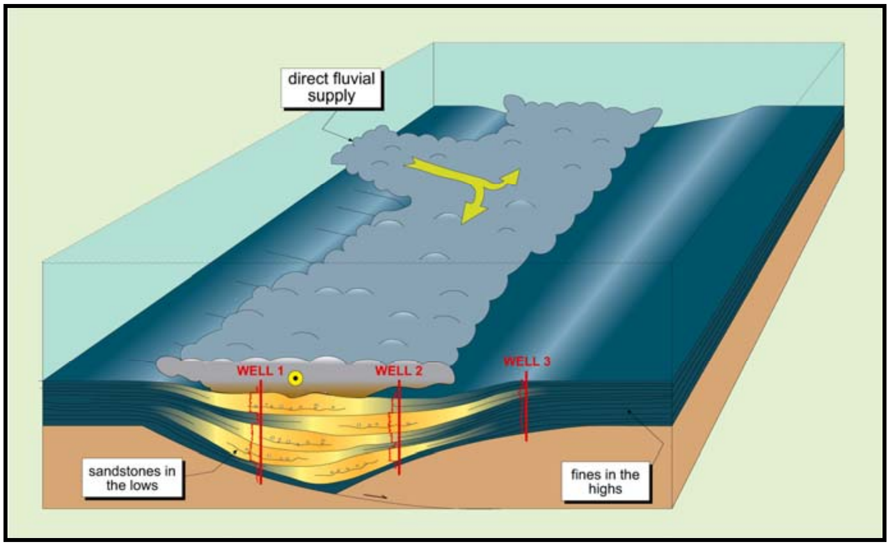


Figure 2. A schematic model of how the fault-bounded depocenters are filled by axial hyperpycnal flows in the Oilbird Field.

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