Structural and stratigraphic architecture of the Tumbes forearc basin (Northern Peru)

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1. Introduction

Eocene to Quaternary sedimentary infill of the Tumbes basin consists of numerous lithostratigraphic units i.e. Plateritos, Máncora, Heath, Zorritos, Tumbes, Mal Pelo, La Cruz formations. We carried out a reappraisal of these lithostratigraphic units based on tectonic and sedimentologic data. The aim of this paper is to establish the stratigraphic architecture (Catuneanu, 2002) of the Tumbes basin (Fig. 1) characterizing and mapping the successive depositional environments and deciphering base-level changes at the shoreline.

2. Structure

The Tumbes basin corresponds to a broad Neogene and Quaternary half-graben (60-80 km wide) limited to the west by the Peru Bank and an east-dipping NE-SW normal fault, which is part of the Dolores-Guayaquil megashear zone (Deniaud et al., 1999). Offshore seismic data show that tilting of the Tumbes half-graben developed after the Tumbes Fm sedimentation and started probably in the Pliocene. This tilting provoked westward gravity-driven deformation and growth fault systems associated with roll-over anticlines (Fig. 2). Growth faults soled to décollement in the black shales of the Heath Fm. In its onshore part, the Tumbes basin is also westward tilted and deformed by east-dipping listric normal faults.

3. Sedimentary Facies and stratigraphic architecture.

The identification of depositional sequences is based on numerous sedimentary sections mesured in the NW-SE valleys (Fig. 1-Quebrada Plateritos, Quebrada Rubio and Quebrada Animas).

The synthetic section (Fig. 3) is 4 km thick. It displays an overall coarsening and thickening upward pattern. Its basal part is composed of large-volume debrite-turbidite couplets indicating base of slope depositional environment and onlapping basinal fines. The basal surface of this sedimentary package is a submarine erosion surface and is interpreted as a regressive slope onlap surface. This catastrophic erosion records in the basin the onset of base-level fall at the shoreline and therefore considered as a basal surface of forced regression. During base level falling, slope fans which belong to a falling stage systems tract developed coevally with the formation of a subaerial unconformity. Such unconformity is recorded at the base of the coastal Plateritos Fm by a deep continental scour surface. This subaerial unconformity is overlapped by coastal deposits which record base level rise. The top of the Plateritos Fm exhibits a sharp grain-size decrease therefore interpreted as a maximum regressive surface. Resting on this surface are fine grained sandstones embedded in marls and displaying wave ripples. This transgressive systems tract is covered with coarsening and thickening upward deltaic deposits over a maximum flooding surface. Therefore this prograding package of the Mancora Fm is interpreted as a highstand systems tract. Within the Mancora Fm a deep erosion surface occurs separating the previous HST from coarsening upward alluvial strata, which are interpreted as a lowstand incised valley fill. Resting on this lowstand systems tract, estuary of tidally-controlled sedimentation develops into a fining-upward transgressive systems tract. The Heath Fm is developing above this transgressive systems tract and consists in seaward stacking pattern of shallowing upward parasequences. Hence we interpret it as a highstand systems tract. This arrangement is interrupted by sediment gravity flow deposits exhibiting clasts of the Mancora Fm. Hence this lowstand shelf-perched is controlled by base level fall and interpreted as a falling stage systems tract. It is overlaid by the prograding Zorritos Fm which is incised then onlapped by the Cardalitos Fm.

4. Conclusions

The structure of the Tumbes can be clearly defined as an extensional forearc basin. Extensional structures are linked to a plurikilometric scale tilted block associated with southeast dipping border fault of the Peru Bank, and consist of gravitational proximal raft structures the leading normal faults of which are branched onto the Heat décollement. This structural framework is superimposed on the sequence architecture. Most of the raft structures are younger than the Middle Miocene erosional event. This may basically change the topography of the shoreline region which tends to become steeper. As a result, the transgressive systems tract of the Cardalitos Fm is directly onlapping the Middle Miocene subaerial unconformity whereas preceding subaerial unconformities were overlapped by lowstand systems tracts. Therefore, the morphology of the Tumbes basin changed from a shelf setting basin in the Oligocene-Lower Miocene to acquire tectonically-controlled ramp configuration after the Middle Miocene.

References

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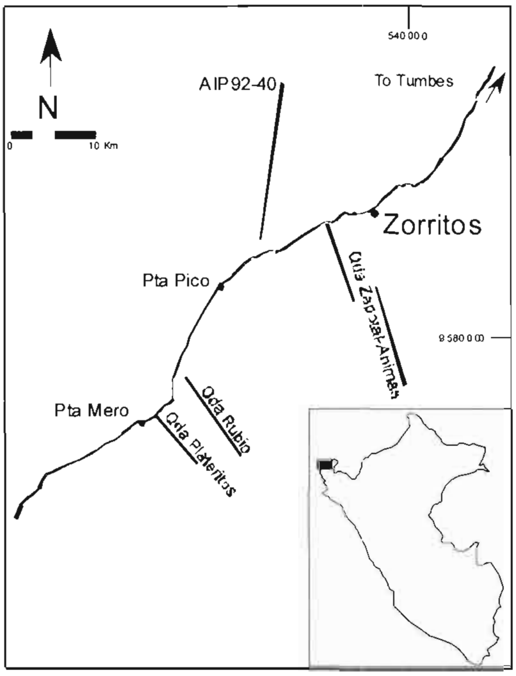

Figure 1. Location map of the Tumbes basin

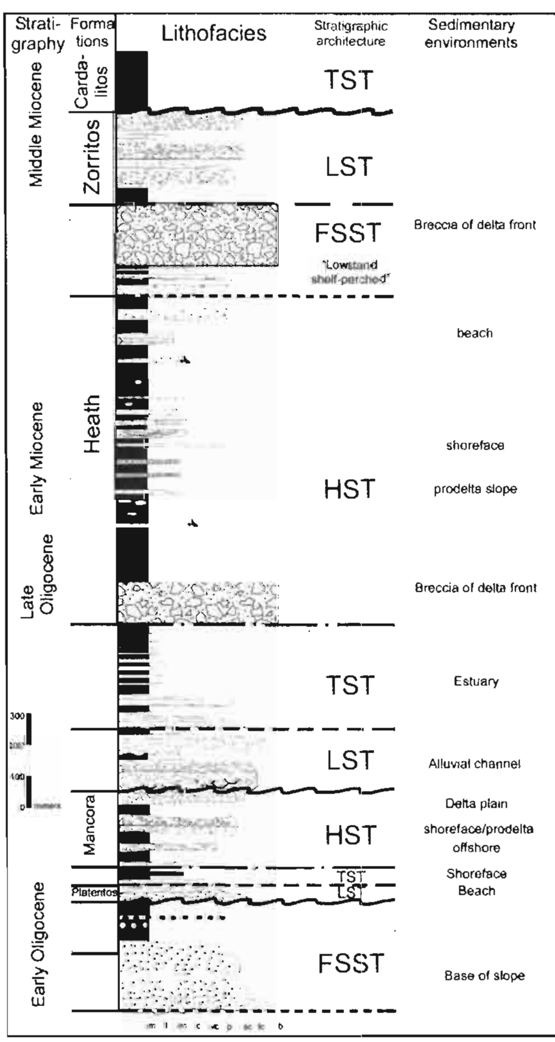

Figure 2: Synthetic stratigraphic column of the Tumbes basin

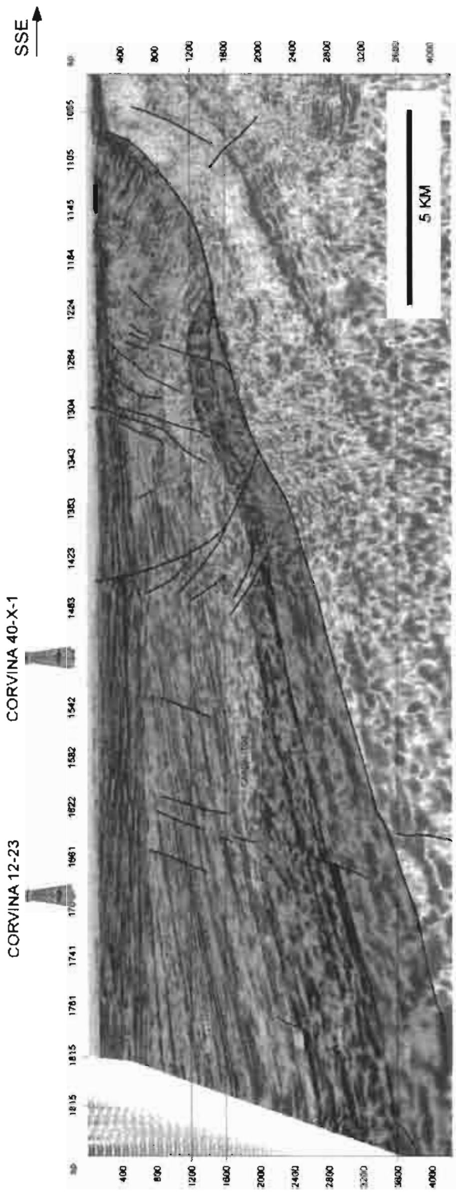

Figure 2: Seismic section AIP92-40 displaying the proximal part of a raft structure (location on fig.1).