Additional Type I Sequences in the Lower Miocene
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The lower Miocene, the Burdigalian and Aquitanian Stages, has previously been interpreted separately Vail et al. (1977) and Haq et al. (1988) as being deposited in four third order sequences. The boundaries of the lower Miocene occur just above the sequence boundaries at 25.5 and 16.5 million years ago. Efforts at the Minerals Management Service to construct a stratigraphic framework have resulted in the inclusion of four previously unrecognized Type I sequence boundaries. All the additional sequences are in the Aquitanian portion of the lower Miocene. The age dating of these sequences has ben based mostly on benthic paleontologic data, as little planktonic information has been provided to the Minerals Management Service.

Prentice and Matthews (1988),using data on oxygen isotopes of deep-water benthic verses planktonic foraminifera, drew a glacioeustatic curve for the period from 70 million years ago to the present. This curve shows that the sea-level, based on ice volumes, was between 80 and 160 meters below the present level and each rise of fall in the lower Miocene was 20 to 40 meters. Based on the Milankovitch-band insolation changes a theoretical sea-level curve for any 5 million year span of the Tertiary was produced, Prentice and Matthews (1991). This curve shows 6 sea-level falls on the order of 50 to 100 meters in a 5 million year period. Ye et al. (1993( put forth evidence that the lower Miocene sedimentation has been affected by even the highest frequencies of the Milankovitch-band insolation changes. In this paper the authors interpret that there are falls in sea-level in the range of 20 to 40 meters at time intervals averaging 0.8 million years. These values for sea-level fluctuations are the same as anticipated from the Matthews and Frolich (1991) glacioeustatic curve based on oxygen isotopes.

The magnitude of sea-level fluctuations for the lower Miocene, interpreted by us to have caused Type I sequence boundaries, is on the order of 50 to 100 meters which corresponds closely with the theoretical sea-level changes based on insolation calculated by Prentice and Matthews (1991). The magnitude of the rises and falls of sea-level creating these Type I sequences is based on paleoecology data for marine shales, depositional modeling for sands, seismic facies, and sequence studies. These data are combined by constructing geologic cross sections at both the regional and field level. The seismic and geologic sections shown are from Mustang, Matagorda, High Island, ans West and East Cameron Areas of Federal waters.

Downthrown to the regional growth faults, middle to outer neritic shales have been incised by valleys in which were deposited fluvial and deltaic point bars. Upthrown to the growth faults in Western Mustang Island Area, the seismic facies is characterized by strong parallel reflectors, and only thin sands were deposited. This was interpreted as transgressive and highstand deposits of thin sands.

## Introduction

This presentation is the result of the examination of well and seismic data over most areas of the Gulf of Mexico, outer continental shelf, federal waters, where the lower

Miocene is productive.  This study also concentrated on fields where most of the production was from strata below the Siphonina davisi paleontologic zone top.  This area includes North Padre, Mustang, Matagorda, High Island, Sabine, West and East Cameron Areas.  In south Texas, the lower Miocene productive area is divided by a major growth fault system.  (See Study Area Map.)  In the area upthrown to the growth falls, the lower Miocene is 4000 to 5500 feet thick while in the downthrown area it is usually 14,000 to 16,000 feet and possibly up to 22,000 feet thick in some places.

For this presentation the top of the lower Miocene is placed at the top of the Amphistegina "B" zone and the base is placed at the top if the Bolivina perca zone. These foraminiferal zones are respectively nearly equal to the calcareous nannofossil zones Helicosphaera ampliaperta and H. Recta. These nannofossil zone tops are closely associated with the maximum flooding events in the sequence labeled TB1.4 and TB2.3 on the cycle chart provided by Haq et.al., 1987 or HA and HR on the 1992 TGS Cycle Chart.

The shelfal deposits of lower Miocene in both the south Texas and High Island through East Cameron Areas are dominated by deltaic sedimentation.  In the upper portion of the lower Miocene above Siphonina davisi, the major sand packages, which are over 800 feet thick, show excellent lateral continuity and can be identified over the entire region.  These sand packages in most cases have an overall coarsening upwards characteristic, indicating that they have been deposited by prograding systems with large areal extent.  The shelfal deposits downthrown to the growth faults below Siphonina davisi have very little lateral continuity even though the sand packages may exceed 1000 feet.  These packages often have a fining upwards characteristic that indicate deposition by waning or transgressive systems.

Because the additional Type I sequences occur between the sequence boundary at the base of the sequence labeled SB and above the flooding event in the sequence labeled HR on the 1992 TGS chart, the geologic and geophysical sections presented here only show these portions of the section.

## Methods of Investigation

An earlier study Blood, et al. (1990) identified more unconformities in the western Gulf of Mexico than could be accounted for on the global sequence chart of Haq (1988). In this earlier work, unconformities were identified by downcutting. On geologic data this downcutting was inferred where delta plain or alluvial plain point bars were cut into outer neritic or upper bathyal shales.  On seismic data downcutting was inferred where  basinward dipping reflectors were truncated in the downdip direction.  The earlier work of Blood et al. was confined to South Texas and did not examine the lower Miocene section in settings upthrown to the regional growth faults.

The paleontologic reports indicated that unconformities were present because different paleozones were missing from field to field. A further review of detailed paleontologic reports revealed the presence of oxidized layers in the portion of the lower Miocene below the top of the *Marginulina ascensionenis* zone in wells in Brazos, High Island, and West Cameron Areas. It was established that these oxidized zones could be associated with unconformities on geologic and geophysical data.

To establish that the intervals between the unconformities were sequences, well logs and seismic sections were analyzed by the methods described in Posamentier and Vail (1988) and Posamentier, Jervey, and Vail (1988).

The stratigraphic interval of interest in every well log was interpreted and divided into systems tract: highstand, transgressive, or lowstand. The lowstand tracts were further divided into basin floor fan, slope fan, incised valley, and prograding wedge complexes. The sands within these systems tracts were color coded. This was done for each sand on every log that was to be seismically analyzed. For the highly faulted fields in High Island through East Cameron Areas on Cross Section C-C', composite logs were constructed to show the restored stratigraphic section across each field.

The seismic sections were then interpreted for systems tracts and tied to the geologic interpretations by time to depth conversions. Where possible, the top of each systems tract and the top of the slope and basin floor fans were carried on the seismic sections using a 2-mile by 2-mile grid of data over approximately two-thirds the area where the lower Miocene is productive and a 2-mile by 4-mile grid over the remaining areas.

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Climate; Implications for Hydrocarbon Exploration: Armentrout, J.M., R. Bloch, H.C. Olsen, and B.F. Perkins, eds. Fourteenth annual research conference Gulf Coast Section of the SEPM, p. 287- 298Summary

* Careful sequence analysis reveals that the lower Miocene contains eight Type I sequences of Posamentier and Vail (1988).

* Each sequence contains the highstand, transgressive, and lowstand systems tracts of Posamentier and Vail (1988).

* Each of these sequences contains deep-sea fans in the lowstand systems tract which from their seismic characteristics fit the model for slope fans (Posamentier and Vail 1988).

* While sequence boundaries in some areas preserve fluvial erosion with incised valley fills, in most areas the lower Miocene sequence boundaries are wave-cut benches with bay muds, beach sands, or inner neritic clays onlapping oxidized, older, outer neritic shales.

* Sequences are most easily recognized on the downthrown side of growth fault systems. The rapid subsidence of the footwall (0.7 to 0.8mm/year) allows for sufficient accommodation (Jervey 1988) so that the shelf edge builds up instead of prograding. This results in each sequence having a lowstand prograding wedge on the basinward side of the fault system with slope fans, if present, being developed further basinward.

* Downthrown to the major growth faults in both the southern and northern areas, slope fans of successive sequences are separated on seismic data by a few strong reflectors. These reflectors are interpreted as lowstand prograding wedge with little preservation of the transgressive or highstand systems tracts.

* On the upthrown side of a growth fault, transgression occurs as a broad flat wave erosion surface at the top of the previous sequence. In these settings the transgressive systems tracts have only thin sands at their bases, and highstand progradations are represented by more distal shale- rich elements. Successive sequences are progressively sand enriched so as to form one apparent sequence of progradation and transgression in the lower Miocene between the *Discorbis "B"* and *Bolivina perca*, which are very major

condensed sections Haq et al. (1988).

* Reise, Olsen, and Rosen (1988) previously interpreted the lower productive intervals of the Matagorda Block 668 Field as being highstand fan deposits. The current interpretation places these productive sands in lowstand slope fans of the AC and GK sequences. See seismic line X-X' west of the field.

* This study infers that the additional sequences are third-order sequences. The data currently available to us for interpretation do not show any significant differences in the characteristics between these sequences.