ORIGIN AND DEVELOPMENT OF *Turborotalia pachyderma* (EHRENBERG)

Studies of the morphology and ultrastructure of *Turborotalia pachyderma* (Ehrenberg) support the concept that this species arose from *T. continuosa* (Blow) in the upper part of Neogene Zone 12; both species occur together up to the upper Miocene zones N16 or N17, which is the upper limit of *T. continuosa.* Early chambers in *T. pachyderma* have the highly arched, laterally directed aperture of *T. continuosa.* This is a lineage quite distinct from that leading from *T. globorotaloidea* (Colom) to the *Neogloboquadrina dutertrei* (d'Orbigny) group in the upper Miocene (N17-N18). The *pachyderma* group invariably has a well-developed thickened imperforate lip and the umbilicus is small or closed; the *dutertrei* group has an open umbilicus, and the apertural edge has only a smooth band (temperate forms such as the subspecies *subcretacea*) or toothlike flanges (tropical forms such as the typical *dutertrei*).

Preferential coiling ratios occur almost at the base of the range for *T. pachyderma,* derived from its ancestor *T. continuosa.* Sinistral populations adjusted to cold polar waters whereas dextral populations adapted to temperate waters, providing one of the better planktonic indices of paleoceanography for the late Neogene.

Upper Miocene and Pliocene forms have mostly 4 to 4½ chambers in the final whorl; the aperture varies from being almost a closed slit to more of an open arch. In the glacial Pleistocene, additional variants developed sometimes with 5 chambers in the final whorl; other variants show the progressive restriction of the aperture, especially the development of a highly thickened wall in polar waters.

In wall thickening, the early stage is that with little thickening (*"incompta"* of Cifelli), a second stage is that in which some thickening is added (*"pseudopachyderma"* of Cita, Silva, and Rossi), and finally a third stage is the typical thick-walled form. Wall thickening progressively reduces the depressions between the chambers until it is very difficult to recognize the individual chambers in extreme cases. This transition occurs as the populations settle progressively deeper in the water column.

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GEOLOGY OF OLIGOCENE HACKBERRY TREND, GILLIS ENGLISH BAYOU—MANCHESTER AREA, CALCASIEU PARISH, LOUISIANA

Local subsidence after Oligocene *Nonion struma* deposition created an elongate channel 15 mi long extending north-south from Indian Village field to South Manchester field; the channel ranged in width from 3 to 6 mi. This subaqueous channel was developed within the marine slope environment and subsequently was filled with Hackberry sediments supplied from an updip delta.

The area can be subdivided into updip and downdip areas based on structure of the pre-Hackberry section and the lithology of the Hackberry section. The updip section is characterized by slump block faulting in the pre-Hackberry section and a dominant shale lithology in the Hackberry interval. The downdip section consists of strongly folded and faulted pre-Hackberry sediments; the lithology of the Hackberry section is dominantly shale with massive sandstones in the lower part.

The Hackberry section, which was deposited unconformably on the slope surface, contains the highest percentage of sandstones in the channel axis. Association of the sandstones with deep water pelagic shales, the geometry of the sandstone bodies, and the sequence of primary sedimentary structures strongly suggest that the sands were deposited by turbidity currents in deep water.

As Hackberry mud and sand deposition continued the channel was filled, the depositional slope was reduced, and less sands were carried downslope into the basin. In *"Cibicides hazardi* time" gradation was achieved and a prograding shallow-marine sequence was deposited.

Hackberry sandstones are productive in the study area, producing a condensate-rich gas from stratigraphic and structural traps.

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STRATIGRAPHIC CONTROL OF PRODUCTION FROM JURASSIC CALCARENITES, RED ROCK FIELD, WEBSTER PARISH, LOUISIANA

Although associated with structural reversal and closure against a post-Smackover fault, hydrocarbon accumulation at Red Rock field in the upper members of the late Jurassic Smackover and Buckner Formations largely is controlled stratigraphically by nondeposition or complete cementation of the reservoir facies. Red Rock is unique among the shelf-slope fields of Arkansas and Louisiana in that calcarenites of these members are productive on the downthrown side of a major fault. Petrographic study reveals no significant difference between calcarenites in downthrown and upthrown wells. Thus production may be expected from other areas which are now downthrown if they were favorably situated during deposition and diagenesis of the reservoir facies.

On the shelf slope, Smackover nonskeletal calcarenites were deposited as bars on shoals usually associated with slight structural uplift. Although Buckner calcarenites are similar to those of the Smackover, their geometry suggests a beach environment. A thick east-west bank of mixed facies was deposited regionally along the subsiding seaward edge of the shelf slope. Several transgressive units extend updip from this bank, and reservoir facies were deposited along the beaches, especially where high-energy conditions persisted for considerable periods of time on positive features such as at Red Rock. Between transgressions, lowering of sea level or lack of subsidence permitted southward progradation of evaporitic mudflats. Uplift of the continent caused seaward progradation of clastics and the sandstone of the "P" tongue of the Schuler Formation grades into Buckner mudstone. During deposition of the latter interval, maximum displacement occurred along the down-to-north fault.

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QUANTIFYING MULTIPLE WORKING GEOLOGIC HYPOTHESES—GEOLOGY AND COMPETITIVE OFFSHORE LEASE BIDDING

Federal waters in the Gulf of Mexico, south of Louisiana, constitute, through the competitive bidding effort, an excellent case study of state of the art exploratory technology.

In order of increasing variability, the judgment-controlling parameters are: (1) cost of drilling and production, (2) revenue per marketable quantity, (3) res-