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-

ervoir recovery efficiency, (4) entrapment history and area of accumulation, (5) functional reservoir thicknesses, and (6) the individual and group credibility of assigned values.

A precise combination of these parameters would establish an *in situ* reserve of hydrocarbons and its worth. Computers can minimize effectively the options for the involved disciplines excepting geology. The assignment of probabilities and values to multiple working geologic hypotheses continues to govern the assumed reserve and competitive bid. Expansion of measurement capability is probable, and its increased definition power will accentuate the role of conceptual geology.

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BLACK WARRIOR BASIN

The Black Warrior basin of Mississippi and Alabama is a potentially large oil and gas province with numerous possible reservoir units. This study excludes the rocks of the Ouachita folded belt in central Mississippi.

All the Paleozoic systems except the Permian are present in the study area and only the Cambrian does not crop out on the surface. There are at least 77,725 cu mi of sedimentary rocks, predominantly carbonates, in the basin.

Oil and gas have been, or presently are, produced from the Cambro-Ordovician, Ordovician, Mississippian, and Pennsylvanian in the Black Warrior basin. Analysis of the depositional and structural configuration of the area shows new trends that offer tremendous potential for a future major oil and gas province. The basin is considered a part of the Appalachian geosyncline. For each system present an attempt has been made to reproduce the tectonics affecting deposition and to depict the rocks as originally deposited. In this manner trends of high-energy deposition can be postulated, shorelines can be reconstructed and potential stratigraphic traps delineated. When these relations are analyzed, the known oil and gas shows in the Black Warrior basin become very significant.

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EAST BAY, MISSISSIPPI RIVER DELTA

Walsh discovered a quasi-permanent upwelling zone in East Bay, between South Pass and Southwest Pass of the Mississippi delta. He applied remote sensing to the study of physical characteristics of the sea surface around the delta. The purpose of cruise 68-A-14 of the R/V *Alaminos* was to verify Walsh's findings and to see if they were reflected in the bottom sediment.

In spite of a norther (cold front) coming over during the first days of the cruise and mixing the water body to a certain degree, the presence of cells with higher surface salinity and temperature than the surrounding water was substantiated. The bottom sediment distribution pattern shows an oval area underneath the salinity-temperature cells which is more silty than the surrounding sediments. Cores reveal that the cells were present during the accumulation of at least 7 m of sediment, indicating that the phenomenon is natural and not caused by warm brines released by the activities of the oil industry in this area.

Bathymetry analyses show a large variation in small topographic features and fewer gullies than indicated by Shepard a decade earlier. Comparing his and the present results, a trend of shallowing of East Bay seems to continue, but at a rather low rate.

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PRELIMINARY SCANNING ELECTRON MICROSCOPE OBSERVATIONS ON *Orbitolina* FROM LOWER CRETACEOUS GLEN ROSE FORMATION, TEXAS

The foram *Orbitolina* occurs profusely on the outcrop. The fossils vary in size and shape, probably depending on whether they are either microspheric or megalospheric in their initial stage. Their internal structure as well as external features are being studied. Heretofore, only the specimens with a megalospheric initial stage have been studied in detail. For this purpose, many specimens have been etched with dilute hydrochloric and acetic acids, and the results have been quite satisfactory except for the extreme outer marginal zone of the test.

Orbitolina, besides the embryonic apparatus, has a very complex and delicate internal structure. This structure is divided into 3 zones: the central complex, the radial, and the marginal. Preliminary observations were concentrated on the radial zone in general, and on the marginal zone in particular, as these are present in all specimens and play an important role in the test.

The radial and marginal zones consist of chambers, and the chamber passages with connecting tubes, called stolons, cover and encircle the entire test in successive offsetting layers. This pattern is striking and beautifully delicate. The chamber walls, as well as the chamber passages and their stolons, apparently have been strengthened by the cementation of calcite crystals, as evidenced by the holes left after etching. Between the chambers, chamber passages and stolons, the living *Orbitolina* may have filled the space with crystals and foreign material of different sizes. The finest crystals were observed in the outermost part of the marginal zone and the coarser seem to have been confined to the chambers and chamber passages.

Many specimens were etched to obtain the chamber, chamberlets, and cellules of the marginal zone. Only 1 specimen was successfully etched, yielding several chambers with chamberlets and cellules. After the crystals between the chamberlets and cellules were dissolved by acid, voids or empty spaces remained. These, when observed with transmitted light, appeared to be the features previously described as "partitions" and/or "plates" in axial and horizontal thin sections of *Orbitolina.*

Without the aid of the scanning microscope, some minute details within *Orbitolina* either would not have been known, at least to the writer, or would have been difficult to interpret using only the stereoscopic microscope. These observations, and others to be made in the near future, will contribute toward making the morphology of *Orbitolina* more readily understood.

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GRAND ISLE BARRIER ISLAND, LOUISIANA—HUMAN ACTIVITY IN NATURAL DYNAMIC SYSTEM

Grand Isle, Louisiana, is a recently formed barrier