

water from the hard geopressed zone has occurred have three identifying characteristics: low fluid pressures, high formation-water salinity values, and residual high pressure areas. These areas are considered to be highly prospective places to search for hydrocarbon accumulations. In the study locality there are five areas below which a vertical flush has occurred from the hard geopressed zone and each area contains commercial accumulations of hydrocarbons.

Pressure, temperature, and salinity studies, when coupled with lithology and structure, add a new dimension to hydrocarbon exploration and should definitely be used in the search for new reserves of oil and gas.

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Ostracode Biostratigraphy of Lower Oligocene (Vicksburgian), Mississippi and Alabama

Ostracodes are abundant and diverse in most samples collected from clastic and carbonate facies of the Vicksburg Group (Mint Spring, Marianna, Glendon, Byram, and Bucatunna Formations) and the underlying Red Bluff and Bumpnose Formations. About 92 species have been identified from 125 samples collected from measured sections and cores from Mississippi and western Alabama. Graphic correlation, no-space graph, and principal coordinate analyses of the data have resulted in a zonation that allows more precise correlation of the lithostratigraphic units than heretofore existed in the literature.

The sequence is divided into three successive first-appearance interval zones, defined, oldest to youngest, on *Actinocythereis dacyi*, *Aurila kniffeni*, and *Actinocythereis rosefieldensis*. The top of the *A. rosefieldensis* Zone is defined by the first appearance of *Leguminocythereis quadricostata*. In Mississippi, the Red Bluff is placed in the *Actinocythereis dacyi* Zone; the base of the *Aurila kniffeni* Zone is approximately coincident with the base of the Mint Spring; and *Actinocythereis rosefieldensis* first appears in the upper part of the Glendon. The Byram and the Bucatunna, where it is fossiliferous, are included in the *Actinocythereis rosefieldensis* Zone. In western Alabama, the basal carbonate rocks of the Oligocene, commonly referred to the Red Bluff by other workers, are here considered to represent the westernmost extent of the Bumpnose; the overlying dark clays, usually referred to the nonmarine to brackish or near-shore marine Forest Hill, are here placed in the Red Bluff. Both the Bumpnose and Red Bluff represent the *Actinocythereis dacyi* Zone. The ostracode data suggest that the Mint Spring and the lower part of the overlying Marianna of western Alabama are older than the Mint Spring of Mississippi and therefore correlate with the Forest Hill. This correlation is confirmed by analysis of occurrence data for the *Pecten perplanus* lineage. The upper part of the Marianna in western Mississippi is included in the *Aurila kniffeni* Zone. No ostracodes were recovered from the Glendon in western Alabama; *Actinocythereis rosefieldensis* is first found in the Byram.

Published and unpublished planktonic foraminifer data indicate that the *Actinocythereis dacyi* and *Aurila*

kniffeni Zones are approximately correlative with the *Cassigerinella chipolensis*-*Pseudohastigerina micra* Zone (= P18 and P19). The *Actinocythereis rosefieldensis* Zone approximates the *Globigerina ampliapertura* Zone (= P20). Published calcareous nannofossil data indicate that the *Actinocythereis dacyi* Zone closely approximates the *Ericsonia subdisticha* Zone (NP21). The *Aurila kniffeni* and lower *Actinocythereis rosefieldensis* Zone correlate with the *Sphenolithus predistentus* and *Helicopontosphaera reticulata* Zones (NP22 and NP23, undifferentiated). Ostracode and calcareous nannofossil data from South Carolina indicate that the base of the upper Oligocene *Leguminocythereis quadricostata* Zone, and, therefore, the top of the *Actinocythereis rosefieldensis* Zone, is within the calcareous nannofossil *Sphenolithus distentus* Zone (NP24). The upper part of the *Actinocythereis rosefieldensis* Zone and the lower part of the *Leguminocythereis quadricostata* Zone are apparently represented in Mississippi and western Alabama by the unconformity between the Bucatunna and the overlying Chickasawhay Formation. The latter formation is of late NP24 and late *Leguminocythereis quadricostata* Zone age.

A study of the distribution of ostracode genera thought to be cogent environmental indicators and a species of *Trachyleberidea* that has trefoil surface ornamentation indicates that the entire sequence below the Byram in western Alabama was deposited in relatively deep waters, that is, probably at outer sublittoral depths. This sequence includes the Red Bluff clays previously thought to represent an eastward tongue of the deltaic Forest Hill Formation. In western Mississippi, deeper water indicators are present in the upper part of the Mint Spring through Glendon interval, but they are not dominant. The lower part of the Mint Spring and Byram are dominated by inner sublittoral forms. In eastern Mississippi, the Red Bluff, Mint Spring, Marianna, and Glendon represent open-marine, probably middle sublittoral, sedimentation. No ostracodes were obtained from rocks that could unequivocally be said to represent the Forest Hill Formation. The Byram in eastern Mississippi and western Alabama was deposited at inner sublittoral depths, as was the marine part of the Bucatunna. The presence of *Jugosocythereis* in all the shallow-water facies strongly suggests that tropical to perhaps subtropical conditions prevailed during deposition of these Vicksburgian sediments.

Seven new species are proposed: *Ghardagliaia obovata* Mumma, *Hermanites moorei* Hazel, *Leguminocythereis quadricostata* Mumma and Hazel, *L. alata* Hazel, *L. edwardsae* Hazel, *Patellacythere comptonae* Hazel, and *Loxocncha pseudoinflata* Huff and Hazel.

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Paleoenvironments and Trace Fossils of Large Aggrading Delta Margin Embayment—Upper Woodbine Formation of Northeast Texas

The broad Lewisville embayment of northeast Texas covers an area of 30,000 sq km and developed during the latter half of Cretaceous (Cenomanian) Woodbine deposition as a result of reduced clastic influx and bypassing of sediment toward the south, where deltaic sys-

tems persisted. Strike-oriented shoreline sandstone bodies separated by finer grained shelf and back-barrier sediments are the dominant feature of the Lewisville Member. This marine-dominated succession reflects significant aggradation which kept pace with vertical rates of delta sand accumulation in adjacent areas along depositional strike.

Classical regressive beach sequences are rare in outcrops of the strike-oriented sandstones. Instead, there is evidence of substantial modification by tidal channel incision, or by partial reworking during episodes of low-energy marine inundation. External and internal geometry of these sandstones is thus highly complex. Trace fossils are abundant and indicate locally discontinuous sedimentation. *Thalassinoides* and *Ophiomorpha* are dominant, but escape burrows characterize some beds. Oyster reefs developed in tidal channels and interbar depressions, and along bay or lagoon margins. Clays and silts of coastal lake, bay, and lagoon origin reflect seasonal variation in sediment supply and water chemistry. Small flood-tidal deltas and washovers developed in places along the seaward margins.

Fluvial facies are prominent in outcrop but are not reflected in subsurface sandstone isoliths, presumably because of the volumetric dominance of the strike-oriented systems. Bed-load and mixed-load streams supplied fan deltas and small bayhead deltas, respectively. Fan-delta sandstones, with irregular Gilbertian foresets, but lacking the more typical upward-coarsening pattern, show a varied suite of trace fossils, including *Gyrochorte*, arthropod tracks, and delicate feeding traces.

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Depositional Environments of Some Naborton-Dolet Hills Sediments (Tertiary, Northwestern Louisiana) and Their Relation to Lignite

A preliminary study of the Naborton-Dolet Hills ligniferous sediments from a single cored well suggests deposition in subenvironments of a deltaic system. The lithology, sedimentary structures, macerals, clay mineralogy, and facies relations are comparable to sequences found in the recent deposits of the Mississippi delta.

The upper Naborton Formation, including the Chemard Lake lignite lentil, consists of organic rich muds, carbonaceous clays, and lignite which probably formed as aggradational deposits on a deltaic plain during a constructional phase of deltaic development. The eroded top of the lignite seam in the study well indicates that a brief marine inundation, or destructional phase, followed deposition of Naborton sediments in the study area. Thinly laminated silty clays containing foraminifera overlie the lignite. The clays grade upward into the fine to medium-grained sand of the Dolet Hills Formation. This sand is massive to ripple laminated and most likely represents a crevasse, or bay-fill deposit.

Several well samples were tested for the presence of radioactive elements. No unusual concentrations of these elements were found associated with the Chemard Lake lignite.

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Foraminifers and Calcispheres from Cuesta del Cura and Lower Agua Nueva(?) Formations (Cretaceous), East-Central Mexico

This study is based on measured and sampled sections in Peregrina Canyon, Tamaulipas, Santa Rosa Canyon, Nuevo León, and at several localities in the Sierra de Catorce, San Luis Potosí. All sections included some covered intervals.

The Cuesta del Cura and the Agua Nueva(?) are composed of gray to black well indurated, laminated, microcrystalline, cherty limestones and dark fissile limestones and calcareous shales. The fissile limestones and shales are voluminous in the Agua Nueva(?), giving it a more clastic aspect which is the basis for its separation. Typically the Cuesta grades over a short interval into the underlying lighter gray, thicker bedded, unlaminated limestones of the Tamaulipas to form a distinct change in lithic properties, but the upper contact is obscure and necessarily arbitrary. The Cuesta del Cura averages 150 m in thickness; a maximum of 190 m of Agua Nueva(?) was measured and sampled.

Foraminifers and calcispheres are common to abundant in most samples. Along with radiolarians, they form the grains of wackestones and packstones. Planktonic forms dominate, giving faunules a strongly pelagic aspect. Induration allowed study by thin section only. Recrystallization and two dimensional specimens made identification difficult. However, many critical species of the middle Cretaceous fauna were recognized, including *Favusella washitensis*, *Ticinella roberti*, *Globigerinelloides breggiensis*, *Thalmaninella subticinensis*, *T. ticinensis*, *Planomalina buxtorfi*, *Rotalipora apenninica*, *Praeglobotruncana stephani*, *P. delrioensis*, *Globigerinelloides bentonensis*, *Rotalipora gandolfi*, *R. greenhornensis*, *R. cushmani*, and *Globotruncana helvetica*.

The distribution of the foregoing forms permitted division of the succession into eight informal biostratigraphic zones: *Globotruncana helvetica* zone (First occurrence); *Grandes globigerines* zone (Interval); *Rotalipora cushmani* zone (Total Range); *Rotalipora greenhornensis* zone (First occurrence); *Rotalipora gandolfi* zone (Partial Range); *Planomalina buxtorfi* zone (Total Range); *Thalmaninella ticinensis* zone (First occurrence); *Thalmaninella subticinensis* zone (First occurrence).

The foraminiferal distribution establishes a range of middle Albian to middle Cenomanian for the Cuesta del Cura and middle Cenomanian to middle Turonian for the lower Agua Nueva(?).

Calcispheres present include: *Calcisphaerula innominata*, *Pitikonella ovalis*, *P. trejoi*, *Stomiosphaera conoidea*, and *S. sphaerica*. The ranges reported for these forms are long. Their distribution generally reinforced foraminiferal implications.

Microcalamoides diversus (forma C) of unknown affinity occurs in the basalmost few meters of the Cuesta del Cura, suggesting correlation with the middle Albian.

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Louisiana Chenier System—Some Preliminary Reinterpretations and Refinements