sidence related to mineral extraction, both of which are commonly associated with salt-water intrusion. The net effect is a rapidly accelerating man-induced transgression of a major coastal system.

GIBSON, THOMAS G., U.S. Geol. Survey, Washington, D.C., and LAUREL M. BYBELL, U.S. Geol. Survey, Reston, VA

Facies Changes in Hatchetigbee Formation in Alabama-Georgia and the Wilcox-Claiborne Group Unconformity

Mapping of Wilcox Group and lower Claiborne Group strata in western Georgia and eastern Alabama has shown significant facies changes within the Hatchetigbee Formation. In updip areas, the Hatchetigbee (upper part of the Wilcox) is composed of cross-bedded and massive quartz sand and carbonaceous laminated silt and clay that were deposited in lagoonal through very shallow marine (lower shoreface) environments. Sections 30 mi (48 km) downdip consist of shelly glauconitic silt and very fine-grained sand, commonly including a thin sequence of laminated silt and clay at the top. These strata represent inner-shelf deposits succeeded by a regressive, more nearshore or lagoonal phase. The shelly beds downdip are coeval with and lithologically similar to the Bashi Marl Member of the Hatchetigbee in western Alabama.

The Hatchetigbee is thinner downdip, 20 to 35 ft (6 to 11 m) thick than updip, 55 ft (17 m) in our study area. On the basis of measured sections and biostratigrahic data in eastern Alabama and biostratigraphic data from western Alabama, the Bashi Member in the study area is a downdip equivalent of the entire updip Hatchetigbee Formation. Calcareous nannofossils and planktonic foraminifers place both the transgressive and regressive events represented by the Hatchetigbee Formation entirely within the first 500,000 years of the Eocene (lower part of calcareous nannofossil Zone NP10 and middle of planktonic foraminiferal Zone P6). The overlying Tallahatta Formation of the Claiborne Group contains calcareous nannofossils diagnostic of Zones NP13-16; thus, the lowest part of the Claiborne Group is of latest early Eocene age. The absence of Zones NP11 and 12 indicates a gap of at least 2.6 m.y. between the top of the Wilcox and bottom of the Claiborne in this area. This unconformity suggests a major coastal offlap in the eastern Gulf coastal plain during the early Eocene at a time when worldwide eustatic sea-level curves indicate a major highstand of sea level.

HANDFORD, C. ROBERTSON, Louisiana Geol. Survey, Baton Rouge, LA

Genetic Characterization of Recent and Ancient Sabkha Systems

Ever since modern sabkhas were introduced to the geologic community and perceived as a concept applicable to ancient facies analysis, the literature has abounded with reports of inferred sabkha facies, many of which were compared with the modern Trucial Coast model of sabkha sedimentation. However, this well-described model probably has been overworked and stretched too far to be directly applicable to many ancient shallow-water to supratidal evaporite sequences. This predicament has risen partly because there is relatively little detailed information available on other modern sabkhas, despite the fact that there are other sabkhas around the world, few if any exhibiting the same characteristics as those of the Trucial Coast.

Because all major depositional systems, such as marine deltas, for example (Galloway, 1975), exhibit a continuous spectrum of morphologic types, it must be recognized too that not all sabkhas are the same. They show significant variations in terms of physical processes that govern their development, and of the sedimentary responses to those processes. Thus, sabkhas should be distinguished or characterized on a genetic basis to prevent oversimplification and overuse of any one model.

On the basis of dominant physical processes, three end members are recognized: (1) marine-, (2) fluvial-lacustrine-, and (3) eolian-dominated systems. Collectively, they may be displayed in a triangle diagram, upon which the positions of Recent sabkha systems can be superimposed. In general, playas fall into the fluvial-lacustrine-dominated field, interdune sabkhas are eolian-dominated, and coastal sabkhas are normally dominated by marine processes.

Marine processes are mainly storm-, spring-, and wind-tidal flooding, and discharge of marine-derived brines at the sabkha surface. Playas, as well as some coastal sabkhas, are dominated by fluvial-lacustrine processes. Alluvial fans, flanking the landward side of coastal sabkhas and surrounding playa basins, contribute most of the sediment and consist of aquifers through which continental ground water flows, dissolves minerals, and discharges at the sabkha surface as saline brines. Wind, the third major process, is a factor in any sabkha, but is especially prevalent in interdune deflation depressions in both continental and coastal settings. It removes sediment above the ground-water table and enhances evaporation, resulting in precipitation of evaporites in interdune sediment.

Sediment composition is the other significant factor in characterizing sabkha types. Carbonate-sulfate minerals (gypsum-anhydrite), soluble salts (halite, sylvite, polyhalite, etc), and terrigenous clastics are the dominant sedimentary components of sabkhas, but most are either dominated or distinguished by one or a mixture of those sediment types. By treating each of the three major sediment types as an end member, sediment variation between sabkhas can be displayed.

A genetic examination of sabkha systems clearly reveals that the Trucial Coast is only one end member to a spectrum of sabkha types, both in terms of physical processes and sediment composition. Thus, care must be taken when comparing modern and ancient sabkha systems to correctly characterize the processes responsible for deposition of the strata in question and the dominant sediment composition.

HAY, WILLIAM W., Joint Oceanographic Institutions, Inc., Washington, D.C.

Northern Gulf of Mexico as an Anomalous Passive Margin

The development of a passive margin involves a sequence of thermally induced events lasting about 100 m.y. before reaching maturity, when sediment accumulation responds to subsidence related to cooling of the lithosphere. This early sequence of events includes arching and uplift with erosion and shedding of sediment to the adjacent continental interiors, rifting with associated lacustrine and fluvial sedimentation, potential evaporite deposition, development of a narrow ocean with potential for restricted circulation, and subsidence of marginal shelves to sea level with reversal of drainage recycling large volumes of previously offloaded sediment onto the young margin. The northern margin of the Gulf of Mexico is unique among passive margins in that critical phases of its development coincide with the Cretaceous highstand of sea level and overriding of Pacific spreading centers by the North American continent. The Cretaceous sea level maximum coincided with the phase of early subsidence which should have caused reversal of interior drainage and rapid sedimentation on the margin. The result was to store sediment in the continental interior until much later in the development of the margin. Cenozoic sea level decline coincided with the interaction of North America and Pacific spreading centers focusing anomalously large volumes of sediment on the northern Gulf margin. The only other passive margins with similar timing and which might have a similar history are those associated with the initial splitting of Gondwanaland.

HONDA, HIROMI, and EARLE F. MCBRIDE, Univ. Texas at Austin, Austin, TX

Diagenesis and Pore Types of Norphlet Sandstone (Upper Jurassic), Hatters Pond Area, Mobile County, Alabama

The Norphlet Sandstone is one of the productive hydrocarbon reservoirs in the Hatteras Pond field. Despite its great burial depth (−18,500 ft or −5,638 m), this sandstone retains fairly good porosity (10 to 14%), but has low permeability (0.1 to 5.0 md). Evaluation of pore-size measurements and pore types helps to explain the low permeability. Pore types are classified on time of generation (primary, secondary), size (megapore, mesopore, micropore), and mode of occurrence (intergranular, intragranular, micropore). Analyses of published data of permeability, porosity, and pore types indicate that intergranular pores produce the best permeability, and that intragranular and micropores provide low permeability. Microporosity is determined empirically as the difference between the porosity determined by porosimeter and in thin section.

Effective hydraulic pore radius ($\bar{r}_e$) is defined as the radius of a straight capillary pipe having the same permeability as the rock under consideration. Most $\bar{r}_e$ values for Norphlet samples indicate the presence of micropores. Observation shows that pores of the water-bearing Norphlet are mostly intergranular and intragranular pores, whereas the hydrocarbon-bearing part has mostly micropores because of extensive illite cementation. Following decementation of carbonate and anhydrite, authigenic illite was precipitated in the sandstone and produced low permeability by two means: (1) by plugging throats of relatively large intergranular pores, and (2) by developing septa that subdivide large intergranular pores into small ones.

Principal diagenetic events in the Norphlet were (1) shallow cementation by anhydrite and calcite, (2) decementation, (3) dolomitization and illitization, (4) deep cementation, and (5) stylolitization. Decementation of anhydrite and calcite is probably related to hydrocarbon generation and accumulation and with briny formation water. Authigenic illite developed in secondary pores following decementation and largely controlled reservoir behavior. Differences in reservoir quality in the water-bearing and hydrocarbon-bearing zones are interpreted to be caused by different times of decementation and durations of illite development in the two zones.

KONTROVITZ, MERVIN, Northeast Louisiana Univ., Monroe, LA, and SCOTT W. SNYDER, East Carolina Univ., Greenville, NC

Reliability of Microfossil Assemblages as Paleoenvironmental Indicators

Ostracoda and Foraminifera have been used throughout the petroleum industry as paleoenvironmental indicators even when the reliability of the assemblages cannot be demonstrated. Such reliability can be evaluated only by knowing if the fossils have been subject to transport by water currents.

In this study, threshold velocities of shells were measured in a flume with a moveable sediment substrate. The velocities were different for the several genera and some species thereby providing a means of evaluating fossil assemblages. An assemblage composed of specimens with the same threshold velocities would have been transported (sorted) or represent the residual after other shells had been moved away. An assemblage with shells having different velocities would be undisturbed and would be reliable as an environmental indicator.

The best predictors of threshold velocity for the small calcareous shells are several measures of shape including the maximum projection sphericity and operational sphericity. They can be used to predict (.01 level) threshold velocities and provide a reliable objective means of testing the usefulness of fossil assemblages.

LAMB, JAMES L., Exxon Production Research Co., Houston, TX

Marine Environmental Terminology and Depth-Related Environments

To aid the petroleum geologist concerned with geologic and paleontologic reconstructions, this paper reviews the classification of marine environments as used widely by oil company micropaleontologists in the coastal regions of the Gulf of Mexico, and offers a tabulation in categories of the more commonly used environmental terms to clarify their usage. Uniform usage of environmental terms by geologists and paleontologists is desirable for clear communication, especially those terms relating to depth-related environments identified by fossils, such as the neritic, bathyal, and abyssal realms.

LOUCKS, R. G., Cities Service Exploration and Production Research Co., Tulsa, OK, and D. A. BUDD, Univ. Texas at Austin, Austin, TX

Diagenesis and Reservoir Potential of Upper Jurassic Smackover Formation of South Texas

The hydrocarbon potential of the Smackover Formation in south Texas is virtually untested. Much of the section penetrated is impermeable, however, reservoirs as thick as 33 ft (10 m), with porosity ranging from 4 to 26% and permeabilities ranging from 0.1 to 6.5 md, have been cored at depths below 18,000 ft (5,486 m). Nearly complete dolomitization has resulted in the development of intercrystalline porosity in inner-shelf wackestones and shoal-complex grainstones. In addition, some grainstones have subsurface-derived oomoldic porosity.

In the grainstone facies, four general stages of diagenesis affected porosity: Stage 1 (marine-phreatic environment)—precipitation of an isopachous carbonate cement and extensive grain micritization; State 2 (shallow-meteoric environment)—precipitation of very coarse-crystalline snytaxial calcite and fine-crystalline equant calcite, dissolution of aragonitic skeletal grains, and incipient solution-compaction; Stage 3 (regional fluid-mixing environment)—pore precipitation of and grain matrix replacement by fine- to medium-crystalline rhombic dolomite; and Stage 4 (subsurface environment associated with basinal fluid expulsion)—dissolution of ooids and dolomite, microstylolitization by solution compaction resulting from decarboxylation of kerogen, and precipitation of coarse-crystalline calcite and baroque dolomite. The magnitude of each general diagenetic stage varies regionally.

Porosity development in dolomitized wackestones is sporadic but within grainstones porosity is in part facies related. Hydraulically equivalent oolitic grainstone and oolitic quartzarenite facies are commonly dolomitized and have