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.

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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.

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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.

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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.

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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 associated porosity development. In addition, dolomitization of oolitic facies is more extensive in the updip half of the shoal-complex trend. These facies/diagenetic relations can be used as an exploration tool in the Smackover Formation in south Texas.

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Diagenetic History of Norphlet Formation (Upper Jurassic), Rankin County, Mississippi

Most of the Norphlet sandstone examined in four cores (−15,770 to −22,500 ft or −4,807 to −6,858 m) is eolian in origin as shown by thick, high-angle cross beds, bimodal texture with well-sorted laminae, and relict hematite grain coatings typical of desert sand. Norphlet sandstones average 77% quartz, 16% feldspar, and 7% rock fragments.

Partial to total loss of halite cement from cores during coring and slabbing operations hampers the interpretation of diagenetic history. However, the inferred sequence of diagenetic events is: cementation by illite, K-feldspar, quartz, calcite, anhydrite, and halite; development of secondary porosity by dissolution of halite, plagioclase, VRF's, and carbonate cement; hydrocarbon migration and pyrite generation; dolomitization; and cementation by late-stage illite and quartz. Halite and anhydrite were derived from the underlying Louann. Pyrite is present in most samples and formed when sour gas passed through the sands and reduced hematite grain coatings to pyrite. The scarcity of quartz cement is attributed to the lack of shale beneath the Norphlet.

Illite cement of two ages is present. Early-formed illite is leaflike flakes that coat quartz grains that inhibited the development of quartz overgrowths. It is not a seriously deleterious mineral. Late illite is thread-like and grows in narrow secondary pores where it seriously reduces permeability. Illite cement and sericitic alteration of plagioclase are more abundant deeper than −19,900 ft (−6,065 m).

Halite was introduced after moderate burial because prior to its development the sandstones underwent modest compaction as shown by sutured quartz grains and pre-cement porosity values of 22 to 30% (indicating compactional losses of 15 to 23% porosity before cementation).

The original texture of the sands strongly influenced diagenetic events.

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Emendation of Pecan Gap Chalk (Campanian) in Northeast Texas

The outcrop of the Pecan Gap Chalk in northeastern Texas can be divided into two parts at the change in strike from westbound to southbound. The eastern part, about 60 km in length, is composed of chalk with partings and thin beds of marl, which overlie the Wolfe City Sandstone unconformably. The upper contact with the Marlbrook marl varies from disconformable to questionably conformable. The southern part, about 30 km in length, is composed of a silty marl unit, hitherto unnamed, and an overlying chalk and calcarenite with silty quartz. These two units are conformable to slightly unconformable with one another and apparently conformable with the Wolfe City and Marlbrook. At the junction of the two parts of outcrop, there is an area of about 2 sq km with exposures of a quartzose arenite and calcarenite that is distinguished by abundant glauconite-phosphorite, abundant foraminifers, coccoliths, pelecypod prisms, thin, even bedding, and prominent mottles of burrows. These three units are described as new members of the Pecan Gap, and the formation is emended accordingly.

The relations of the three units to one another and to the chalk of the eastern belt are unclear, particularly in the environs of Farmersville, Texas, where the sequence seems discordant with that elsewhere. The appearances of the planktonic foraminifers, *Globotruncana ventricosa* (White) and *G. calcarata* Cushman, seem to bear out the stratigraphic complexity of the Farmersville area; elsewhere they suggest absence of the silty marl along the eastern outcrop and approximate equivalence of the chalk and calcarenite of the southern outcrop and the Pecan Gap of the northern part. They indicate that much of the section of the southern part of the outcrop is missing farther south and along the eastern outcrop.

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Bed Forms on West Florida Shelf as Detected with Side-Scan Sonar

A Side-Scan Sonar investigation on the west Florida shelf reveals a multitude of bed-form types. A nongenetic classification was devised based on apparent wavelength and ripple index (R.I. = Wavelength/wave height). This system divides the observed features into four groups: *Giant*—wavelength greater than 30 m, R.I. 30 to 100; *Large*—wavelength less than 30 m but greater than 1 m, R.I. 15 to 30; *Small*—wavelength less than 1 m, R.I. 5 to 15; and *low-relief swells*—wavelength greater than 300 m and relief only a few meters.

Five major zones roughly parallel to the coast are delineated according to the distribution of bed-form types.

Zone A, parallels the coastline out to approximately 20 m depth and is characterized by giant to large-scale bed forms. These features are observed on the sonographs as long, sinuous, and sometimes bifurcating, troughs of high reflectivity (coarse-grained?) sediment, interspaced with mounds of presumably finer grained material. Similar bed forms described in the literature have been labeled "current lineations."

Zone B extends out to mid-shelf depth (40 to 100 m) and is characterized by low-relief swells and a few patches of giant to large-scale features. The low-relief swells at times correlate with large elliptical patches of apparently fine sand on a relatively coarser grained, flat, sea floor.

Zone C is centered around the Florida Middle Grounds region and is characterized by small-scale bed forms and low-relief swells. These small-scale bed forms observed on the sonographs resemble current ripples. The orientation of these ripples varies from predominantly north-south across the Florida Middle Grounds to an east-west orientation in areas farther south.

Zone D is situated offshore Cape San Blas along the Florida panhandle. The bed forms in this zone are characterized by high relief (2.0 to 8.0 m) giant-scale features. Superimposed on the giant-scale bed forms and on the sea floor fringing this zone are small-scale bed forms resembling current ripples.

Zone E encompasses the outer shelf and is generally void of bed forms. However, a few unusual giant to large-scale features are observed.

Most of the giant, giant to large, and large-scale bed forms on the west Florida shelf are considered to be storm-related features. Some giant-scale features and the low-relief swells may be relict structures left over from times of lowered sea level. The small-scale bed forms within Zone C are possibly the results of either internal waves or tides set up on the summer thermocline and/or currents created by Loop Current intrusion on the shelf. The latter event may also generate strong shelf-edge currents creating the bed forms in Zone E.