influences shapes and sizes of modern foraminifera.

By analogy, assemblage composition, including the presence and abundance, or absence, of planktonic and smaller benthic species, along with shapes and size distributions of the larger foraminifera, can be used in paleodepth analysis and to supplement other petrographic evidence in carbonate facies interpretation.

Among the current limitations of the use of larger foraminifera as paleodepth indicators are the complications caused by taxonomic heterogeneity of both the larger foraminifera and their algal symbionts. Nevertheless, the potential for use of larger foraminifera in paleoenvironmental analysis is tremendous, as is the potential benefit of further studies of both modern and ancient assemblages of larger foraminifera.

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Facies Analysis and Petroleum Potential of Smackover Formation, Western and Northern Areas, East Texas Basin

The Smackover Formation (Upper Jurassic) in northeast Texas is a transgressive-regressive carbonate sequence which has been extensively dolomitized. The extent of dolomitization is directly related to the presence of the overlying Buckner anhydrite which has provided the magnesium-rich brines necessary for dolomitization.

The Smackover Formation is subdivided informally into a lower and upper member based on distinctive lithologic characteristics. The lower member, which rests conformably on the fluvial-deltaic sandstones of the Upper Jurassic Norphlet Formation, contains a laminated, organic carbonate mudstone facies that grades into an overlying locally fossiliferous, pelletal-micritic facies. The vertical sequence of facies indicates a transgression of the sea. They are interpreted to represent an inter-tidal mudflat to shallow-marine, low-energy platform or protected lagoonal environment. The upper member of the Smackover Formation consists mainly of broken skeletal debris and pelletal allochems in a micritic matrix. The sediments are better winnowed and better sorted upward in the sequence. Interbedded with and overlying the skeletal-pelletal facies is a clean well-sorted dolomitized oolitic-grainstone facies. This uppermost informal member marks the beginning of a progradational sequence which lasts throughout the remainder of Smackover deposition and continues through deposition of the evaporites and red beds of the overlying Buckner Formation.

Deposition of the Smackover Formation most closely resembles Holocene carbonate sedimentation in the southern Persian Gulf. Both areas are represented by a similar carbonate ramp depositional framework together with closely approximated salinity and climatic conditions.

Most of the Smackover production in northeast Texas occurs along the Mexia-Talco fault zone in the deeper gentle salt-related anticlines and salt-graben systems. Reservoir rocks are primarily leached and dolomitized oolitic grainstones and dolomite. Laminated organic carbonate mudstones which characterize the lower, transgressive phase of the Smackover Formation provide an excellent source rock for petroleum.

Exploration targets for the Smackover Formation are the areas where dolomitized oolitic and skeletal grainstones occur on top of structurally high areas such as over salt ridges or swells in the deeper portions of the basin. Along with this are those areas along the updip limit of the Smackover Formation in which the upper member has been leached and dolomitized and occurs in a stratigraphically favorable position.

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Aragonite Crusts and Pisolites Beneath Dolomitic Tepees, Lake MacLeod Evaporite Basin, Western Australia

Research currently being conducted by the Sedimentology and Marine Geology Group, under Brian W. Logan at the University of Western Australia, has recently concentrated on Lake MacLeod, a 2,000 km^2 (770 mi^2) coastal salina on the western coast of Australia. This work has shown that this evaporite basin, which is 3 to 4 m (10 to 13 ft) below sea level, is separated from the Indian Ocean by a topographic barrier, but seawater under hydrostatic head, seeps freely through the barrier and discharges from several vents and springs in a carbonate mud flat at the north end of the basin. From there, seawater flows slowly across the basin, evaporating and depositing carbonate, gypsum, and ephemeral halite. About 10 to 12 m (33 to 39 ft) of evaporites have been deposited in the past 5,300 years.

In July 1982, the authors visited the carbonate mud flats and discovered abundant aragonite pisolites and botryoidal-mammillary crusts of fibrous aragonite cement beneath "lily-pad" tepee slabs of cemented protodolomite. This protodolomite host-rock is well-lithified, intraclast, peloid packstone with abundant coarst fenestrae. Thick aragonite crusts cover both the undersides of "lily-pad" slabs and the lithified floors of tepees. Crusts covering the floors are more botryoidal and consist of both aragonite nubs and mounds (0.2 to 2.5 cm, 0.08 to 1 in., in diameter), and a few scattered, loose pisolites, several millimeters in diameter. Pisolites are composed of multigeneration fibrous layers of square-tipped aragonite rays surrounding peloid-intraclast nuclei. Thus, it seems that periodic deposition of a fine layer of carbonate mud, peloids, and intraclasts across the floor of a tepee is a prerequisite to pisolite growth.

Stable isotope analysis of the host rock and aragonite cements gave expected marine values ($\delta^{18}O = +0.25$ to $+1.14$ PDB and $\delta^{13}C = -0.18$ to $+0.16$ PDB) and reflect precipitation from ground water (marine composition) discharging from seeps in the carbonate mud flats.

The manner in which crusts, pisolites, and tepees occur at Lake MacLeod raises the possibility that they and their ancient counterparts from the Permian basin share a common origin. Perhaps Permian pisolites and aragonite crusts formed beneath cemented slabs of peritidal sediments in tepees bathed by marine water which seeped across exposed portions of the shelf crest.

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Depositional Environments in an Alluvial-Lacustrine System: Molluscan Paleoecology and Lithofacies Relations in Upper Part of Tongue River Member of Fort Union Formation, Powder River Basin, Wyoming

The upper part of the Tongue River Member of the Fort Union Formation (Paleocene) in the northern Powder River basin, Wyoming, contains assemblages of excellently preserved nonmarine mollusks which occur in laterally continuous outcrops of diverse lithologic sequences and sedimentary structures. These attributes offer a unique opportunity for interdisciplinary interpretation of depositional environments based on molluscan paleoecology and lithofacies relations. Taphonomic histories of mollusk assemblages as reflected by molluscan biofabric (size, shape, orientation, and distribution of faunal elements), and the taxonomic composition, diversity, and abundance representation of species in assemblages are of particular importance in interpretations of paleoecology and depositional environments.

Three facies are recognized vertically within an alluvial-lacustrine system. The interfluvial lake and lake splay facies is characterized by sequences of coarsening-upward detritus, abundant continuous limestone beds, and few beds of discontinuous coal and continuous carbonaceous shale. Limestones contain two lacustrine mollusk assemblages: a locally reworked assemblage dominated by the bivalve *Plesielliptio* (two species), and the gastropods *Viviparus, Lioplacodes* (three species), and *Clenchiella*; and a quiet-water assemblage dominated by sphaeriid bivalves. This facies reflects development of numerous lakes bordered by well-drained backswamps in interfluvial flood basins. Lakes were repeated infilled by carbonate mud, splay detritus, and backswamp deposits.

The interfluvial crevasse splay-crevasse channel facies is characterized by sequences of coarsening-upward detritus and few discontinuous limestone beds, separated vertically by thick, continuous coal and carbonaceous shale beds. This facies includes small crevasse channel sandstones which scour into splay sandstones. Biofabric of lacustrine mollusk assemblages, which are identical in composition (but with dwarfed species of *Plesielliptio*) to locally reworked lacustrine assemblages of the interfluvial lake and lake splay facies, reflects deterioration of lakes through active infilling by crevasses.

The fluvial channel and interchannel facies is typified by thick channel sandstones laterally separated by sequences of coarsening-upward detritus, overbank sediments, and rare limestones. This facies includes thick, continuous coal and carbonaceous shale beds. Muddy-substrate flood basin lakes are characterized by an untransported lacustrine mollusk assemblage differing from those of the interfluvial lake and lake splay facies in both composition and relative abundance of species. Transported mollusk assemblages dominated by the gastropod *Hydrobia eulimoides* occur in crevasse sandstones. Relative to northerly flowing major channels, proximal and distal parts of splay deposits can be differentiated by their mollusk assemblage composition. The fluvial channel and interchannel facies reflects deposition on flood basins that were formerly occupied by lake, crevasse, and backswamp deposits. Thick, continuous coal beds reflect the spread of backswamps from interchannel depressions to abandoned major channel ridges. Cessation of fluvial channel and interchannel sedimentation was marked by widespread lacustrine deposition.

The vertical sequence of facies just described also reflects the areal distribution of deposits of major channels that pass laterally into overbank and crevasse splay channel areas, which in turn merge into large and small lakes. Alluvial-lacustrine deposition in the upper part of the Tongue River Member is similar to that of anastomosed reach of the Saskatchewan River, Canada, as reported in a 1980 study by Smith and Putnam.

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Oil Potential of Western Gulf of Suez

Since 1886, Egyptian and foreign companies have explored the Gulf of Suez by classical mapping and geophysical techniques. During that time 13 oil and gas fields have been discovered. Average daily production currently is of the order of 50,000 BOPD. Structurally, the western Gulf of Suez is divided into two major provinces: West Bakr and West Zeit. In the former, beds characteristically dip to the northeast; in the latter, they dip to the southwest, both in surface outcrop and in subsurface. Within each province, fields are located over structural traps.

As a result of drilling it is apparent that the structures resulted from major movement during the early Miocene. A major unconformity occurs at the top of the lower Miocene Nukhul Formation; and the beds of the overlying middle Miocene Belayim Formation transgress on to rocks as old as Precambrian.

The Nubia Sandstone, one of the best reservoirs, is a blanket deposit over the whole gulf ranging in thickness from 130 m (425 ft) to in excess of 660 m (2,150 ft). The Miocene sands are more sporadic in their distribution and thickness. Three depocenters are known in West Bakr, Shukheir, and Wacdi Dib areas. Further reservoirs of lesser importance are Cretaceous sands, 6.5 m (21 ft) to 32 m (105 ft) thick throughout the area, Eocene carbonates, and Miocene reefs.

Production up to the present has been from structural traps; future expansion of production will depend upon our ability to locate stratigraphic traps. Sands sourced by the shales have seldom given high yields. The hope is that through the generation of depositional environment models it will be possible to define prospects where the optimum sand/shale ratio of 1/4 to 1/6 can be found.

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Seismic Stratigraphy and Clay Mineral Distribution in Shallow-Marine Siliciclastic Deposits, Central Mississippi Sound, North-Central Gulf of Mexico

Three north-south high-resolution (7 kHz) seismic profiles and 16 20-foot cores taken at shot-point locations in central Mississippi Sound were utilized to determine: (1) any meaningful seismic reflector configurations in the subsurface; (2) the clay species dispersal pattern and its relation to transport systems that move sediment into the depositional basin; (3) any change in clay mineral species that has occurred through time with respect to deposition of 5 to 6 m (16 to 20 ft) of sediment; and (4) the geologic history and sedimentary processes acting within central Mississippi Sound and adjacent areas.

Interpretation of shallow seismic events (20 m [66 ft]) and clay mineral analysis indicates that extrinsic factors largely determined the clay mineral species and geologic history of Pleistocene and Holocene sedimentation in central Mississippi Sound. Trend surface maps, residual maps, profiles of the smectite (montmorillonite) to kaolinite ratios, and seismic profiles illustrate that: (1) Mississippi Sound has been influenced by transgressions and regressions associated with proglacial and interglacial stages; (2) a toplap seismic reflection configuration forms the probable Pleistocene-Holocene boundary; (3) at least one ancient barrier island is located inside the Holocene barrier system; (4) there is a late date for sea level reaching its present location (2,500 years B.P.); (5) the influence of the Mississippi River system on sedimentation is soon after inundation of Mississippi Sound; (6) the longshore currents and flood tides supplied sediment rich in kaolinite to the study area; (7) the drainage systems emptying into the study area have local influence on clay mineral distribution; and (8) the dredging of ship channels affects the clay-mineral distribution within the sediments immediately below the sediment-water interface in central Mississippi Sound.