The informal term "Langtry formation" is applied to these strata, which flank shallower water platform facies to the east, north, and west (Austin Chalk and San Vicente Member of the Boquillas Formation), and pass into basinal limestones of the San Felipe Formation in the La Mula basin to the south.

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Sediment Distribution About Salt Domes and Ridges on Louisiana Slope

Salt ridges and domes underlie much of the present Louisiana slope. The bathymetric expression of underlying salt could be either a mound or a flattening of the normal rate of descent down the slope. The "mounded" salt features form barriers to the gravity-driven sediments from the shelf break. Much industrial research has been done in the search for reservoir sands about such an obstruction. Clues to depositional patterns about salt features may be obtained from studies in the deep ocean about seamounts located in pathways of ocean-bottom-following currents. Parallel-bedded sediments form foredrifts on the upcurrent side of a seamount. These foredrift sediments were deposited where the prevailing ocean bottom currents were locally decelerated by the obstructing seamount. In waters overlying the obstruction, a Taylor column of dead water or a slow cyclonic eddy provides tranquil oceanographic conditions, permitting a greater fallout of sediments. Moats are found on the sides of the obstruction and are the result of erosion or nondeposition owing to acceleration of deflected waters. Leedrifts are found on the downcurrent side of the obstruction. Current gyres result from deceleration of accelerated currents along the obstruction's flanks, and a complex sedimentation pattern results. Flow over the obstruction's top is determined by size and shape of the obstruction relative to size and velocity of the bottom-following current. A turbulent wave will be set up which may have sufficient amplitude to influence sedimentation on the downcurrent side. There are appreciable differences between the sedimentation patterns about a dome and a ridge.

If ocean bottoms currents equal gravity-driven terrigenous sediment movement and seamounts equal salt domes and ridges, then the result of deep ocean surveys are directly applicable to sedimentation on slopes with underlying salt basement. The salt-related sedimentation pattern of the present slope should be applicable to similar paleoenvironments.

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Paleoenvironments and Hydrocarbon Potential of Upper Jurassic Norphlet Formation of Southwestern Alabama and Adjacent Coastal Water Area

Upper Jurassic Norphlet sediments in southwestern Alabama and the adjacent coastal water area accumulated under arid climatic conditions. The Appalachian Mountains of the eastern United States extended into southwestern Alabama, providing a barrier for air and water circulation during Norphlet deposition. These mountains not only contributed to the arid climate but also affected sedimentation. Norphlet paleogeography was dominated by a broad desert plain rimmed to the north and east by the Appalachians and to the south by a developing shallow sea. The desert plain extended westward into eastern and central Mississippi.

Initiation of Norphlet sedimentation was a result of erosion of the southern Appalachians. Norphlet conglomerates were deposited in coalescing alluvial fans in proximity to an Appalachian source. The conglomeratic sandstones grade downdip into red-bed lithofacies that accumulated in distal portions of alluvial fan and wadi systems. Quartzose sandstones (Denkman Member) were deposited as dune and interdune sediments on a broad desert plain. The source of the sand was the updip and adjacent alluvial fan, plain, and wadi deposits. Wadi and playa lake sediments probably also accumulated in the interdune areas. A marine transgression was initiated late in Denkman deposition, resulting in the reworking of previously deposited Norphlet sediments.

Norphlet hydrocarbon potential in southwestern and offshore Alabama is excellent with four oil and gas fields already established. Petroleum traps discovered to date are primarily structural traps involving salt anticlines, faulted salt anticlines, and extensional fault traps associated with salt movement. Reservoir rocks consist of quartzose sandstones, which are principally eolian in origin. Porosity types include both intergranular and secondary dissolution. Smackover algal carbonate mudstones were probably the source for the Norphlet hydrocarbons.

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Sources and Distribution of Silt, South Texas Shelf

Fourier grain shape and mineralogic analyses were conducted on the coarse silt fraction of the surficial sediments on the south Texas continental shelf to determine the sources and distribution of the silt. The distribution patterns were evaluated in light of the late Pleistocene paleogeography and modern hydrodynamic conditions prevailing on the shelf to determine whether the coarse silt fraction was relict, palimpsest, or modern in origin.

Two coarse silt-grain shape types are present in varying proportions in the samples from the south Texas shelf. One is associated with quartzose coarse silt and is considered to represent multicyclic coarse silt-size detritus derived from the Texas coastal plain and high plains. The second type is associated with more feldspathic coarse silt and is considered to represent first-cycle, coarse, silt-size detritus derived from igneous and metamorphic rocks of Texas, New Mexico, and Mexico.

Each of the major river systems that supplied sediment to the south Texas shelf during the late Pleistocene and Holocene is characterized by distinctive proportions of first- and multicyclic coarse silt. The Brazos-Colorado and Rio Grande systems, which drain igneous, sedimentary, and metamorphic rock terranes, deposited sediment enriched in first-cycle coarse silt on the shelf during the late Pleistocene low sea level stand. At the same time, the Guadalupe and the Copano-Nueces-Baffin coastal plain river systems, which drain sedimentary rock terranes only, deposited sediment enriched in multicyclic coarse silt on the shelf.

In the southern part of the other south Texas shelf, the distribution patterns of first-cycle and multicyclic coarse silt define the late Pleistocene alluvial plains of the Rio Grande and the south Texas coastal plain rivers. The locations of the alluvial valleys, as defined by grain shape analysis, coincide precisely with the locations of these valleys as defined by shallow seismic studies; therefore, the coarse silts in this area are considered to be relict in origin, unmodified by the weak (0-10 cm/sec) semipermanent bottom currents that prevail in the southern part of the outer south Texas shelf. The preservation of paleogeographic features in the surficial sediments of this area of the shelf indicates that no modern coarse silt, which might bury this relict surface, has been deposited here during modern times.

In the northern part of the south Texas outer shelf, first-cycle coarse silt originally deposited on the ancestral Brazos-Colorado delta is found not only in the delta area, but also overlying most of the alluvial valley of the Guadalupe system lying west of the delta. Therefore, the coarse silt on the northern outer shelf in the vicinity of the Brazos-Colorado delta and the ancestral Guadalupe valley is palimpsest in origin and apparently is being reworked by the strong semipermanent bottom currents that prevail in this region.

In the southern part of the south Texas inner shelf, the patterns of distribution of first-cycle and multicyclic coarse silt indicate that the inner shelf coarse silt is also relict in origin. The apparent absence of modern coarse silt on this part of the inner shelf is thought to reflect the paucity of this size fraction in the major sediment sources of the southern inner shelf—the Rio Grande and Padre Island. In the northern part of the south Texas inner shelf, evidence indicates that the inner shelf coarse silt is a mixture of palimpsest silt reworked from the late Pleistocene substrate and modern silt provided by the Colorado River.

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Rules of Sandstone Diagenesis Related to Reservoir Quality

The reservoir quality of sandstone is almost entirely controlled by diagenetic events. The chemical and physical processes responsible for diagenesis are complex and they influence sand during all stages of burial and, in some basins, during subsequent uplift. Petrographic studies by many workers in the past 10 years provide the basis for formulating rules of sandstone diagenesis that help in predicting reservoir quality in different formations. Most of the rules listed below are empirical, and causative factors are still poorly understood. The list is also not complete.

1. The detrital mineral composition of a sand predetermines 50-80% of its diagenetic history.

2. Porosity lost by compaction cannot be regenerated during subsequent diagenetic events. Sands with abundant ductile grains (clay clasts, fecal pellets, shale clasts, micaceous rock fragments) can lose much primary porosity from the mashing of these grains during compaction.

3. The loss of primary porosity through compactional deformation of clays and ductile grains takes place during burial of 8,000-10,000 ft (2,450-3,050 m); loss of porosity by compaction at greater depths is by pressure solution of detrital grains.

4. Pressure solution of quartz grains is enhanced by the presence of grain coatings of illite and to a lesser degree by chlorite.

5. Quartz cement has an affinity for the coarser, more permeable sands in a formation. However, it rarely fills all pores in a sandstone except in some coarser grained laminae or in quartzarenites.

6. Carbonate cement may have a patchy distribution in a bed, but it fills all pores to produce a nonporous rock where it is present.

7. Carbonate cement is the dominant or only cement in sands with abundant carbonate fossil fragments or carbonate rock fragments; the carbonate cement is derived from the sand.

8. Poikilotopic calcite cement is the result of cementation that progressed from widely spaced nucleation sites.

9. Kaolinite forms by the replacement of feldspar and to a lesser degree of muscovite and also by free-standing growth in both primary and secondary pores.

10. Kaolinite should be expected as a diagenetic mineral in feldspar-rich sands (arkose and subarkose) that are poor in volcanic rock fragments.

11. Chlorite and/or mixed-layer clay should be expected as a diagenetic mineral in sandstone with more than 10% volcanic rock fragments.

12. Chlorite and mixed-layer clay, because of their tendency to bridge pores and produce baffles in pores, can seriously reduce permeability.

13. Early formed illite, typically present as grain coatings, does not seriously reduce permeability; late-formed illite tends to bridge pores and produce baffles and seriously reduce permeability.

14. Micrite cement is formed in continental sands above the water table.

15. Opal cement is formed in continental sands above the water table in stratigraphic sections where volcanic ash beds are intercalated with sands.

16. Some degree of secondary porosity is to be expected in a sandstone. However, there are few clues at present to predict the degree of secondary porosity or the cleanliness of secondary pores produced. Many secondary pores are micropores within incompletely dissolved feldspar or rock fragments. The best secondary pores are produced by dissolution of carbonate cement and evaporite cement.

17. Secondary porosity develops chiefly at depths greater than 6,000 ft (1,830 m) in the Gulf Coast, but can persist to depths of 20,000 ft (6,100 m). After their generation, secondary pores undergo some destruction during subsequent deeper burial by infilling with late-diagenetic ferroan carbonate and/or kaolinite.

18. Sands that had the greatest permeability at the time of deposition will develop the best secondary porosity. The best permeability will be in the coarsest, well-sorted sandstones (except in quartzarenites, where the coarsest beds selectively may undergo complete cementation by quartz).

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Southwestward Extension of Vicksburg-Jackson Shale Ridge, Refugio and Aransas Counties, Texas

Exploratory drilling in Refugio and Aransas Counties, Texas, has demonstrated that the major structural axis of the Vicksburg-Jackson shale ridge, which was first identified in north-central Calhoun County, Texas, plunges southwestward in the subsurface across northeastern Refugio County into northern Aransas County. The length of the shale ridge is approximately 52 mi (84 km), extending southwestward from Lavaca Bay in Calhoun County to Copano Bay in Aransas County, Texas.

The southwestern limb of this regional structure is not as strongly uplifted in the subsurface of Refugio and Aransas Counties as it is in north-central Calhoun County. The structural characteristics of the ridge are steep dip to the southeast in the upper Frio, lower Frio unconformities associated with dip reversal to the north-northwest in the lower Frio section, and up-to-the-coast faulting.

Oil and gas discoveries in recent years along the southwestern extension of the shale ridge have been from structures similar to those found along the shale ridge in north-central Calhoun County. Two of the discoveries have been significant; additional exploration along the shale ridge should identify other drillable anomalies.

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Recent Foraminifera of St. Andrew Bay, Florida

Foraminiferal analysis was conducted on 403 bottom samples from St. Andrew Bay, a polyhaline to ultrahaline estuary on the northwest coast of Florida. Intertidal samples (140) and subtidal samples (263) were collected by the National Marine Fisheries Service during November 1974 and April 1975. Water properties samples were collected also at 69 of the subtidal stations. Foraminiferal concentrates were obtained by carbon tetrachloride float from an undisturbed, upper 1 cm (0.4 in.) of tube (intertidal) and grab (subtidal) samples. A census of populations was taken by random, 300-specimen counts. Subspecies were recognized but none are new. Biofacies were based on percentages of populations and geographic patterns of distribution.

The genus *Ammonia* dominates foraminiferal populations at 75% of the statistically valid stations (stations with 300 or more foraminifera) and forms the only major biofacies of the bay. *Ammonia parkinsoniana tepida* and *typica* are the dominant *Ammonia*. The smaller and more fragile *A. parkinsoniana tepida* is dominant in the central, deeper parts of the St. Andrew Bay, where salinity and temperature are higher; whereas *A. parkinsoniana typica* is dominant in intertidal areas, where salinity and temperature are lower. The salinity and temperature relationships of the ecophenotypes are the same as reported for San Antonio Bay, Texas, but the bathymetric relationships are reversed. The ecophenotypes define secondary biofacies within the major one.

Several species characteristic of the continental shelf occur in widely varying percentages, but with a definite geographic pattern, along the deepest and most central parts of the bay. It is suggested that this secondary biofacies reflects the effect of flood tidal action on meroplanktonic larval stages of the species.

The remaining 25% of the stations are dominated by *Elphidium*, miliolids, *Ammobaculites, Nonionella, Miliammina, Rosalina,* and *Trochammina,* which occur erratically in abundance and distribution. *Elphidium* shows the greatest adaptability to pollution. No biologic relationship is apparent between bottom sediment and foraminifers.

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Detrital Composition of Pliocene-Pleistocene Sands, Offshore Louisiana

Pliocene and Pleistocene sands that underlie the Louisiana shelf are lithic arkoses and feldspathic litharenites. The composition of this detrital material is similar to that of Eocene and Oligocene sandstones of the Texas Gulf Coast. Among rock fragments, grains of volcanic and low-rank metamorphic origins dominate. Untwinned plagioclase is the dominant feldspar. Calcium content of plagioclase in unalbitized sands is as great or greater than that observed in unalbitized sandstone samples from the Eocene and Oligocene of Texas.

Despite a primary detrital composition that is potentially as reactive as detrital assemblages in the older units, Pliocene-Pleistocene sands have comparatively lesser amounts of cementation and grain alteration. An interesting reflection of the lesser degree of grain alteration is the relatively more unstable and complex assemblage of heavy minerals present in the younger sands.

In addition to detrital composition, the depositional setting of the Pliocene-Pleistocene clastics was also broadly similar to that of other major wedges of Tertiary sediment in the Gulf Coast basin. Thus, differences in stages of diagenesis are believed to be the result of different physical and/or chemical environments present during burial.