POROSITY DEVELOPMENT AND DISTRIBUTION IN SHOAL-WATER CARBONATE COMPLEXES—SUBSURFACE PEARSALL FORMATION (LOWER CRETACEOUS) SOUTH TEXAS[1]

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ABSTRACT

The Lower Cretaceous Pearsall Formation in the subsurface of South Texas consists of contemporaneous carbonate and terrigenous clastic facies deposited in two major depositional systems: shoal-water carbonate complex and open, shallow-water shelf. Carbonate facies that were deposited in the high-energy environments are porous grainstones and boundstones. These are surrounded by a halo of nonporous lower energy packstones and wackestones. The open shelf contains more terrigenous material than the carbonate shoal. Dominant facies on the shelf are oncolite packstone, terrigenous mudstone and shale and mottled to interbedded carbonate wackestone and terrigenous mudstone.

Four stages of diagenesis are recognizable in Pearsall carbonate grainstones. Micrite envelopes, former aragonite cement, and broken grains are the dominant features in the first diagenetic stage which occurred in the marine environment. The next stage of diagenesis took place in a series of local meteoric-phreatic environments produced by partial subaerial exposure. The cements, fine-crystalline equant to bladed rim, medium-crystalline equant, and syntaxial calcite, indicate an oxidizing water chemistry varying in Mg and low in Fe. Leaching of aragonite shells created moldic porosity. Mg-calcite and aragonite grains stabilized to calcite in this stage.

Later with initial burial, medium- to coarse-crystalline equant calcite cement, low in Fe and Mg, precipitated from a regional meteoric ground-water system. Finally, at depths over 2,000 feet, quartz overgrowths, anhydrite, Fe-zoned baroque dolomite and Fe-zoned coarse-crystalline equant calcite were precipitated. Hydrocarbons created a reducing environment. Dewatering of juxtaposed shale released Mg and Si and along with stylolitization, produced a hydraulic pump pushing water through the rocks.

Approximately 95 percent of the high porosity and permeability is contained in the grainstone and boundstone facies; therefore, distribution of the porosity in the Pearsall Formation can be predicted from mapping depositional facies. Two major forms of porosity are primary interparticle and secondary moldic porosity.

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CARBONATE FACIES DISTRIBUTION AND DIAGENESIS ASSOCIATED WITH VOLCANIC CONES—ANACACHO LIMESTONE (UPPER CRETACEOUS) ELAINE FIELD, DIMMIT COUNTY, TEXAS

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ABSTRACT

Late Cretaceous volcanic activity along the northern rim of the Rio Grande Embayment resulted in the growth of a number of cones that form an arcuate trend in south central Texas. Some of these cones grew to sea level and served as nuclei for shallow-water carbonate sedimentation. Resulting limestones are known as the Anacacho Formation. Significant hydrocarbon accumulations have been found in the limestones associated with many of the volcanoes such as the Elaine Field in Dimmit County, Texas. Facies distribution and diagenetic fabric were analysed from core and electrical logs.

Shallow water on the flanks of the emergent volcano favored rudist-reef development, which, with other marine fauna, supplied abundant shell material for reworking into shoals. Diagenetic fabrics of the resulting grainstones include precipitation of bladed and mosaic calcite as well as limpid dolomite, indicating cementation during meteoric-phreatic conditions. This evidence supports subaerial exposure of the shoals as beaches, allowing the development of a lagoonal environment landward. Seaward of the beach, red-algal ridges and a muddy sand halo developed. The muddy sand halo was supplied with shell material from high-energy areas, whereas the mud was a product of deeper water accumulation. With increasing water depth off the flanks of the volcano these facies grade into a mud-rich open-shelf environment dominated by burrowing organisms.

After this initial carbonate buildup the volcano subsided and the facies onlapped the volcano as a result of the changing relative sea level. Subsidence continued until the volcano was completely submerged. Faults reflecting readjustments of strata over the plug are recorded in sediments as young as the Navarro Group.

Porosity in Elaine Field carbonates occurs in areas where, a fresh-water lens developed in association with subaerial exposure. In these areas dissolution of grains and limited cementation produced excellent quality hydrocarbon reservoirs.

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LOWER CRETACEOUS SEDIMENTARY FACIES AND SEA LEVEL CHANGES, U. S. GULF COAST

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ABSTRACT

In the northern U.S. Gulf Coast, Lower Cretaceous sediments form an arcuate prism which thickens from a few hundred feet updip to more than 10,000 feet along the ancient shelf margin 100 to 300 miles downdip. This prism was divided into eleven time-stratigraphic units using hundreds of control wells with lithologic and faunal data. This information led to the recognition and mapping of major depositional facies including alluvial valley, delta, prodelta, inner shelf, middle shelf, outer shelf and basin within each time-stratigraphic unit. During continuous deposition in Early Cretaceous time these major facies units have transgressed and regressed many times across the broad subsiding shelfal areas. The transgressions in Upper Cotton Valley, Lower Hosston through James, and Mooringsport through Washita times are thought to be controlled primarily by eustatic relative rise in sea level. Regressions in Upper Hosston, Rodessa, Glen Rose, and Paluxy times are probably controlled by a decreased rate of subsidence and an increase in the supply of clastic sediments from rising uplands inland.

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DIAGENESIS AND GEOCHEMISTRY OF A GLEN ROSE PATCH REEF COMPLEX, BANDERA COUNTY, TEXAS

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ABSTRACT

Rigid reef framework for the Pipe Creek patch reef complex (lower Glen Rose Formation) was produced by syngenetic rudist accretion, internal sedimentation, and submarine cementation of the reef frame and internal sediment. Clionid sponges bored the reef framework during accretion and produced cavities, calcareous silt, and peloids that can be easily mistakened for vadose features. Local pholad-bored surfaces developed on the reef crest(s) when vertical framework accretion exceeded local subsidence so that truncation and extensive bioerosion of the reef crest(s) occurred in the littoral zone. Small forereef beaches contain littoral cementation features. Submarine diagenesis of backreef beds included peloid induration and grain micritization.

Epigenetic diagenesis that affected the sequence at Pipe Creek is divided into three distinct phases: phase I — marine connate — closed, phase II — early fresh water — open, and phase III — late fresh water — open. During phase I, partial incongruent dissolution of magnesian calcite submarine cements and internal sediments in the caprinid reefs effectively raised the Mg/Ca ratio of the interstitial marine water. This water composition change stimulated dolomitization of clay-rich backreef lime muds by cloudy, 8 to 10μm anhedral to subhedral dolomite.

Fresh water began to displace marine connate water either during late Glen Rose or latest Fredericksburg time (phase II). The change from a closed marine to an open fresh-water system caused the final incongruent dissolution of magnesian calcite, partial dolomitization of the sediments by clear, 50 to 60μm, euhedral dolomite, inversion of some aragonitic mollusks to calcite, and conversion of lime mud to lime mudstone (micrite). As the water became progressively enriched in CO_2, megascale dissolution of aragonitic allochems occurred. Moldic porosity developed during this phase has been preserved by the precipitation of intergranular equant sparry calcite. Clay-rich beds have recrystallized, indicating that clay materials have acted as nuclei for microspar and pseudospar. At the end of this phase, the rocks had been converted from predominately metastable (aragonite and magnesian calcite) to stable (calcite and dolomite) minerals.