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Outcrop-to-Basin Stratigraphy and Structure of Glen Rose Limestone of Central Texas

The Glen Rose Limestone is a proven oil and gas producer in south Texas along the Stuart City reef trend. However, it has not been productive, except in minor occurrences, in the East Texas basin, even though it is present in an area of approximately 75,000 mi^2 (195,00 km^2) and attains a maximum thickness of 3,500 ft (1,067 m). This absence of production is believed to result from a lack of exploration rather than a lack of potential. Therefore, a regional study of the outcrop-to-basin stratigraphy and structure of the Glen Rose in central Texas was undertaken to correlate existing stratigraphic nomenclature and to determine the depositional and diagenetic history. Be relating these to known production, it should be possible to identify potential exploration fairways.

Cross sections were used in establishing stratigraphic correlations, resulting in a division of the Trinity Group different from that commonly seen in literature. The group is divided into the Glen Rose and Travis Peak subgroups, with the division at the outcrop placed at the Hensel-lower Glen Rose contact. However, in the basin, the Pearsall-Rodessa contact is used as it is time-equivalent to the division adopted at the outcrop.

Examination of cores, cuttings, and sample logs defined the depositional and diagenetic environments of Glen Rose strata. Isopach maps and seismic sections were used to map distribution of facies tracts related to production. Facies and structure of known production areas were compared to those of untested areas to define possible exploration fairways and to map recommended exploration trends. Principal of these is the Stuart City reef trend.

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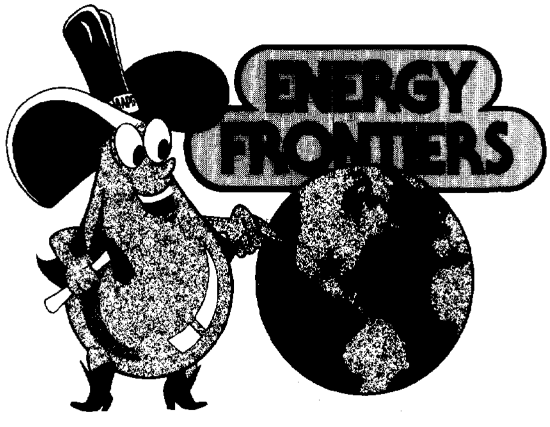
Continental Shelf Topography: Possible Key to Understanding Distribution of Shelf-Bar Sandstones from Cretaceous Western Interior Seaway

A comparison of Holocene shelf sand ridges on the Georges Bank-Nova Scotia-Newfoundland-Labrador shelf system and the Texas shelf with Cretaceous shelf-bar sandstones from the Western Interior seaway provides new insights into the possible role shelf topography may have in controlling shelf-bar distribution, as well as providing a possible sand source on an otherwise muddy Cretaceous shelf. The Holocene ridges are elongate, asymmetric in cross section, 2 to 20 m (6.6 to 66 ft) in height, up to several kilometers in length, and are spaced from 90 m to 3 km (295 ft to 1.9 mi) apart in parallel sets. They occur up to a maximum of 300 km (186 mi) from the present shoreline, and in different areas appear to be actively influenced by tidal, storm, and/or oceanic currents. The shelves upon which the ridges sit are up to 400 km (250 mi) wide, and 100,000 km^2 (39,000 mi^2) in area, with water depths of 50 to 200 m (165 to 660 ft).

The commonly prolific hydrocarbon-bearing Cretaceous shelf-bar sandstones (e.g., Shannon, Sussex, Gallup, Hygiene, Viking, Cardium, etc) exhibit similar geometries and dimensions to these Holocene ridges and are thought to have been deposited tens to hundreds of kilometers from the paleoshoreline in comparable water depths. Material for these sandstones is commonly thought to have been transported long distances across a flat, muddy shelf, since the sandstones are usually associated with thick shale sections.

All of the Holocene ridges sit atop topographic highs on the shelf surface. They are generally part of a Holocene transgressive sand sheet derived by reworking of underlying substrate while contemporaneous mud is deposited in adjacent low areas. The above comparisons suggest the Cretaceous shelf-bar sandstones may have been deposited upon similar shelf highs. Such topographic highs could develop on the Cretaceous shelf surface by (1) recurrent folding or faulting, as has been proposed for some Wyoming sandstones, (2) fluvial erosion and sculpturing during lowered sea level, as on the Texas shelf, (3) deposition of thick accumulations of sediment (e.g., deltas), as on some Holocene Atlantic shelves, and (4) preservation of paleotopography from stratigraphically lower unconformity surfaces, as has been suggested for the Cretaceous of Alberta.

A sequence of events is proposed for the evolution shelf-bar sandstones which considers the role of shelf topographic highs coupled with fluctuations in water depth in providing the source, development and burial of shelf sand ridges. The initial stage is development of the topographic high on the shelf. With shallowing of water, sediment derived by erosion on the high forms a sediment sheet which later is molded into sand ridges by shelf hydrodynamic processes; during this stage mud is winnowed and



deposited in adjacent low areas. With deepening of water, sand ridges first stabilize then eventually become buried in shelf mud. Repeated cycles of development of highs and changing water depth can give rise to a series of locally sourced shelf-bar sandstones associated with shale. This sequence of events assumes erosion and deposition can occur on different parts of the shelf topographic high, which is of the same general size as northwestern Atlantic shelf highs upon which Holocene ridges sit.

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Early Cretaceous Drowning and Recovery of a Carbonate Continental Margin, Eastern Arabia

The eastern margin of the vast Mesozoic carbonate platform which underlies much of Arabia is exposed in the mountains of Oman and the United Arab Emirates. Outer platform and margin facies occur as autochthonous windows in the Oman Mountains and as allochthonous terrane in the Musandam Mountains to the north. These strata are in turn surrounded by westward-thrust nappes of contemporaneous deep-water strata and oceanic lithosphere.

Inundation or drowning of the platform occurred in earliest Cretaceous time and is reflected by Jurassic reef limestones overlain directly by Lower Cretaceous pelagic carbonates. In Oman the outer platform strata are buried by over 250 m (820 ft) of these radiolarian lime mudstones. The abrupt upward transition in middle Cretaceous time to ooid grainstones and then muddy fossiliferous limestones interbedded with rudist biostromes documents buildup to sea level and eastward progradation of first high-energy facies and then lower energy interior facies. In the Musandam Mountains to the north, however, where the Jurassic margin proper was drowned, deep submergence was accompanied by flexure and the Lower Cretaceous limestones are slope deposits as indicated by numerous turbidites, debris flows, and slope unconformities. These strata are also transitional upward into shallow water facies so that by Middle Cretaceous time the high-energy facies were once more at the shelf edge.

These events, which are reflected along the length of this extensive continental margin, occurred during a time of apparant eustatic sea level rise.

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Regional Variations in Development and Characteristics of Barrier Island Foredunes Along Texas Coast

Analyses of grain-size parameters, carbonate content, and heavy-mineral content of foreshore and dune sediment samples collected along the Texas coast indicate that five textural zones exist. The characteristics of these zones are controlled by sediment supply, nearshore hydrography, and shoreline stability. In general, Texas coast sediments are fine to very-fine grained, well-sorted sands. Dune and foreshore subfacies can be distinguished from one another by mean standard deviations, skewness values, and carbonate content.

Variations in dune geometry and size are controlled by climate, coastal orientation, and wind direction and velocity. Measurements of the foredune cross-stratifications show that polymodal distributions of the dip angles and azimuths are typical along the Texas coast. Pyramidal dune forms, which are produced by seasonal variations of wind direction, result in bimodal distributions of cross-bedding azimuths; the two direction modes are bisected by the prevailing winds from the southeast. Offshore-directed winds from the north and west produce a significant number of offshore-dipping beds at each sample station.

Analysis of the internal structure of the Texas coast dunes demonstrates the variability of cross-stratification dip angles and azimuth values that is possible in an eolian environment. The information from this study may be used to help define relict coastal orientations and eolian processes that acted within an ancient depositional setting. Depending upon diagenetic processes, the well-sorted character of the dune sediments may provide porosity values that are suitable for hydrocarbon accumulation. Therefore, it is important to recognize and understand these eolian deposits.

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Fourier Grain Shape Analysis as a Tool for Indicating Batch Recoveries of Bitumen from Athabasca Tar Sands

Effects of weight percent fines have been considered in the past as important factors in controlling the recoveries of bitumen from tar sands using batch extractors. However, in the marine sands of the Athabasca deposit, fines break down as a predictor of batch recovery; in some places even low fines tar sands do not yield acceptable batch bitumen recoveries. It was predicted that a sand unit high in rough-surfaced, diagenetically altered grains would yield low primary bitumen recovery. Scanning electron microscopy of the solids from batch extraction tests revealed that quartz grains with very rough, pitted, and overgrown surfaces retain bitumen. (These solids appear to be transported preferentially with the bitumen to froth and secondary tailings.) Grains with smooth surfaces were found to be dominant in primary tailings.

Fourier grain-shape analysis was employed to identify tar sand shape types since scanning electron microscopy inspections are time-consuming and expensive. Five grain shape families were so identified and verified by SEM.

Two types of grains unaltered by diagenesis are very fresh, rounded, sub-aerially abraided grains, and fresh, angular grains with concoidal fractures. Three other grain shape families represent particles whose surfaces were strongly modified by diagenesis. The diagenesis was found to be primarily overgrowth: (1) rough silica plastering with a sponge-like appearance, producing high surface areas; (2) silica plastering with multiple crystals; and (3) complete simple overgrowth.

Fourier grain-shape analysis yields the proportion of high surface area grains in 900 grain samples taken from marine sand intervals of 3 cores. That proportion, plotted versus weight percent primary recovery by batch extraction, indicates that when the proportion of high energy grains exceeds 40%, primary recoveries were less than 80 wt. %. (Primary recovery, in contrast, shows no relationship to weight percent fines for these marine sands and cannot be used as a batch recovery indicator.)

The results suggest the feasibility of predicting recovery in advance of mining, thus permitting adjustments to mining/extraction strategies. It must be kept in mind, however, that extrapolation of bitumen recovery results from bench-scale batch tests to large-scale continuous units is not straightforward.

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