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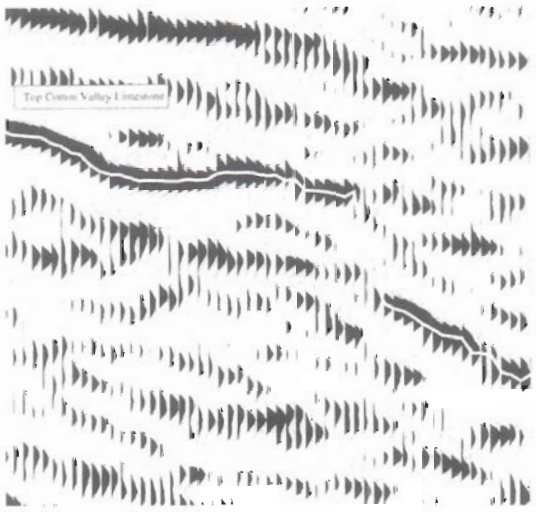
The Outboard Trend of the Cotton Valley Limestone Pinnacle Reef Play, East Texas

Abstract

The Upper Jurassic Cotton Valley Limestone Pinnacle Reef trend has been a rapidly expanding gas exploration play in the East Texas Basin since the 1993 Marathon #1 Poth discovery in Leon County, Texas. Although the play has been expanding in all directions, the majority of exploration activity has been in a fairway along the western margin of the East Texas Basin in Freestone, Limestone, Leon, and Robertson Counties. Amoco and its partners, Spirit 76 and Kaiser Francis, are exploring a new Cotton Valley Limestone Pinnacle Reef Outboard Trend, which is located downdip of the established production fairway. New data collected from the Amoco #1 J.W. Vanderbeek discovery and other recently drilled wells confirm that porous, productive, deep and shallow water, carbonate buildup facies are present in the Outboard Trend.



Seismic line from 3D volume showing observed character of a buildup in the Outboard Trend. Note overall mounded shape, internal reflectors, drape of overlying reflectors, and characteristic absence of Cotton Valley Limestone reflector on downdip flank.

As interpreted from 3D seismic data, the Outboard Trend carbonate buildups typically form isolated paleogeographic highs along an outer distally steepened ramp and ramp-margin. Overall, the buildups are aggradational, and internal buildup seismic reflectors show stacking with minor progradational and retrogradational offstepping. Each depositional package is usually characterized by an initial transgressive sequence, followed by a shallowing-upward sequence. Most of the Outboard Trend is capped by a gradual drowning sequence in which upper Cotton Valley massive mudstone-wackestones grade upward through transitional marly limestone into Bossier Shale or occasionally change abruptly and directly into Bossier Shale.

Many Outboard Trend buildups are cored by micrite-rich sponge-microbial mounds that are thought to have been initiated during transgressive events at relatively deep-water subphotic depths. Commonly associated biota consist of bryozoans, serpulid worm tubes, echinoderm ossicles, and tiny thin-walled pelecypods. Mudmound flank beds contain mound lithoclasts and biota that occur in some debris flow beds, with adjacent intermound areas consisting mainly of dark gray lime mudstone and fine-grained wackestone. As the mounds grew upward into the photic zone, coral-sponge-microbial boundstones developed, with small branching corals often being the dominant component, with sparse chaetetid sclerosponges and possibly solenoporid red algae. Cement-filled skeletal molds and shelter cavities are common in this phase of the buildups. The associated biota is similar, but with the addition of larger thick-walled pelecypods, scattered small gastropods, and rare tiny dasycladacean algae. Flank and interreef limestones at this paleobathymetric level are typically outer-shelf skeletal wackestones and packstones dominated by mollusc debris, and with rare nodosariid foraminifera. The shallowest ⇒

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water facies in the trend consist of peloidal-skeletal to skeletal packstone and grainstone, with occasional sparse ooids, which indicate periods of above-wavebase, moderate- to high-energy depositional conditions.

Four general limestone facies are predominant in the Cotton Valley Limestone Outboard Trend: (1) sponge-microbial to coral-sponge-microbial boundstone (mounds/reefs), (2) skeletal wackestone to packstone (buildup flanks), (3) lime mudstone to fine-grained wackestone (intermound), and (4) peloidal-skeletal to skeletal packstone-grainstone (moderate- to high-energy shoals). The first two facies types (boundstone and skeletal wackestone-packstone) form productive reservoirs along the Outboard Trend that exhibit up to 19 % porosity. The pore system of these reservoir facies consists of co-genetic open fractures, microfractures, and associated microporosity found within micritic grains and matrix, along with minor amounts of cement-reduced skelmoldic, intergranular, and vuggy pores. Porosity development is related primarily to deep-burial diagenesis (fracturing and burial dissolution). The best porosity and highest net pay are found in stratigraphic intervals that are dominated by biohermal components and deep-burial cements. Skeletal-poor facies (lime mudstone to fine-grained wackestone) and facies containing abundant meteoric cements generally do not have good reservoir development.

An additional reservoir facies type recently discovered in the Amoco #1 J.W. Vanderbeek well consists of skeletal grainstone containing coarse-grained, well-abraded, and partially micritized corals, red algae, and molluscs deposited in a high-energy, shallow-water shoal. Porosity ranges between 6 and 22 % and consists of large, cement-reduced intergranular, intragranular and skelmoldic macropores, along with micropores found within the micritized portions of skeletal grains. Microporosity ranges between 65 and 80 % of the pore system and is the result of intense meteoric dissolution. Marine, meteoric, and deep burial cements are minor, and no evidence of deep burial dissolution or fracturing exists in this reservoir facies type.

Further work that will provide greater exploration predictability is in progress on the stratigraphic/biostratigraphic and diagenetic features of the Outboard Trend. □