Cotton Valley Reef Trend, East Texas Basin: Exploration and Diagenesis Model

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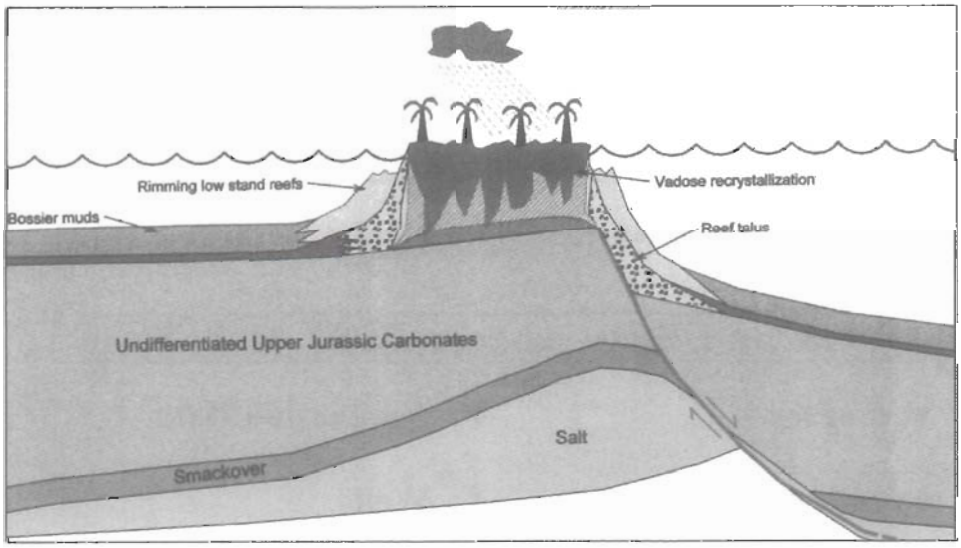
Exploration has exploded in the mature East Texas Basin for deep, overpressured "pinnacle" reefs in the Cotton Valley Limestone (Haynesville). Reefs have been reported to be more than 800 ft high, 100 acres and contain as much as 100 BCF in a single reef.

The reefs germinated during Cotton Valley Lime deposition and grew into the mixed siliciclastic/carbonate environment of the Bossier Shale along compactional features, and salt-withdrawal-induced fault scarps, and salt-cored and basement structures. Productive reefs always have abundant delicate finger coral, and faunal diversity has been seen to increase with wave energy. Generally, wave energy was moderate and the reefs grew within wave base. Deepwater microbial mounds have not been seen to date. Reef poisoning and growth-inhibiting influences of nearshore influxes of terrigenous sediment and fresh water have been inferred locally to have resulted in tight reefs. Cumulative reef height was driven by vertical accomodation space provided by long period (third order) relative sea-level rise.

In the East Texas basin, local salt withdrawal and regional tectonics caused by post-rift thermal subsidence were the dominant processes affecting sea level. Recent studies of the Upper Jurassic eustacy curve indicate that sea level was probably static and did not provide accomodation space globally. The Upper Jurassic was a time of "greenhouse" climate where smaller polar ice caps induced low amplitude (10–20 ft?) fourth-and fifth-order sealevel cycles. This composite sealevel curve provided the opportunity for reef communities to accumulate vertically via the third order rise and provided a mechanism to create significant porosity via the higher frequency sealevel fluctuations. Drops in sea level exposed reefs (islands) where rain collected at the near surface, generating a freshwater lens (water table).

Gross recrystallization occurred over much of the most recent reef cycle construction into micro-rhombic calcite and micro- to fine porosity. Less stable calcite components (aragonite, Mg calcite) morphed into more stable calcite and vugular porosity. These reefs are rhythmically stacked patch reefs that look like pancakes with synoptic relief probably never exceeding 50ft. Each "pancake" grew vertically 20–50ft. during each fourth or fifth order sealevel rise and was then leached during the subsequent drop.

Exceptions to this process have been inferred locally where local freshwater influx depressed the tops of the reefs to slightly deeper, preventing their exposure to freshwater leaching. The reefs backstep in space and time away from the locus of thermal subsidence at the center of the basin—a failed rift. There is ample evidence for these hypotheses from well logs, Sr and C/O isotopes, fluid inclusions, SEM, and petrography.



First Stage: *Reef grows in moderate to high energy environment. Fauna is dominated by corals and sponges; facies by grainstones.* **Second stage:** *Reef is exposed during sea-level drop. Much of the reef becomes finely porous because of recrystallization of micro-rhombic calcite. Dissolution of coral framework and grains enhance capacity and flow rates of fluids in the reef complex. Figure by Dan Zeigler.*

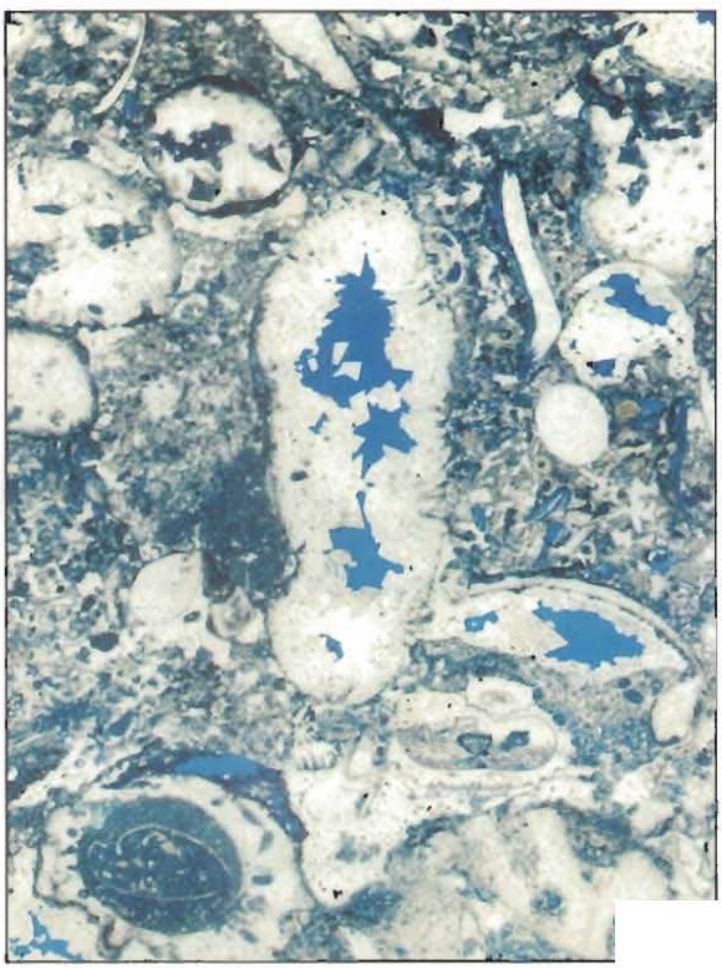
Biographical Sketch

Daniel G. Zeigler *grew up in Philadelphia, Pa., and earned a B.S. in geology in 1977 from Indiana University of Pennsylvania. He started in the industry as a mudlogger with Baroid and independent geologist during 1977–1979. Zeigler became a staff geologist with Southeastern Exploration and Production Company (SEPCO) in 1980 and explored the Triassic rift graben frontier on the eastern seaboard until 1988. He returned to graduate school in 1988 at the University of Texas at Dallas Ph.D. program. He studied deformation using global positioning systems at the Nevada Nuclear Test Site, Baja California, and New Zealand.*

In 1991, Zeigler joined SK Resources as a staff geologist. Since then, SK has become a major player in the Cotton Valley Reef Trend. Other areas of interest include the Mississippi Salt Trend, South Texas Sligo trend, and the Lodgepole Formation of North Dakota.

Note: The reservation code for this meeting is 5-0-1

See next page for cover photo



The Above Thin Section Photo Shows a Productive Cotton Valley Reef Coral Debris Facies.