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REGIONAL PATTERNS OF DIAGENESIS, POROSITY EVOLUTION, AND HYDROCARBON PRODUCTION, UPPER SMACKOVER OF THE GULF RIM[1]

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ABSTRACT

The exploration fairway of the Upper Jurassic Smackover, from the Rio Grande to Panhandle Florida, consists of a rather simple carbonate ramp depositional system characterized by thick, widespread blanket ooid sands. The ooid sand belt gives way landward to quartzose clastics, and locally to shales and evaporites. This high-energy ooid sand belt rapidly changes into dark, fine-grained limestones and shales in a seaward direction. Early salt movement, buried basement structures, and growth faulting locally affected facies patterns within the upper Smackover. Salt anticlines which were active during Smackover deposition, and led to localization of favorable facies, are particularly important along the East Texas and South Arkansas parts of the trend. Buried basement structures as well as salt structures controlled detailed sedimentation patterns in the Alabama-Florida parts of the trend, whereas growth faults controlled sedimentation along a narrow belt straddling the Arkansas-Louisiana border. Initial porosities and permeabilities were generally quite high across the entire Smackover fairway prior to burial. Presently observed porosity-permeability trends were generally controlled by post-depositional processes including compaction, dissolution, cementation and dolomitization. Regional differences in burial history across the Gulf rim, related in part to proximity to the isolated interior salt basins (Mississippi, North Louisiana and East Texas salt basins), has resulted in striking differences in reservoir characteristics across the trend, reflecting significant regional differences in pathways of porosity evolution.

East Texas is a province dominated by dolomitized reservoirs, with production controlled by proximity to major fault trends, such as the Mexia-Talco, or well-defined salt anticlines. Reservoir quality is tied inextricably to dolomitization. Dolomitization occurred early, associated with a regional fresh meteoric water system, hence reservoir characteristics were generally established prior to significant burial. Fracturing is a general feature of East Texas sequences and there is evidence that fractures have acted as conduits for hydrocarbon migration. East Texas Jurassic rocks contain mainly gas. Oil migration occurred relatively early in the burial history of the sequence. Late burial diagenetic events in East Texas seem to have had little influence over ultimate porosity evolution.

Because of the depths involved, the South Texas Jurassic has not been explored to any extent and no production has been established. Recent works by Loucks and Budd (1981) on the available material indicates strong similarity to East Texas in terms of porosity evolution and general diagenetic framework. Loucks and Budd (1981) note, however, significant late subsurface secondary porosity development.

South Arkansas, Louisiana, and Mississippi stand out in stark contrast to the Texas part of the trend. Reservoirs are generally limestones, with porosity either as early fresh meteoric, secondary moldic, or as preserved primary porosity. The early meteoric moldic porosity occurrs in a predictable trend across the updip portion of the fairway. Reservoirs with preserved primary porosity occur in a band seaward of the secondary trend, and show no evidence of fresh-water influence, or of early diagenetic processes other than minor marine cements. Porosity preservation in this zone was a function of grain type (ooids vs. pellets) and original sediment texture, and hence was ultimately controlled by depositional processes. In the primary porosity zone, production is almost always associated with salt-related structures, whereas in the early secondary zone, updip permeability barriers (diagenetic and stratigraphic?) as well as salt-related structures are important. Late diagenetic events that were associated with the migration of basinal derived fluids across the shelf during moderate burial, included cementation, dedolomitization, and calcite dissolution. All reservoirs in this part of the trend show ample evidence of significant porosity enhancement during this late solution phase. The limestone trend of Arkansas, Louisiana, and Mississippi is primarily an oil province with hydrocarbon migration which took place much later than that to the west in Texas.

In Alabama and Florida, the trend is again toward dolomite reservoirs. Most dolomite, and hence porosity and permeability, formed early in association with meteoric water processes. Most large reservoirs such as Jay are associated with salt anticlines, with minor production from updip basement structures. This part of the trend is mixed gas and oil. Hydrocarbon migration into reservoirs seems to have been a relatively late event.

The Jurassic upper Smackover of the Gulf Rim is a simple sedimentologic system that has had a complex and variable burial history along the trend, which is distinctly reflected in major regional differences in diagenetic history, reservoir-porosity type, trap characteristics, and hydrocarbon migration timing.

REFERENCE

Loucks, R.G., and D.A. Budd, 1981, Diagenesis and reservoir potential of the Upper Jurassic Smackover Formation of South Texas: Gulf Coast Association of Geological Societies Transactions, v. 31, p. 339-346.

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