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Saddle Crystal Dolomites as Fractured Reservoir Indicators, Mississippian Biohermal Facies, Hardeman County, Texas

Dolomitized Mississippian biohermal facies in the Hardeman basin of Texas produce mainly from fractures. During Osagian time, crinoid-bryozoan mud mounds were common in the shallow basin. In several field areas, early dolomitization, leaching, solution brecciation, and silicification occurred episodically during the development of the muddy, biohermal core sequences. Subsequent burial diagenesis involved calcite cementation, pressure-solution, several stages of fracturing, and a late stage of dolomitization. The dolomite consists of saddle crystals that lined early vugs and fractures and replaced skeletal grains. The dolomite has δO^{18} values of -10 to -12 (PDB) and originated in the subsurface after fracturing occurred. It is readily distinguished in cuttings, making it a fracture-vug indicator that is identifiable at the well site. As the Quanah field reservoir and many others in the area owe their permeability mainly to fractures, the saddle crystal dolomites identify the primary productive zones and may enable the mapping of permeability trends.

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Chappel (Mississippian) Biohermal Reservoirs in Hardeman Basin, Texas

Carbonate mud mounds with flanking crinoidal sands are commonly associated with oil production in the Hardeman basin. These buildups are similar to the Waulsortian facies in Europe and to the Mississippian bioherms in the Sacramento Mountains of New Mexico. Cores and logs from Sun Oil Co.'s Quanah field provided subsurface control, enabling us to delineate six principal lithofacies that portray the depositional history of the Quanah buildup. The facies, in ascending order, are: (1) the mudstone core facies, (2) the skeletal wackestone upper core facies, (3) the skeletal veneer facies, (4) the flanking facies, (5) the intermound facies, and (6) the oolite shoal facies. The facies relations indicate an overall shoaling-upward sequence with two regressive-transgressive cycles superimposed. Early regression subjected parts of the core facies to subaerial exposure. Early dolomitization and solution brecciation resulted in intercrystalline and vuggy porosity. Subsequent marine sedimentation blanketed the karst surface. The dolomitized, vuggy core facies was subjected to several episodes of fracturing in the subsurface. One early fracture set was partly filled with large saddle dolomite crystals. Equivalent limestone strata were not comparably fractured and do not contain the saddle dolomite.

The Quanah biohermal reservoir exhibits three kinds of porosity: moldic-vuggy, intercrystalline, and fractures. However, the porous zones are only marginally productive unless they are fractured because the vuggy porosity has low permeability.

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Determination of Depositional Environments of Sand Bodies by Use of Vertical Grain-Size Progressions

An attempt to distinguish modern fluvial, coastal barrier, and turbidite sands, using grain-size (acquired from an automated settling tube) analysis yields poor results when two dimensional scatter diagrams and log-normal plots are used to examine samples collected at random from these environments. This is not to suggest that grain-size analysis is not a valuable "tool," but only that the environmental subdivisions used were too general. In reality, each of the environments examined consists of several different subenvironments, each characterized by its own unique processes, and commonly by its own unique grain-size populations. Through time, these subenvironments migrate laterally, occasionally depositing an orderly, unique, stratigraphic sequence. Much previous work has been done in describing such sequences, but emphasizing those features that are most easily recognized in the field. Our results demonstrate that unique grain-size progressions also exist within these sequences.

By examining vertical progressions in grain-size data, it was possible to distinguish sand bodies deposited in braided rivers and alluvial fans, meandering rivers, coastal barriers, and deep-sea fans with far better results than obtained by examining samples taken at random from these different environments. This approach has been used to investigate ancient sandstone bodies whose depositional origins have been previously established from stratigraphic and facies relationships and from detailed examination of sedimentary structures. Our diagnosis, based on grain-size progressions alone, is the same as those of previous investigations. Hence, grain-size vertical progressions should prove to be a useful "tool" in subsurface geology in providing a means of reconstructing the depositional environment of sandstones, and thus, in predicting the lateral extent and facies relationships, and in the correlation of sand units.