strike from the outcrop section; the nearly perfect vertical sequence of lithology in a core compensates for the loss of lateral exposure in outcrop. Correlation of the outcrop section with electric logs permitted mapping of the distribution of the rock-stratigraphic units, and the resultant geometric interpretation precluded a delta interpretation for this particular stage of Mesaverde deposition in this area.

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RECOGNIZING ESTUARINE AND TIDAL CREEK SANDBARS BY BIOGENIC SEDIMENTARY STRUCTURES

Estuarine and tidal creek sandbars bear many similarities to fluvial channel sandbars in their physical sedimentary structures, but are considerably different with respect to biogenic sedimentary structure. Consideration of these biogenic structures with current-produced physical sedimentary structures and with facies geometry produces unique, readily recognizable, paleoenvironmental indicators.

The abundant burrowing fauna collectively found in estuarine and tidal-creek bars represents species which are individually characteristic or very common in other intertidal environments, such as beach (burrowing shrimp, *Callianassa major*), tidal flat (burrowing shrimp, *Callianassa atlantica,* and polychaete worms *Onuphis* and *Diapatria*), marsh (fiddler crab, *Uca*), estuarine channels (burrowing shrimp, *Upogebia*), and sand flats (acorn worm, *Balanaglossis*). Other biogenic structures found in tidal creek bars include tracks, trails, and markings produced by more typical subtidal organisms such as the sand-collar snail, *Polinicies;* hermit crab, *Clibanarius;* blue crab, *Callinectus;* mantis shrimp, *Squilla;* and feeding depressions made by rays.

Two subenvironments are found on most of the tidal creek sandbars studied and each contains a characteristic suite of biogenic and physical sedimentary structures. The channel side of the bar consists predominantly of sand and preserves a record of megaripples and small current ripples. Associated with these structures are burrows of *Onuphis, Callianassa major, Callianassa atlantica,* and *Uca.* Energy is less and muddy sand accumulates on the side of the bar away from the channel current. Ripple laminae generally are not developed here and bioturbated sediments comprise the principal structures. A great density of burrows is found in this subenvironment, and *Upogebia, Diapatria,* and the razor clam, *Tagelus,* are typical burrowing forms.

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GEOLOGICAL RESERVOIR ANALYSIS, MADISON FORMATION, ELK BASIN FIELD, WYOMING-MONTANA

The Elk Basin field is in the northeast end of the Big Horn basin, on the Wyoming-Montana state line. The structure is a NW-SE-trending asymmetrical anticline, approximately 8 mi long and 4 mi wide, with about 5,000 ft of structural closure. Oil production from the Madison Formation was discovered in 1946, and the Madison has supplied more than 75 MM bbl of oil within 5,100 productive acres from a closure of about 1,400 ft. A recent core study of the Madison reservoir shows that it can be divided into several separate, distinct, geologic and production units.

The Madison carbonate sequence has been altered greatly and distorted by groundwater erosion as a result of the formation of karst topography, by subsequent solution brecciation in Late Mississippian-Early Pennsylvanian time, and by selective remineralization in some areas of the field. The overall effects are the collapse of sections of the upper Madison—up to 300 ft thick—into brecciated rubble zones, thereby removing blocks from effective communication with each other. There are areas of remineralization which, because of redeposition of dissolved carbonates, silica and anhydrite into pore space and fractures by the downward percolating groundwater, have caused local, relatively tighter zones, forming, in effect, local stratigraphic traps. Zones of insoluble reside of clay and rock fragments form an effective barrier between the "A" and "B" producing zones, and account for the different reservoir characteristics of these zones.

An important effect of the groundwater action has been the removal of the more soluble limestone, leaving the less soluble dolomite and thereby forming the good secondary porosity found in the Elk basin Madison. The development of this secondary porosity can be correlated and subdivided into readily recognizable and distinct zones. This shows a certain degree of continuity, which is necessary in evolving an efficient drilling and flooding program. Electric-log and core evaluation of other Big Horn basin fields which penetrate the Madison indicate the existence of a situation similar to that in the Elk Basin reservoir, except that the Madison in other fields generally does not have such pronounced karst-solution development.

The above-mentioned variations can be unified into a practical working hypothesis for reservoir engineering analysis; the hypothesis so developed provides a useful three-dimensional reconstruction of the Elk basin Madison reservoir. Application of the hypothesis has led to a dramatic production response within the reservoir. The practical success of the hypothesis has important exploration implications; specifically, the exploration geologist must understand known producing reservoirs before effective exploration for new reservoirs can be carried out successfully.

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VARIATIONS IN LATE PENNSYLVANIAN MOLLUSCAN FAUNAS

Certain nearshore facies of the upper half of the Pennsylvanian System in the Mid-Continent region are characterized by faunas which are dominantly molluscan. Although individual faunules are reasonably well known, few comparisons have been made between successive faunas. Five molluscan faunules ranging in age from Desmoinesian to Virgilian were examined on the specific and supra-specific levels. The abundance of individual species, genera, and families within each formation, variations in the abundances with time, and the phylogenetic changes aid in the interpretation of the paleoecologies of these unusual populations.

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COMPARISON OF RECENT AND ANCIENT COARSE-GRAINED POINT BARS[1]

Sequences of sedimentary structures in modern point-bar deposits of the Amite River in east Baton Rouge Parish, Louisiana, are analogous to features ob-

[1] Publication authorized by the Director, Bureau of Economic Geology, The Univ. of Texas at Austin.