INTERPRETATION OF DEPOSITIONAL ENVIRONMENTS OF COMMON CLASTIC HYDROCARBON RESERVOIRS FROM SEDIMENTARY STRUCTURES

by

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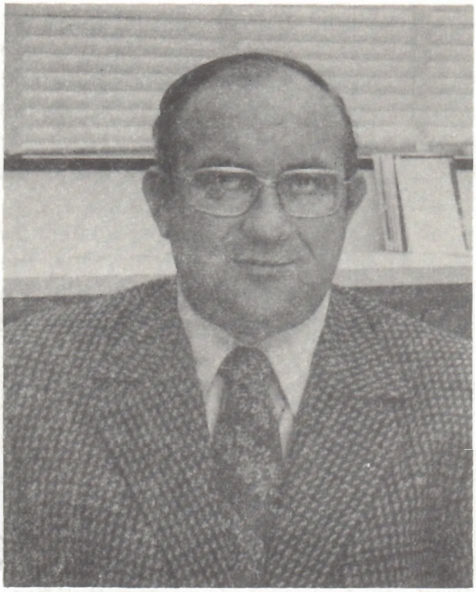

BIOGRAPHICAL REVIEW

Alonzo D. Jacka is a native of Wisconsin. He received a B.S. Degree in Geology from Beloit College, Beloit, Wisconsin in 1953, and then went to the University of Wisconsin to earn a Masters Degree in 1957. He was awarded a Doctorate Degree in Geology from Rice University in 1960.

Dr. Jacka has been on the faculty of Texas Tech University since 1959 and is now Professor of Geoscience. His research activities involve developing criteria for interpreting ancient depositional environments by analysis of sedimentary structures, textures, paleontology and mineralogy in both quartzose clastic and carbonate sediments. He has done considerable work on Permian and Cretaceous rocks in the Permian Basin and Rocky Mountain region where interpretation of depositional environments is deduced from integrating outcrop data with subsurface cores and various types of logs. His current research project concerns diagenesis of sandstones, carbonates, and evaporites with emphasis on factors controlling cementation and development of occlusion of porosity.

Dr. Jacka has published many papers on depositional environments, paleogeography and diagenesis of sediments, and he has been retained as a consultant by several major oil companies at different times during his tenure at Texas Tech University. Dr. Jacka is a member of the American Association of Petroleum Geologists, the Geological Society of America, the Society of Economic Paleontologists and Mineralogists, Sigma Xi, and the Lubbock Geological Society.

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ABSTRACT

The sedimentary structures most abundantly represented in sandstones are indicative of current deposition and include parallel lamination, current lineation, small truncation current ripples, climbing ripples, large truncation current ripples, sand waves, dunes and megaripples. Because these are formed in a broad spectrum of depositional environments - fluvial, transitional, shallow marine and deep sea-oceanic habitats - vertical sequences and suites of sedimentary structures are more definitive in discriminating basic sandstone models than individual features. To a large degree, sedimentary structures in sandstones record abnormal or catastropic events such as floods or storms, and episodes of scour are closely followed by deposition and "back-filling." Interpretation of sandstone models must not be strictly based upon recognition of idealized, "complete" sequences of sedimentary structures, because partially truncated sequences are commonly recorded.

One standard sequence of sedimentary structures was established by Bernard and his co-workers at Shell Research from study of recent meander belt deposits of the Brazos River. This has become known as the point bar sequence and consists of the following sedimentary structures upward from the base: 1) massive or crudely bedded interval of sand and/or gravel containing mud crack blocks and rip up clasts in the basal portion, 2) interval of large trough or festoon crossbedding, 3) interval of parallel lamination, 4) interval of small current ripple cross lamination, 5) interval of parallel laminated fine to very fine sand or silt - commonly grades upward into laminated sand-silt-clay, 6) interval of silt-clay (includes clay drape); grain size exhibits upward fining. I have also found the so-called point bar sequence well developed in Permian deep sea channels of the Deleware Basin where sand was introduced through submarine canyons and deposited in water depths of up to 3000 feet. The same sequence may be closely simulated in tidal channels and deltaic distributary channels. To discriminate among these models it may be necessary to closely examine channel-flanking, floodplain or overbank deposits.

Another standard sequence, which I first described from outcrops of Upper Cretaceous sandstones in the Rocky Mountain region, records seaward progradation of barrier islands or shoreline-strike sand bodies. In ascending order the following sequence of environments and structures is recorded in the prograding barrier island sequence: 1) infra-surfzone deposit consists of thin, undulatory and wave rippled beds, 2) surfzone deposit - consists of large truncation current ripple crossbedded sets (trough or festoon crossbedding) which exhibit 180° reversals, 3) foreshore and backshore beach deposits contain seaward and landward dipping bundles or sheaves of laminae bounded by storm-cut truncation surfaces. To varying degrees, structures in surfzone and infra-surfzone deposits may be destroyed by bioturbation. The so-called barrier island sequence may be closely simulated in tidal bar belts and destructive phase delta front sheet sands.

All of the aforementioned sediment models constitute common hydrocarbon reservoirs. It is important in exploration and exploitation to isolate the actual model so that geometry and orientation of clastic reservoirs may be predicted with the highest degree of confidence. The probability and mechanism of hydrocarbon entrapment differ for each model.