Lithofacies, Diagenesis, and Porosity, Ivishak Sandstone, Prudhoe Bay Area, Alaska

The Permo-Triassic Ivishak Sandstone is the main reservoir interval of the Prudhoe Bay field, North Slope, Alaska. Studies of cored sequences from the field and offshore (Reindeer Island) reveal that porosity development within the Ivishak Sandstone has a complex relationship dependent on both depositional (lithofacies) and postdepositional (diagenetic) history. These factors are related to the tectonic history of the basin.

Five dominant lithofacies are identified: (1) interbedded very fine sandstones and mudstones, (2) parallel laminated carbonaceous fine sandstones, (3) multistory upward-fining medium sandstones, (4) conglomerates, and (5) multistory upward-fining coarse to granular sandstones. These lithofacies occur everywhere as upward-coarsening to conglomerate sequences. In the onshore (Prudhoe Bay field) area the coarsening sequence is overlain by a gross upward-fining sequence of gravelly to medium-grained multistory sandstones. This thins dramatically to the north, and is absent at Reindeer Island. Consideration of lithofacies and thickness variation leads to an interpretative model concerning evolution of the basin with respect to tectonics and sedimentation. Thus initial progradation of an active alluvial fan-delta system from the northeast was replaced by progressive transgression from the south of more distal upon proximal facies.

Petrographic characteristics of the rocks reveal that porosity development is intimately related to lithofacies. Porosity within the medium-grained sandstones is predominantly due to dissolution of early nodular calcite. Porosity within the conglomeratic intervals appears to be much more of a primary (textural) origin.

Hypothetical porosity profiles can thus be constructed based on predicted lithofacies distribution across the area in any direction.

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Deposition and Diagenesis of Glauconite Sandstone, Berrymore-Lobstick-Bigoray Area, South-Central Alberta

The depositional environments of the Glauconite sandstone in the Berrymore-Lobstick-Bigoray area are distributary channels, delta platform, distributary mouth bars, and interdistributary bays.

The diagenetic mineralogy is consistent with the formation water chemistry. A simplified model for evolution of Glauconite sandstone water compositions includes (1) original derivation in a deltaic setting giving composition of early pore waters as brackish to normal marine, (2) alteration due to inorganic and organic chemical diagenesis, and (3) dilution through time due to meteoric water recharge. The formation waters now evolved have such a composition as to be (1) oversaturated with respect to hematite, kaolinite, and illite (late-stage cements); and (2) near equilibrium to undersaturated with respect to quartz, calcite, siderite, and dolomite.

The early diagenetic mineralogy is a function of early pore waters and thus the subenvironment. For example, ankerite cement forms early at the base of distributary channels.

The intermediate to late diagenetic cementation is a function of early diagenetic mineralogy. For example, hematite is formed by the oxidation of siderite due to meteoric water recharge. Oxidation of pyrite is quantitatively unimportant. Occurrence of late stage hematite is associated with structural highs which are most affected by meteoric water recharge.

Delta platform deposits contain gas, and distributary channel and distributary mouth bar deposits contain water. Delta platform deposits are isolated from distributary channel and distributary mouth bar deposits by a vertical permeability barrier of ankerite cement and a lateral permeability barrier of siderite and kaolinite cement, respectively.

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Subsurface Paleoenvironmental Analysis of Gas-Producing Medina Group (Lower Silurian), Chautauqua County, New York

A paleoenvironmental interpretation of the gas-producing Medina Group from the subsurface of Chautauqua County, New York, was made by making a lithologic study of a core from Panama, New York, and analyzing over 140 gamma-ray well logs. The oldest formation, the Whirlpool, is a light gray sandstone interbedded with thin lenses of siltstone. Isopach patterns reveal that the Whirlpool Formation was deposited in elongate parallel thick areas trending NE-SW which are similar to the patterns produced by modern tidal current ridges. The Whirlpool Formation is interpreted to be deposited as a tidally influenced sublittoral sheet sandstone. The Power Glen Formation is a medium dark gray shale interbedded with a light gray siltstone. It is interpreted as being deposited in: (1) a marine shelf and prodelta environment; and (2) as distal bar deposits. The Grimsby Formation has a light gray basal sandstone followed by medium red sandstone and interbedded with blackish red shales. The isopach patterns indicate that it was deposited in elongated dendritic areas that trend nearly north-south. The Grimsby is interpreted as a tidal-dominated delta, analogous to the modern Ord River delta of western Australia. There are four subenvironments: (1) channel and distributary mouth bars, (2) overbank splay deposits, (3) tidal channel, and (4) tidal flat. A regional correlation was made with the northeastern Ohio White Clinton sands to the basal light gray section of the subsurface Grimsby of northwestern Pennsylvania and Chautauqua County, New York. The Red Clinton of Ohio is correlated with the upper sections of the subsurface Grimsby.

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Temperature Anomalies Associated with Rocky Mountain Oil and Gas Fields

Over the years, a number of observers have reported on temperature observations which show a particular oil or gas field to be "hotter" at the pay depths than the surrounding rock at the same depth. Our study of 22 oil and gas fields from six states in the Rocky Mountain region demonstrates that at least 15 of these fields have positive temperature gradient anomalies at the pay level. Nine of these "hot" fields are contained in structural traps and six are primarily stratigraphic accumulations. Three of them are gas and 12 are oil fields.

All of our temperature measurements were recorded during drill-stem tests except for a few values taken from temperature logs. Drill-stem test temperatures usually are recorded a longer time after mud circulation has ceased in the well bore than are wire-line log temperatures. Therefore, the former generally are a truer measure of the formation equilibrium temperature than are the latter.

Speculating on the causes of these temperature anomalies over oil and gas fields, we conclude that upward fluid movements at depth is the most important factor. The upward-moving fluids carry heat along with them, and both heat and fluids are trapped whenever suitable trapping conditions are encountered in the reservoir rocks through which the fluids pass. The main evidence for this conclusion is the fact that observed temperature