but differences between high and low resistivities can reflect differences in original environment of sand deposition.

Diagenesis can add significant quantities of clay to a rock through chemical precipitation in pore spaces. Diagenetic (authigenic) clays are of importance because they can significantly effect electric-log response (SP, gamma ray, neutron, density), and can largely control the reaction of a sand reservoir to well-bore fluids. It is often forgotten that diagenesis can also remove clays from a sandstone, thereby "cleaning-up" an originally dirty sandstone.

The composition of drilling and stimulation fluids also has a significant effect on reservoir quality, especially when the sandstone pores are lined with diagenetic clays. Use of incorrect drilling or stimulation fluids can make a potentially good reservoir nonproductive.

In the Pliocene-Pleistocene section of the Gulf of Mexico, variations in environment of deposition, diagenesis, and the composition of drilling fluids can play havoc with interpretations based solely on log characteristics.

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Environment of Deposition of Upper Wilcox Sandstones, Katy Gas Field, Waller County, Texas

At Katy gas field, sandstones of the upper Wilcox Group produce gas at depths of 10,021 to 11,000 ft (3,054 to 3,353 m) in reservoirs controlled by stratigraphic and structural characteristics. Producing zones are from 6 to 42 ft (1.8 to 12.8 m) in the upper Wilcox "First Lower Massive" sandstones, and "D," "C," "B," "A," and "Second Wilcox" interbedded sandstones and shales. The reservoir sandstones are dip-trending with production being localized on the top of the anticline.

The upper Wilcox sequence has been interpreted as delta-front grading upward to bay-marsh transitional deposits and, alternately, as deep-water turbidite deposits. The field is located downdip from the Wilcox fault zone, downdip from known delta-destructional deposits in the upper Wilcox, and is as much as 45 mi (75 km) downdip from the postulated late Sabinian shoreline. Full-diameter cores from the upper Wilcox sequence show the sandstones are submarine, constructional-channel turbidites, giving way vertically to thinner turbidite sandstones in a predominantly shale section. The sandstones are representative of submarine fan deposits, having bedset associations characteristic of channel deposits (A, AB, and ABD) becoming middle fan associations (AE, BE, ABCE, and BCE) and then outer fan associations (ABE, BDE, CDE, and DE) upward in the section. The thicker channel sandstones show limited lateral extent along strike, grading to thin, overbank sandstones.

Sandstones are sparsely bioturbated, and shales are bioturbated only when they overlie sandstones. The burrows are characteristic of a wide range of water depths from middle neritic to bathyal. Benthonic forams found in the cores are abraded by transport and represent a range of water depths from middle to outer neritic. Therefore, water depths during Wilcox deposition were probably bathyal, as indicated by deeper water trace fossils.

The deposition of the upper Wilcox Group is associated with transgression during late Sabinian and incipient uplift of a deep-seated, diapiric mass under the field. Electric-log correlations and sandstone isopach maps suggest that the sands were deposited as parts of a submarine fan that shifted northeastward through time.

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Cap-Rock Formation and Diagenesis, Gyp Hill Salt Dome, South Texas

Cap rock from Gyp Hill salt dome, Brooks County, south Texas, was formed by salt dome dissolution that left a residuum of anhydrite sand, which was subsequently cemented by gypsum and at a later time altered to gypsum by fresh meteoric groundwater. The cap rock consists of gypsum at the surface (0 to 90 m) and gypsum-cemented anhydrite above the salt (90 to 273 m). Samples from the salt contain 13 to 42% disseminated anhydrite crystals and $<1.0\%$ dolomite rhombs in halite. The cap-rock–salt boundary is marked by a cavity several meters high. Salt dissolution has concentrated the insoluble material into an anhydrite sandstone with 20% porosity at the base of the cap rock. Cap rock porosity is largely occluded within 6 m above salt by poikilotopic gypsum cement and crushed anhydrite laths (presumably from the overburden pressure of the cap rock). A transition zone occurs between 90 and 120 m below the surface where anhydrite is being completely hydrated to gypsum. Above this zone, the cap rock is entirely gypsum and indicates flushing by fresh meteoric groundwater. Through the total thickness, anhydrite is in disequilibrium, as evidenced by the gypsum cement and embayed anhydrite laths.

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Live Oak Delta Complex—Unstable, Shelf-Edge Delta in Deep Wilcox Trend of South Texas

Detailed correlation and study of approximately 500 well logs from the deep Wilcox trend of south Texas have shown at least three major deltaic complexes in the Rosita delta system. These sandstone-bearing units, previously considered to be a lower Wilcox strike-transported, shelf-edge sand facies, are reinterpreted as upper Wilcox deltas that prograded across a stable shelf to an unstable shelf margin.

The Live Oak delta complex, the youngest observed, consists of numerous lobes. The youngest of these, the Luling and Slick deltas, are both extensively growth-faulted and show a downdip change from delta plain to pro-delta facies. Areas of maximum net sandstone occur in the downdip part of the growth-fault zone where rapid relative subsidence rates compensated for basinward decrease in sandstone percent. A gulfward displacement of facies and associated growth faults occurred between deposition of the older Luling to deposition of the younger Slick delta. This suggests that the deltas prograded out to the shelf margin and that the associated growth faults reflect gravity instability related to the adjacent prodelta slope.

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Well Log Analysis Concepts in Clastic and Argillaceous Sediments, United States Gulf Coast

Reliable estimates of amount, type, and distribution of clay minerals encountered in Gulf Coast sands improve log-derived determination of reservoir properties, such as porosity, hydrocarbon saturation, and permeability.

Log-derived determination of clay properties also provide information for geologic and formation evaluation studies, including detailed stratigraphic correlations, clay diagenesis, source rock potential, cation exchange capacity, overpressure detection and evaluation, and commercial hydrocarbon distribution in overpressure regimes.

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Diagenesis of Middle Miocene Sands in Geopressure Zone of Lirette Field, Terrebonne Parish, Louisiana

A study of temperature, pressure, and salinity distribution in the Lirette field reveals important information concerning the effects of the hydrodynamic regime on sandstone diagenesis. Mineralogic examination of associated shales also aids in the understanding of diagenesis in these sands.

The Lirette field is a large domal structure related to deep-seated salt, approximately 20,000 ft (6,096 m), bounded to the north and south by major growth faults. Isothermal surfaces in the Lirette field closely follow the structure. Isotherms commonly drop in downthrown fault blocks. Along fault leakage zones, temperatures increase. Pressure distribution in the Lirette field is primarily related to structure, and the presence of a sufficient shale to sand ratio. Formation water salinities are lower ($<$50,000 ppm) for wells that have been "flushed" by geopressured waters.

The well-documented decrease of smectite in mixed-layer illite-smectite is present in Lirette shales. A more detailed analysis indicates that some montmorillonite may be converted to beidellite before it is converted to illite.

Sandstone diagenesis in the Lirette field is complex and there are significant lateral and vertical variations. The relative sequence of diagenetic events in Lirette sands is as follows: (1) spherulitic calcite cement, probably formed at or near the sediment-water interface; (2) authigenic chlorite rims and platelets, which help to preserve primary porosity; (3) quartz and feldspar overgrowths, uncommon; (4) ferroan calcite cement, due to localized flushing of sandstones by waters released from clay diagenesis; and (6) authigenic kaolinite cement, which reduces porosity along fluid escape routes.

Extensive carbonate cement and orthomatrix are the primary contributors to decreased porosity. Late stage kaolinite cement in flushed zones also reduces porosity, but to a lesser extent.

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Clay Minerals as Indicators for Depositional Environment in South Halletsville Field, Lavaca County, Texas

The South Halletsville field, Lavaca County, Texas, has gas and condensate production from lower Wilcox sandstones and shales which have been interpreted as either channel turbidite deposits in outer-shelf to slope locations or deltaic and strand-plain sands and muds. Twenty-four core samples from the General Crude Oil Co. 1 A. G. Henkes Gas Unit were analyzed by X-ray diffraction methods to determine whether a semiquantitative estimate of clay mineral content would aid in determining the depositional environment. Discrete illite and chlorite are of particular interest because the presence of these minerals is interpreted as being due to original deposition.

Three shale samples, from 10,194 to 10,206 ft (3,107 to 3,111 m) and 11 sandstone samples, 10,180 to 10,194 ft (3,103 to 3,107 m) were selected from one core section. This sequence of samples is particularly important because it contains a shale and the overlying sandstone. In addition, a deeper sandstone was sampled in the interval of 11,032 to 11,072 ft (3,363 to 3,375 m).

If a turbidity-type event had occurred, the weight percent of non-diagenetic clays should (1) decrease significantly as the boundary is crossed between the shale and the overlying sandstone, and (2) gradually increase in progressively shallower samples within the sandstones. However, the weight percent for chlorite does not vary significantly regardless of a change in lithology, shale to sandstone, or a change in depth. The illite content gradually decreases with shallower depths in both core intervals. This sequence is more compatible with a transgressive deltaic environment.

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Exploration Ramifications of Subsurface Fluid Migrations in Lake Borgne–Valentine Area of Southeastern Louisiana

An area in southeastern Louisiana is studied to determine possible areas of subsurface fluid migrations. The lithology and structural geology are determined so as to identify potential pathways of these migrations. The bore-hole readings are also used to determine the patterns of temperature, pressure, and salinity parameters. Where vertical subsurface fluids have migrated, the fluids at shallow depth have temperature and salinity characteristics of fluids at greater depth, i.e., anomalously high temperatures and low salinities. In addition, the mass movement of the water from depth (out of the abnormally pressured zone) reduces the pressure and lowers the top of this zone.

Areas which indicate migrations are economically important because the migrating waters are theoretically capable of carrying hydrocarbons. Traps in the vicinity of these migrations are of special interest to the hydrocarbon explorationist. Anomalously high temperatures and low salinities are also of interest to the geothermal explorationist.

The part of southeastern Louisiana studied has twelve areas of possible subsurface fluid migrations and