Biogenic and Nonbiogenic Ore-Forming Processes in South Texas Uranium District, Panna Maria Deposit

Geochemical and petrographic studies of core samples from the Panna Maria uranium deposit, a roll-type orebody in the Jackson Group (Eocene) in Karnes County, Texas, yield important constraints on the origin of the deposit. Organic carbon content averages about 0.42 wt. % in reduced rock and correlates positively with sulfur content. Pyrite is the dominant iron disulfide (FeS_2) mineral in most of the ore zone and throughout a surrounding zone of reduced barren ground and is commonly associated with organic debris. Marcasite is sparse except in ore adjacent to the altered tongue in one core and locally in mineralized lignite. Sulfur isotopic compositions ($\delta^{34}S$) of FeS_2 minerals range broadly from -1 to -34 per mil; the lightest $\delta^{34}S$ values (less than -20 per mil) were measured in samples from mineralized lignite and from the nose of the ore roll. Petrographic and geochemical characteristics of the Panna Maria deposit contrast greatly with those of three other south Texas roll-type uranium deposits (the Benavides, Felder, and Lamprecht deposits), which are devoid of organic carbon and which contain more sulfide than does the Panna Maria. These three deposits are characterized by abundant isotopically light ore-stage marcasite and by isotopically heavy pre-ore (in the Benavides) or post-ore (in the Felder and Lamprecht) pyrite. We concluded in earlier reports that sulfide-bearing fault-leaked solutions from underlying hydrocarbon accumulations were important in the formation of the Benavides, Felder, and Lamprecht deposits. Although the Panna Maria deposit shows an apparent alignment along a fault zone, and although underlying formations in the Karnes County area contain sour gas ($\delta^{34}S \simeq +14$ per mil) and produce oil, the deposit lacks characteristics indicating that its formation and/or preservation involved extrinsically derived reductants such as fault-leaked hydrogen sulfide. Mineralization of the Panna Maria, rather, appears to have been controlled by intrinsically derived reductants related either directly or indirectly to the presence of organic matter.

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Structure and Salt Tectonics of Northwest Gulf of Mexico Banks

Members of the Oceanography Department at Texas A&M University have conducted extensive geologic and geophysical surveys across the shelf-edge banks off Texas and Louisiana in the northern Gulf of Mexico. These prominent topographic features are the surface expression of isolated salt diapiric structures, in places capped by carbonate sediments and reefal communities. There is great variability in the details of their physiography and structure. However, analysis of the geophysical data indicates that the banks may be classified into three main structural types: (1) rectangular, fault-controlled, uplifted blocks of sedimentary strata; (2) circular domes modified by faulting more or less parallel with the shelf edge; and (3) circular domes with radial and/or annular fault patterns. The majority of the banks, particularly types two and three, show some evidence of collapse, probably a result of dissolution of salt. Based on the variety and regional setting of the observed structures, evolutionary models have been developed. Ubiquitous local topographic trends associated with the banks occur along the shelf edge and upper slope. They strike roughly northwest-southeast and may reflect structures formed during the early tectonic history of the Gulf of Mexico.

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Interactive Color Display and Analysis—Added Dimension to Seismic Interpretation

Interactive color video display systems provide a new dimension to the analysis of seismic data. Subtle concurrent changes in multiple seismic parameters such as reflection strength, velocity, frequency, and structure can be assimilated more effectively with the aid of interactive color technology. We examine here two typical interpretation problems—bright spots and 3-D data—and illustrate the use of interactive color display and analysis in formulating a solution. The successful analysis of hydrocarbon indicators relies on both the ability to measure the auxiliary effects that hydrocarbon indicators have on seismic data and to display these effects in a form that is visible to the interpreter. If the interpreter can view an optimum combination of subtle changes in these parameters, his ability to predict both the lateral extent of the reservoir and the amount of gas saturation can be substantially improved.

One way to display simultaneous variation in several seismic parameters is through the use of an interactive color imaging system. After digital displays of the seismic reflection data variables are input, color assignments are made interactively among the seismic variables and the primary colors. This process can vary from a simple assignment of a primary color for each variable to a more complex analysis technique that dynamically assigns proportions of the seismic variables to all colors. Unlike some approaches that "color" a single parameter to better illustrate its dynamic range, the methods described here use color to illustrate the simultaneous changes in all variables. These video imagery systems provide flexible, high-resolution displays that can cope visually with large volumes of data that are typical for 3-D surveys. It allows the interpreter to perform a variety of instant, on-the-spot enhancement techniques. Thus, the technology significantly minimizes some of the problems in dealing with 3-D data. Typical vertical sections or horizontal time-slice displays from a cube of 3-D data can be shown in a variable intensity mode. The horizontal Seiscut displays can be viewed in a flexible and easily controlled movie fashion or overlaid in color to enhance delineation of structural features. When the multiple parameter technique is employed on the Seiscut display, it produces an "instant geologic map." Each lithologic unit boundary can be distinguished by its unique color pattern.

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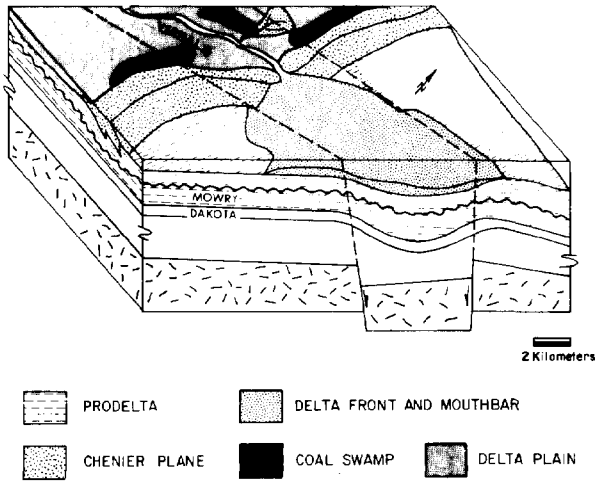
Tectonic Control on Deposition of Frontier Formation (Upper Cretaceous), Northeastern Uinta Basin

Vertical block tectonics significantly affected the deposition of the Frontier Formation of Late Cretaceous age. This syntectonic relationship was identified by detailed facies mapping which recognized seven major lithofacies on the basis of lithology, sedimentary structures, sandstone geometries, fossils, and trace fossils. Each lithofacies is a process-controlled genetic unit and can be related to a depositional environment within a wave-dominated deltaic system. The ascending sequence of environments and lithofacies is: (1) prodelta shales and siltstones; (2) hummocky-stratified, distal delta-front sandstones; (3) low-angle trough to tabular-stratified, delta-front and mouth-bar sandstones; (4) lenticular, medium to coarse-grained, distributary-channel sandstones; (5) lagoonal and delta-plain carbonaceous shales and coals; (6) medium-grained fluvial sandstones; and (7) bioturbated, offshore and shelf sandstones and shales.

These lithofacies change laterally across two east-west-trending basement faults. Delta-front and distributary-channel deposits thicken between the faults, indicating a topographic low or graben at the time of deposition. Within the graben, sandstone



beds have scoured bases and become finer grained upward, suggesting traction-load deposition. Sand-transport directions are normal to the paleoshoreline. Outside the graben, chenier plain and interdistributary sequences were deposited. Likewise, hummocky stratification is more common and sand transport parallels the paleoshoreline, suggesting wave and longshore transport of sand material.

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Solute Transport Model for Pollutant Flux in Vicinity of a Landfill, Dayton, Ohio

Toxic waste disposal and ground-water contamination is a problem which the entire nation faces. The Dayton area in Ohio is presently facing the threat of having its underground water supply contaminated by toxic wastes disposed of in various sites. It is now realized that these toxic substances are leaching out from both existing and abandoned dumpsites and posing a serious problem for an already endangered resource. The study area is located in Moraine, Ohio, which lies south of Dayton. The goal of this thesis was to develop a two-dimensional model showing the transport and dispersion of solutes through the Dayton aquifer, using the USGS program for a computer model of two-dimensional solute transport and dispersion in ground water. The model will show the results for varying water-table conditions, concentration of solutes relative to some distance from landfill, plume direction, time of plume migration, and potential hazards. This model shows results for a two-dimensional, vertical and horizontal model.

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Hydrothermal Approach to Petroleum Exploration

In sedimentary basins, the accumulation of raw materials to form oil and gas deposits is in many ways similar to the accumulation of materials to form mineral (ore) deposits. Logic suggests that the job can hardly be done without an active water system functioning as both solvent and vehicle for the raw materials. Members of the mining community have no problem with this concept. However, a majority of people in the petroleum industry (especially in the Western Hemisphere) seem to have a chronic aversion to water.

Mining and petroleum people both work with the same environment of water-wet sedimentary material. It can be shown that some similarities of petroleum and mineral accumulations are not just coincidence. They are essential functions common to both systems.

An important similarity of petroleum and mineral accumulations—and the main topic of this paper—is the hydrothermal regime. In both systems, hydrothermal conditions are supported by field and laboratory evidence. Such evidence has been used effectively in mineral exploration for many years and there is good reason to believe it can be used in petroleum exploration. If moving waters carry raw materials for oil and gas deposits, and temperatures can be used to track those waters, then the temperatures may also point toward possible oil and gas deposits. As with mineral deposits, places of interest could be where depressuring and cooling associated with upward movements of enriched waters are likely to cause hydrocarbon fall-out.

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Thin Bed Stratigraphy from Complex Trace Attributes

Both model seismic data and broad-band field data acquired to delineate complicated stratigraphy have been converted to displays of the instantaneous attributes of the complex seismic trace. Attribute sections enhance the interpretation of conventional sections not only by qualitatively highlighting specific properties of conventional displays, but also by quantitatively defining wavelet characteristics like dominant frequency, and stratigraphic variables like formation thickness. An example of the quantitative use of complex attributes in wavelet definition is the phenomenon that the maximum instantaneous frequency of a zero-phase Ricker wavelet is synchronous with the central peak of the wavelet and exactly equal to the frequency corresponding to the center of gravity of the wavelet's amplitude spectrum. Peak instantaneous frequency thus is a physical meaningful measure of the spectral content of a zero-phase Ricker wavelet. If the signal in a seismic section can be approximated by zero-phase Ricker wavelets, and if the geophysicist can identify occasional wavelet peaks in the sections which are uncontaminated by noise or interference, instantaneous frequencies at these samples are direct estimates of a significant and absolute spectral characteristic of the signal.

An example of the quantitative use of attribute sections in seismic stratigraphy is their application to estimation of the thickness of thin, porous sands. Pods of porous sand which are encased in high-velocity material and whose thicknesses are of the order of half the peak-to-peak period of the dominant seismic energy show up as anomalously high amplitude zones on instantaneous amplitude displays. These anomalies result from the well-known amplitude tuning effect which occurs when reflection coefficients of opposite polarity a half-period apart are convolved with a seismic wavelet. As sand members thin to a quarter-period of the dominant seismic energy, the thinning is revealed by an anomalous increase in instantaneous frequency. This behavior results from the less well-known but equally important phenomenon of frequency tuning by thinning beds. Frequency tuning reaches a maximum when sand thickness is about a quarter-period and remains evident as the sand continues to thin. The instantaneous frequency section thus can be a sensitive analytical tool for investigating stratigraphic sequences composed of very thin layers. Frequency and amplitude tunings are accompanied by changes in the character of the complex of interfering reflections from various impedance boundaries in a formation of thin beds, and these changes are highlighted by the instantaneous phase display.