tion, although subsidence was greater there than in the southeast. This differential subsidence caused the southeast thinning of the nonmarine upper Muddy sediments. Muddy deposition was terminated by the rapid eastward advance of the Shell Creek or lower Mowry sea. This transgression reworked the uppermost nonmarine Muddy sediments, producing a thin, widespread sandy zone that constitutes the principal reservoir at Hilight field.

Because the lower Muddy was deposited during a southeast to northwest regression, the sandstones are progressively younger toward the northwest. However, the overlying nonmarine upper Muddy thickens northwestward, causing the underlying regressive sandstone to appear to be stratigraphically lower and, hence, older in that direction. This stratigraphic paradox has caused much confusion and difficulty in resolving Muddy stratigraphy.

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GEOLOGIC FRAMEWORK FOR SUCCESSFUL UNDERGROUND WASTE MANAGEMENT

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DEPOSITIONAL SYSTEMS OF CISCO GROUP: THEIR RELATION TO RESERVOIR DISTRIBUTION AND PETROLEUM PRODUCTION ON EASTERN SHELF, MIDLAND BASIN

The Cisco Group is a mixed terrigenous clastic and carbonate rock stratigraphic unit deposited on the Eastern shelf, a late Paleozoic constructional platform developed on the margin of the sediment-starved Midland basin. Detailed facies mapping of the Harpersville format, a boundary-defined unit within the Cisco Group, outlines 3 depositional systems that are differentiated by gross lithologic composition and position relative to the equivalent shelf edges. They are the (1) Cisco fluvial-deltaic system, (2) Sylvester shelf-edge bank system, and (3) Sweetwater slope system. The Cisco fluvial-deltaic system is composed of dip-fed fluvial and deltaic facies and associated strike-fed interdeltaic embayment facies. The Sylvester shelf-edge bank system consists of an offlapping series of elongated, prismatic limestone banks that lie along the shelf margin. The Sweetwater slope system is composed of numerous slope wedges, or fans, which include shelf-margin, slope-trough, and distal-slope sandstone facies. The eastern shelf prograded into the Midland basin by local upbuilding through fluvial, deltaic, and shelf-edge bank deposition contemporaneous with outbuilding by slope-fan deposition.

Oil pools are found in all 3 depositional systems. Productive facies include fluvial, distributary channel, and distributary-mouth bar sandstones of the fluvial-deltaic system and distal-slope and shelf-margin sandstones of the slope system. Production is concentrated in areas where 2 broad, subparallel, structurally-related NE-SW trends intersect the mapped fluvial-deltaic lobes. The complex, lenticular geometry of these thin deltaic sandstones affords maximum opportunity for development of stratigraphic and combination traps.

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ORIGIN OF PETROLEUM

As more and larger oil and natural gas deposits are found throughout the world—some in unlikely places —it becomes increasingly difficult to continue to believe that those hydrocarbons originated drop by drop through the transformation of the remains of minute animals and plants that were locked in marine sediments in relatively recent years. This "organic theory" of petroleum genesis was propounded many years ago when the number and extent of oil and gas discoveries were relatively small and when knowledge of cosmology, chemistry, and other sciences was far less sophisticated than it is today.

It is now suggested that oil and natural gas could have been formed in much larger quantities than was ever considered plausible before, through chemical reactions among components of the atmosphere that existed billions of years ago when the earth was still hot —long before there was any plant or animal life.

During the period 3–4 billion years ago, when the earth's surface was cooling from 1,000°F to about 400°F, the formation of hydrocarbons through the reaction (on catalytic surfaces) of atmospheric hydrogen and carbon monoxide seems inevitable. During that period, when the surface was still too hot for water to exist as a liquid, the earth probably was surrounded with dense clouds of hydrocarbons which literally "rained oil." This oil together with the sediments that it carried with it filled all the surface depressions that existed at the time.

Through this same kind of reaction, it is probable that several simple oxygenated compounds formed simultaneously. These acids, alcohols, aldehydes, *etc.* could well have been the source of amino acids, nucleic acids, and proteins, the precursors of cells and life itself.

The recent discovery of amino acids on a meteorite lends credence to this hypothesis and further proof may not be far off. If it can be confirmed that the clouds around the planet Venus are truly hydrocarbons, as many scientists have suggested, and if further exploration of the surface of Venus, which is reported to be at 720–885°F, discloses evidence of "oil rains" there, then the theory of petroleum genesis now proposed will be lent very strong support.

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BIOLOGIC CONTROL OF STROMATOLITE MICROSTRUCTURE: IMPLICATIONS FOR PRECAMBRIAN TIME-STRATIGRAPHY

Studies of Holocene stromatolitic sediments indicate that the biologic makeup of surficial blue-green algal mats controls the microstructure (features less than several centimeters in size) of stromatolites. Microstructural features include relief along a single growth surface, grain-to-grain relations within laminae, and distribution of organic matter. Recent stromatolitic sediments are basically an intertidal phenomenon. Within the intertidal zone, blue-green algal species are organized into distinct biologic communities. Each community occupies the sediment surface within a specific flooding-frequency range, and each community produces a distinctive microstructure. Recent algal communities have a wide geographic range. Similar communities and zonations may be hundreds and thousands of miles apart, but only where the areas are connected by rapidly flowing open water or wind currents (*e.g.*, areas connected by the Indian Ocean North Equatorial Current). Therefore, major stromatolite-forming algal communities do not have a worldwide distribution.

These data may be applied to the assemblages of stromatolitic microstructures which characterize 100–300 m. y. intervals in the late Proterozoic (Ri-