unbleached rocks is in the relative abundance of clay minerals (and the TMS is very sensitive to clays), areas of potential hydrocarbon-induced diagenetic alteration may be mapped using broad-bank sensors.

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Lockhart Crossing Field: New Wilcox Trend in Southeastern Louisiana

A 1982 Wilcox oil discovery in southeastern Louisiana constituted one of the more significant onshore United States discoveries for the year and illuminated a new oil trend. Prior to this discovery, Lockhart Crossing field was known for its gas and condensate production from Cretaceous lower Tuscaloosa sandstones at depths of 17,000-18,000 ft (5,200-5,500 m). Oil production from sandstones of the lower Eocene of the uppermost Wilcox Group was recently established at 10,000 ft (3,000 m) with successful completion (630 BOPD), of the Callon 1 Reed Erickson. To date, 30 producers and 5 dry holes have been drilled in the field, with production peaking at 10,000 BOPD and recoverable reserves of 15-20 million bbl of oil after secondary recovery.

The main field reservoir is a 40-80 ft (12-24 m) marine sandstone with two distinct facies present. The most dominant of these two facies is a coarsening-upward sequence of very fine to fine-grained glauconitic sand deposited as a nearshore bar. The second is a tidal channel facies with a fining-upward sequence of medium to very fine grained sand. The spatial relationship of these two facies defines a progradational sequence of tidal channels overstepping and eroding into existing nearshore bars. The primary trapping mechanism, however, is structural in the form of a rollover anticline.

In April 1983, Callon and Amoco extended the trend southeast with the discovery of Livingston field. Chances are good that this new trend will yield additional discoveries with continued exploration.

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Growth Movement of Citronelle Dome and Its Genetic Relationship to Other Salt Structures in Southern Mississippi Salt Basin: an Approach in Computer Applications

Citronelle field, one of Alabama's largest oil fields, was created by one of the many salt structures that occur throughout the southern Mississippi salt basin.

The history of domal movement was determined using computer techniques of conventional mapping and trend-surface analysis based on structural tops and thicknesses of 22 lithostratigraphic field units. Unique statistical parameters for each trend surface were then compared using cluster analysis. The definition of three major episodes of domal movement resulted.

The first episode occurred in the Cretaceous during Tuscaloosa deposition. The second occurred in the Paleocene during Midway deposition, and the third occurred in middle Eocene during Claiborne deposition. A similar history of structural development was determined for two other salt structures along the southern margin of the southern Mississippi salt basin.

This genetic relationship appears to reflect subsidence characteristics within the southern Mississippi salt basin. As such, this relationship may be valuable in better understanding the occurrence of oil and gas reserves in the basin and in future exploration efforts in this mature area.

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Petroleum Reservoirs in Silurian Dolomite of Western Illinois

The basal Silurian Alexandrian carbonates, sandwiched between the Ordovician-Silurian and Silurian-Devonian unconformities, have produced more than 3 million bbl of oil from the Buckhorn East and Brooklyn fields on the western margin of Illinois. These fields are shallow (450-670 ft), remote from the most-productive portion of the Illinois basin, and potential exists for additional production from this unconformity play. Three lithofacies were recognized in Alexandrian carbonates in detailed core and wireline studies that included thin-section, x-ray, and SEM analyses. These carbonates are regressive sequences composed of shallow-shelf, restricted-subtidal, and intertidal facies. The shallow-shelf facies is primarily biosparite composed of crinoid and brachiopod debris; this facies is dolomitic in places. The restricted-subtidal facies consists of both bioturbated and undisturbed gray micrites containing stylolites, green chloritic clay, and glauconite; sparry clacite fills vertical cracks. The intertidal facies is tan, mottled, vuggy dolomite composed of algal mats, anhydrite-filled birdseye structures, burrows, and scattered marine fossils.

Petroleum reservoirs apparently developed as a result of dolomitization in intertidal and shallow-shelf carbonates. Vuggy porosity, a possible result of karst leaching, is found in pay zones within the dolomitic intertidal facies. Evidence of emergence and subaerial weathering include the presence of vadose silt, anhydrite, and nontectonic breccia.

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Glacial Cycles, Hydrocarbon Generation and Salt Tectonics on Louisiana Slope

In the northern Gulf of Mexico, maximum growth on regional down-to-the-south faults, maximum salt tectonics, and the timing of maximum oil generation are synchronous. Sedimentary pulses triggered by glacial cycles are recognized to correlate well with the maxima. Synchrony of glacial, structural, and sedimentary events suggest a cause and effect relationship.

During major glacial events, up to an 8-fold increase in melt water had an order of magnitude increase in the amount of sediment brought to the northern Gulf of Mexico. Eight discrete upper Pleistocene sediment packages have been identified in seismic profiles. Likewise, approximately 8 major growth fault trends are recognized on the Louisiana slope. The causal effect of increased lithostatic pressure owing to rapid deposition on underlying plastic salt promotes flowage that activates regional faults and accelerates salt tectonics. Higher biological productivity during glacial maximas and contemporaneous regressive sands explain higher concentrations of hydrocarbons during maximum structural and stratigraphic activity.

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Is Turbidite Facies Association Scheme Valid for Interpreting Ancient Submarine-Fan Environments?

Although turbidite facies reflect only their processes of deposition, turbidite facies associations are routinely used to identify ancient submarine-fan systems and their subenvironments (e.g., upper fan, channel, etc). This credulous leap from interpreting process of deposition to interpreting environment of deposition may not be valid for the following reasons: (1) Mutti and Ricci Lucchi's facies association scheme was developed exclusively from the study of ancient turbidite sequences; however, the true relationship between turbidite facies associations and related environments has not been adequately documented in modern settings; (2) channel-levee complexes of many modern submarine fans such as those of the Amazon and Mississippi are large enough to contain most ancient fan systems in their entirety; and (3) comparable channel-levee complexes have not been recognized in outcrop. Consequently, the validity of turbidite facies associations for interpreting ancient submarine-fan systems and their subenvironments must be considered tenuous until confirmed by detailed core studies of a variety of modern fans.

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Anisotropic Permeability, Eolian Lyons Sandstone

Directional permeabilities from nine attitude-oriented core samples of well-laminated eolian Lyons Sandstone from Larimer County, Colorado, were measured with a gas permeameter. Intrinsic permeabilities across the laminae, parallel to lamination and dip, and parallel to lamination

and strike, were quantified and compared. Relative permeabilities of gas over the spectrum of oil saturation and porosities were also determined.

Permeability across the laminae ranged from 0.5 to 4 md, whereas permeability parallel to lamination ranged from 3 to 97 md. Permeability parallel to lamination was not significantly different when strike and dip directions were compared. Quantitative analyses of textures and fabrics of individual laminae explain the observed diversity of permeabilities. Relative permeabilities were highest at a given oil saturation measured downdip and along the laminae and lowest when measured perpendicular to lamination.

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Bahamian Whitings—No Fish Story

Bahamian whitings, controversial patches of drifting mud-laden water, have been thought to be produced by fish. Observations over several 7-day periods show that whitings are long-lived phenomena (days and possibly weeks) and that the dozens which exist at any time on the Great Bahama Bank continually "rain" aragonitic sediment. Although chemical changes consistent with precipitation have not been detected in seawater near or within whitings, new data indirectly suggest that precipitation from seawater causes whitings.

Lime mud settled in approximately 6 hr in large (30 gal) containers of water taken from whitings, whereas in the sea, the "parent" whitings persisted for days. Sediment traps verified continual transport of sediment. Divers noted no fish stirring up the bottom nor any evidence of bottom feeding. Side-scan sonar failed to detect unusually large schools of fish, and a shrimper's net dragged in the whitings failed to catch any fish known to be bottom feeders. Dragging the net in clear water near active whitings created "artificial" whitings that settled back to the bottom in a few hours. Current measurements within and outside of whitings ruled out current eddies. Near the edge of the Bahama platform, whitings occur over bottom sediments too coarse-grained to be stirred into suspension, yet the muddy bottom of the banks was miles away. These data suggest that natural whitings must be continually replenished with sediment.

Filtration of known volumes of water from 15 whitings and from clear seawater indicates that active-whiting water contains only a very small (10-12 mg/L) amount of suspended carbonate sediment, yet whitings are considered a potential major source of lime mud on the Great Bahama Bank. Inasmuch as nearly one-half the world's oil is pumped from limestone, knowledge of the origin and deposition of lime mud has implications for hydrocarbon exploration.

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Carbon Isotopic Composition of Amazon Shelf Sediments

The distribution of carbon isotopes in Amazon shelf sediment is controlled by the same processes that are forming the modern subaqueous delta. The terrestrial (-27 to -25‰) isotopic carbon signal observed in surficial sediments near the river mouth extends over 400 km northwest along the shelf. Terrestrial carbon is associated with areas of rapid sediment accumulation (topset and foreset regions). A sharp boundary between terrestrial (-27 to -25‰) and marine (-23 to -22‰) isotopic carbon values in surficial sediments is associated with a change in depositional conditions (foreset to bottomset regions) and a decrease in sediment accumulation rate. POC water-column isotopic values (-27‰) near the river mouth are similar to the underlying surficial-sediment TOC isotopic values, but POC water-column samples collected 20 km off the river mouth have marine carbon isotopic values (-22 to -19‰) and differ from the underlying surficial-sediment TOC isotopic values. These water column observations are related to variations in turbidity and productivity. Down-core isotopic variation is only observed in cores taken in areas of lower sediment accumulation rates. These observations indicate that the organic carbon in Amazon shelf sediment is dominantly terrestrial in composition, and the location of deposition of this carbon is controlled by modern processes of sediment accumulation. The modern Amazon shelf is similar to large clinoform shale deposits of the Cretaceous in North America. Thus, the stratigraphic setting may help predict the isotopic variations of carbon in ancient deposits.

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Seismic Expression of Structural Features on Landsat Lineaments: an Example from Denver Basin

Lineaments interpreted from Landsat images mark the location and trend of basement faults observed on seismic lines in the eastern Denver basin.

Linear features mapped as tone and texture patterns on multispectral scanner images in northeastern Colorado and southwestern Nebraska are used to interpret regional lineaments. Individual linear features up to 25 mi (40 km) long and visible on both bands 5 and 7 define a grid of regional lineaments trending northeast and northwest. Comparisons of lineaments with aeromagnetic and gravity maps and with interpretations of basement geology suggest that lineaments are the boundaries of basement blocks with areas of about 1,000 mi^2 (2,590 km^2). Constituent linear features within the lineament zone probably mark boundaries of smaller blocks of about 50 mi^2 (130 km^2).

Seismic lines in northeastern Sedgwick County in extreme northeastern Colorado cross linear features that are components of a broad regional lineament that trends northeast and parallels the South Platte River. Seismic data consist of a grid of about 100 mi (160 km) of multifold Vibroseis lines. Basement faults, generally with offsets of less than 100 ft (30 m), are observed in seismic lines that cross some individual linear features. Monoclines and faults are present in Pennsylvanian to Tertiary strata that overlie basement. A time-structure map on the Precambrian and an isochron map of Wolfcamp (Lower Permian) to Precambrian show that the lineament is a 7-mi (11-km) wide zone of small, downdropped basement blocks. Thickening of Permian-Pennsylvanian strata on the downthrown side of faults suggests tectonic activity. Further tectonic activity is indicated by listric faulting in the Cretaceous Niobrara Formation.

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Chronostratigraphy and Biostratigraphy of Paleogene Formations in Eastern Gulf Coastal Province

Paleogene formations extending from eastern Alabama to Arkansas have been assigned to internationally recognized biostratigraphic zones based on calcareous nannoplankton fossils. All zones from NP 1 to NP 24 are present in the study area, with the exception of NP 11 (within the early Eocene) and NP 23 (within the early Oligocene).

Gulf Coast formations correlate to international standard chronostratigraphic stages as follows. The Clayton and Porters Creek formations correlate to the Danian Stage. The Naheola Formation, Salt Mountain Limestone, Nanafalia Formation, Tuscahoma Sand, and lower Hatchetigbee Formation (in part) correlate to the Selandian Stage. The Hatchetigbee (in part) and lower Tallahatta correlate to the Ypresian Stage; the upper Tallahatta and most of the Lisbon and Cook Mountain Formations correlate to the Lutetian Stage. The upper Lisbon and Cook Mountain formations, the Gosport Sand, Moodys Branch, and lowermost Yazoo formations correlate to the Bartonian Stage. The Crystal River and most of the Yazoo Formation correlate to the Priabonian Stage. The uppermost Yazoo Formation, the Bumpnose Limestone, Red Bluff, Forest Hill, and Mint Spring Formations, Marianna and Glendon Limestones, and Byram and Bucatunna Formations correlate to the Rupelian Stage. The Chickasawhay Limestone and Paynes Hammock Formation span the Rupelian-Chattian boundary.

The Paleocene-Eocene boundary (approximately the NP 9–NP 10 boundary) is therefore within the lower Hatchetigbee Formation (Bashi Marl Member). The Eocene-Oligocene boundary (within lowermost NP 21) is within the uppermost Yazoo Formation (Shubuta Clay Member) in places, and within the lowermost Bumpnose, Red Bluff, and Forest Hill Formations and Marianna Limestone elsewhere in the region.

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Recognition of a Thin Stratigraphic Trap by Seismic Reflection Character Analysis

The Cretaceous Cardium Formation, Alberta, Canada, which produces oil and gas from thin stratigraphic traps comprising coastal and