include delta distributary sandstones and interdistributary bar-fill shales, siltstones, and sandstones. One distributary channel sandstone body displays a "shoestring" geometry, over 12 mi (19.2 km) long and 1 mi (1.6 km) wide, with an average maximum thickness of 200 ft (61 m). This sandstone rests directly on and locally replaces the Lower Hartshorne coal bed. Three major mining problems are related to this sandstone body: (1) the Hartshorne sandstone in this area is a natural gas reservoir which might emit gas into adjacent coal mines; (2) the sandstone body is directly related to local discontinuities and rolls in the Lower Hartshorne coal bed; and (3) an unstable roof may be locally associated with trough cross-bedding and jointing near the base of the sandstone, and with facies changes and slickensides along the lateral margins of the sandstone body.

In contrast to this sandstone body, interdistributary bay deposits, because of their relative homogeneity and lateral persistence, do not present potential facies-related mining problems. Potential mining problems associated with these facies are local and are directly related to structural and stress-release features which are difficult to predict in advance of mining.

To insure safe and economic coal production from the Hartshorne formation, the distribution of major sandstone bodies overlying the coal beds must be considered when planning degasification programs and shaft, slope, and main entry locations.

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Sedimentation Rates and Illite-Smectite Diagenesis

The percentage of expansible smectite layers in a mixed-layer illite-smectite (I/S) clay has been correlated often with temperatures in a sedimentary basin. Sequences in Tertiary Gulf Coast sediments demonstrate that sediment accumulation rates exert a great influence upon I/S expansibilities by influencing thermal history. In sediment piles with high accumulation rates, the greater redistribution of energy produced by increased forced migration of fluids results in lower temperatures and thermal gradients and, as a consequence, the I/S clays are expected to react toward illite at slower rates. I/S clays from deltaic Wilcox (Eocene) shales have 50% expansible layers, in contrast to 25% expansible layers in I/S clays in marginal shelf Wilcox sediments found at similar present-day burial depths and temperatures. The more expansible I/S assemblages in the rapidly accumulating deltaic sediments are consistent with the predictions of energy transport theory in compacting sediments. As these Eocene I/S clays are now being buried under roughly equal thicknesses of sediment at similar rates, the difference in thermal gradient imposed by the original deltaic and shelf margin Wilcox sedimentation is being slowly reduced until both paleogeographic areas have roughly equal geothermal gradients. At similar present-day temperatures around 100°C, the important consideration is that the I/S clays in the slowly deposited shelf margin sediments reached the minimum reaction temperature before the clays deposited at the same time in deltaic sediments. Implication for I/S diagenesis is that the maximum temperature encountered is not as important as the rate at which minimum reaction activation temperatures in the basin are achieved, and that use of expansibility changes in I/S clays as a geothermometer needs to be reevaluated.

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Delineation of Jacksonian-Vicksburgian Boundary in East-Central Gulf Coast Using Evolutionary Series in Ostracods

A comparison of the Ostracoda from the Shubuta clay (Jacksonian Stage) and the overlying Red Bluff Clay (Vicksburgian Stage) of the east-central Gulf Coast region reveals an easy and reliable method of delineating the Jacksonian-Vicksburgian boundary which separates these Cenozoic shelf deposits.

Ten or more Shubuta ostracod species continue into the overlying Red Bluff, but another six span the Jacksonian-Vicksburgian boundary as evolutionary descendants. *Argilloecia subovata* Huff, *Buntonia shubutaensis* Howe, *Eucythere shubutaensis* Howe & Howe, *Occultocythereis broussardi* (Howe & Chambers), *Trachyleberis? montgomeryensis* (Howe and Chambers), and *Trachyleberis? quadrata* Howe & Howe are Shubuta Clay species which evolved into direct evolutionary descendants in the Red Bluff Clay. The descendants were respectively: *Argilloecia* sp. aff. *A subovata* Huff, *Buntonia* n. sp., *Eucythere woodwardsensis* Howe, *Occultocythereis kempi* (Howe & Law), *Actinocythereis quadrataspinata* (Howe & Law), and *Actinocythereis thomsoni* (Howe & Law).

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Petrographic Variation in Western Kentucky #11 Coal Seam

Vitrinite reflectance (rank) and maceral percentages were studied on 90 samples of the western Kentucky #11 coal (and the correlative Illinois #6 coal) from 14 mines (13 in Kentucky, 1 in Illinois). The coals were collected in 3 benches from 2 to 3 channels per mine. The petrographic data were subjected to analysis-of-variance tests of the rank and of the percentage of reactive macerals.

The rank varies from high volatile C to high volatile B, the highest occurring in Webster County, Kentucky, and Gallatin County, Illinois. The seam has a consistently low percentage of inert macerals (generally less than 10%) throughout the field. The percentage of total vitrinite is usually greater than 80% with a decrease in telocollinite accompanied by an increase in "pseudovitrinite" rather than by an increase in the exinite or inertinite macerals. The consistent petrography, along with the large quantity of the reserves (second largest reserve base in western Kentucky), should make the seam an important resource for the synthetic fuels industry.

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High-Resolution Landsat for Geophysical Studies

Landsat provides a tool which can significantly aid geophysical exploration programs. It can be used for

planning the exploration programs, it can be a link which coordinates data from conventional sources, and it can be an interpretation tool in its own right.

Landsat is currently used to map and plan data acquisition programs. It can be processed to provide accurate map quality displays and its continuous coverage makes it a prime source for current information in remote areas and on a worldwide basis.

Feature extraction from the Landsat data helps identify and locate crops, forest, marsh, and other factors which affect operations cost. Data-processing techniques which permit the extraction of depth over coastal waters make this tool useful in marine-acquisition programs as well. Remote bathymetry is providing accurate up-to-date hydrographic information in many areas of the world. Cost savings from this application of Landsat can offset the cost of Landsat data processing.

Frequently displayed at conventional map scales, the Landsat image itself becomes an excellent working document for compiling and integrating other sources of information. It provides the basis for confirming or questioning data quality and accuracy as they are completed. Landsat data can be processed to enhance the surface expressions of geologic features. This then aids the interpreter in the detection of faults, folds, lineaments, and other expression of subsurface geology.

The data lends itself to independent geologic interpretation which can then be compared to interpretations made from gravity or seismic data. The spectral characteristics of the multi-spectral sensor data can be processed to extract information, to enhance edges, and to aid in the detection of lineaments which aids the structural interpretation of the area. Also, the data can be processed to enhance spectral differences which aid in identifying surface rock types. Water-related features can be enhanced to aid in analyzing drainage and drainage patterns. With false color imagery, Landsat data will aid in analyzing vegetation, cultural features, accent faults, folds, and other geologic structures.

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Seismic, Stratigraphic, and Structural Analysis of Northeast Campeche Escarpment, Gulf of Mexico

Multifold reflection seismic profiles and DSDP core holes allow a detailed structural and stratigraphic analysis of the northeast Campeche Escarpment. The escarpment, in the central Gulf of Mexico, marks the northern edge of the massive Campeche carbonate platform.

A major middle Cretaceous unconformity occurs within the sedimentary section both on the platform and in the deep gulf and represents a major change in sedimentation rate and type. Pre-middle Cretaceous sedimentary rocks in the deep gulf are characterized by weakly developed halokinetic structures (salt pillows and associated faulting), suggesting evaporites in the section. Lower Cretaceous (carbonate-prone) sedimentary rocks overlie these evaporites and are deep-water equivalents of the Lower Cretaceous bank sediments. Sedimentary rocks overlying the middle Cretaceous unconformity consist mainly of Pleistocene turbidites, hemipelagics, or laminites which represent the distal part of the Mississippi fan complex. On the platform, Lower Cretaceous bank sediments are shallow-water carbonate rocks while the post-middle Cretaceous is composed mainly of pelagic sediments, foraminiferal nannofossil oozes and chalks.

The seismic reflection data indicate that the northeast Campeche Escarpment is a fault-controlled feature probably related to the early rifting of the Gulf of Mexico. It trends northeast-southwest for approximately 500 km and is modified by local slumping, secondary faulting, and current erosion. The major structural feature on the bank proper is normal faulting, an expression of regional extensional forces. Differential movement between major adjacent fault blocks controlled local sedimentation style.

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Petroleum Source-Rock Evaluation by Thermal Distillation and Pyrolysis

Thermal distillation involves releasing the pore-water hydrocarbons and adsorbed hydrocarbons from a rock sample by heating to temperatures around 300°C. Further heating to 800°C (pyrolysis) causes cracking of the kerogen to form additional hydrocarbons. The present petroleum-source capability and evidence for primary migration can be evaluated from these data. Well cuttings from two COST wells in the Gulf Coast and miscellaneous samples from other areas were analyzed for individual hydrocarbons in the C_6 to C_{15} range by these techniques. The depth threshold of intense hydrocarbon generation was identified in one COST well along with some evidence for primary migration. The second COST well showed no evidence of hydrocarbon migration probably because the organic-carbon content and quantity of hydrocarbons generated were too low to cause migration.

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Water-Rock Interaction During Clastic Diagenesis in Both Open and Closed Systems

Studies have shown that the composition of ocean water may be controlled by reactions with clay minerals which act as solid phase buffers. The compositions of interstitial brines are subject to similar controls, but at least two boundary conditions can be established. In permeable sandstones (open system) it has been proposed that reactions of the form (1), clay mineral + dolomite + $H_2O \rightarrow$ chlorite + calcite + CO_2, produce large quantities of CO_2 as a vapor which may migrate, causing production of secondary porosity during later diagenesis. In this case the mineralogy is clearly controlled by the composition of interstitial waters.

In a closed system, represented by over-pressured shales from the Gulf Coast, published water compositions can be correlated with mineral reactions inferred from X-ray diffraction. Equilibria of the form (2), kaolinite + $K^+ \rightleftharpoons$ clay mineral or feldspar + H^+, can be used to document the path of fluid phase compositional buffering with increasing depth. Theoretical phase rela-