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Evolution and Hydrocarbon Potential of Navarin Basin, Bering Sea, Alaska

The Navarin basin consists of three en echelon subbasins filled with more than 26,000 ft of layered Tertiary sedimentary rock. The subbasins initially formed as a result of extensional deformation associated with oblique subduction of the Kula plate beneath the North American plate in the Late Cretaceous to early Tertiary. By the late Eocene, the fragment of the Kula plate, which now floors the Aleutian basin, was isolated by initiation of subduction at the present Aleutian arc. Active graben growth and major faulting ceased by the late Oligocene. Regional subsidence, controlled primarily by crustal cooling, initiated a second phase of sedimentation within and beyond structurally defined subbasins of pre-late Oligocene. The Navarin basin COST 1 well suggests that since the late Eocene, sedimentation within the three subbasins consisted of predominantly marine mudstone and siltstone and minor amounts of sandstone. Regressive events in the middle and late Oligocene, however, exposed older Tertiary and Mesozoic basement highs to wave-base erosion, which may have formed aprons of coarser grained detritus along the subbasins flanks. Eocene and early Oligocene marine sediments with good liquid hydrocarbon source potential and favorable levels of thermal maturity were present at the well site. This marine sequence thickens toward the deeper parts of the basin, indicating that a significant amount of source rock may be present next to traps associated with basement highs.

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Status of Underground Coal Gasification

Underground coal gasification appears to be one of the most attractive routes for synfuels from coal because the process can produce methanol and substitute natural gas at prices competitive with existing energy sources. The technical feasibility of underground coal gasification has been well established by small-scale field tests. Cost estimates based on the resultant data are favorable. The environmental effects associated with the technology appear to be acceptable. Successful commercialization of the process would probably triple the proven reserves of United States coal, which would be sufficient to last for hundreds of years.

At this stage of development, underground coal gasification is a high-risk technology and will remain so until large-scale field tests are successfully carried out. These tests are recommended by the Gas Research Institute and by the American Institute of Chemical Engineers. A 7-yr program costing about $200 million would permit initial commercial production in 10 yr.

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Basic Two-Dimensional Model for Thrust-Fold Oil-Field Structures of Rocky Mountain Foreland

Seismic profiles matched by a true-scale structural cross section and a photographed clay model analog can be used to illustrate the two-dimensional geometry and developmental history of oil-field structures of the Big Horn basin. From these real and simulated examples, a two-dimensional model of the typical oil-field structure of the foreland is constructed. These structures have the following characteristics. (1) They involve faulted Precambrian basement. (2) The basement generally acts as a brittle, homogeneous material and does not fold appreciably. (3) The folding in the overlying sedimentary section results from rotational movement on a thrust fault that develops at 30° to the sediment-basement contact. The fault is propagated upward into the sedimentary section, producing an anticlinal fold, and downward into the deeper basement. The amount of shortening determines the displacement on the fault and extent of vertical uplift. (4) The folds are flexural-slip and asymmetric, but not concentric, because the ductile sedimentary layers are differentially stretched and thinned over the steep flank and along the overturned underside of the causal fault zone where layer-parallel extension is greatest. Thinning in these domains is compensated by thickening in the subthrust "synclinal" block. (5) Since the basement surface remains essentially planar and continuous "plateau uplift" cannot occur, a hinge must develop behind the primary thrust zone so that rigid-body rotation can take place. The dip on the fault surface increases upward with continued rotation. Longitudinal and transverse extensional faulting occur at shallow levels. (6) The original point of the basement thrust wedge is blunted under the constriction of the overlying sedimentary section by localized fault imbrication.

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The Geologist in Space: Apollo, Shuttle, and Beyond

(No abstract)

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Petroleum and Source-Rock Potential of Eagle Ford Group (Upper Cretaceous), East Texas Basin

The Eagle Ford Group is one of the most complex clastic units in the East Texas basin. At the type locality in Dallas County, Texas, the Eagle Ford consists of 400 ft of bluish-black, carbonaceous clay-shale, subdivided into the Tarrant, Britton, and Arcadia Park Formations. The Eagle Ford thickens to over 900 ft eastward into the basin. This thickening is due to the acquisition of sand bodies within the Britton, Arcadia Park, and sub-Clarksville (which occurs above the Arcadia Park) Formations. The individual formations of the Eagle Ford change in thickness and character throughout the basin, apparently as result of different depositional regimes.

Significant petroleum reserves have been produced from the sub-Clarksville formation in the East Texas basin. However, no exploration for petroleum that could be present in the sands found in the Britton and Arcadia Park Formations has occurred to date. Application of refined depositional models for the various formation suggests new possible exploration targets.

Geochemical analysis of the Eagle Ford Group throughout the basin suggests that the Eagle Ford shales may be a major source-rock for petroleum in Austin, Eagle Ford, Woodbine, and possible Buda Formations. This study examines the nature, distribution, origin, and possible petroleum contributions of Eagle Ford rocks in the East Texas basin.

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Plate Tectonic Contest in North Greenland

North Greenland is characterized by excellent exposure, lack of strong deformation, and great lateral extent of depositional systems. It is thus a unique region for the study of tectonics and sedimentation in successive plate tectonic configurations covering a period of more than 600 m. y.

During late Precambrian to early Paleozoic times the major east-west-trending Franklinian carbonate shelf-clastic deep-water basin developed. The basin probably reached an incipient or narrow ocean stage. At its eastern end it was truncated by the north-south-trending continental margin of the contemporaneous Iapetus Ocean. The progressive closure of Iapetus resulted in Cambrian-Early Ordovician peripheral bulge upward of the eastern part of the Franklinian shelf. Erosion products from the shelf were resedimented into the Franklinian basin. The remainder of the Ordovician was tectonically quiet with starved basin sedimentation. The eastern part of the Franklinian shelf foundered rapidly in the Llandoverian, probably due to loading by Caledonian nappes advancing from the east during the progressive closure of Iapetus. From the start of the Silurian, the Franklinian basin began to receive enormous quantities of siliciclastic deep-sea fan turbidites ($> 1$ million $km^3$) from eastern source areas in the uplifted Iapetus collision zone. A major west-verging thrust belt appears to mark the final phase of Iapetus collision. The Devonian saw the closure of the narrow Franklinian basin by north-south compression. Late Paleozoic, Mesozoic, and Cenozoic basin formation was mainly of transtensional nature in a northwest-southeast-trending zone between Greenland and Svalbard. Eventually, normal continental margin sedimentation started with the onset of spreading in the Paleogene.

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Trinity Shoal: a Reworked Deltaic Barrier on Louisiana Continental Shelf

Abandonment and reworking of deltaic complexes of the Holocene Mississippi River have produced a series of sandy shoals on the muddy Louisiana continental shelf. Trinity shoal, one of these transgressive deposits, is located 30 km offshore of Atchafalaya Bay and the Point Au

Fer-March Island shell reefs. Approximately 1,000 km of high-resolution uniboom and 3.5 kHz subbottom-profile seismic data, taken in this area in 1983 and 1984, provide the data base for this study.

Trinity shoal, associated with the abandoned Maringouin delta complex, is a lunate shore-parallel feature approximately 36 km long and 5-10 km wide. Relief on the shoal ranges from 2 to 3 m, and minimum water depths over the shoal vary from $-5$ to $-2$ m. The shoal sand body is from 5 to 7 m thick and is composed largely of parallel to low-angle clinoform reflectors. Several levels of buried fluvial channels, ranging in age from early Wisconsinian to Holocene, are associated with the shoal deposit. The occurrence of channel features within the shoal sand itself suggests the presence of tidal inlets, indicating a possible barrier-island origin for the shoal.

The underlying deltaic sediments reach approximately 15 m in thickness and are made up of low-angle clinoform reflectors dipping to the southwest. Distributary, bay-fill, estuarine, and buried oyster-reef deposits can be recognized, making these similar to modern Atchafalaya delta deposits. Continued progradation of the Atchafalaya delta will probably result in burial of the Trinity shoal and Maringouin delta deposits by fine-grained sediments, giving these shoal deposits a high-preservation potential and creating an excellent stratigraphic trap.

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Canada Basin: Age and History of Its Continental Margin

Presently available age controls suggest that the Canada basin formed during the Cretaceous Period between about 131 and 79 Ma. The opening process began with continental breakup that may have involved all parts of the North American polar margin at about the same time. The opening was completed by the formation of oceanic crust during the extended Cretaceous interval of normal geomagnetic polarity. Features characteristics of continental breakup, insofar as they are known, show systematic regional differences. From Brock to Axel Heiberg Island, continental breakup was associated with an extended (100+ Ma) stratigraphic hiatus and, northeastward from Ellef Ringnes Island, with extensive tholeiitic igneous activity. From Banks Island to northeastern Alaska, the breakup interval was abbreviated (20-30 Ma), and sparse igneous activity occurred. These differences can be produced by changes in the rate and/or amount of crustal stretching during margin formation and would imply relatively faster or more stretching northeast of Brock Island. A continental margin of fixed age, exhibiting the indicated pattern of crustal stretching, could be produced along the trailing edge of a rotating block (Arctic Alaska terrane, AA) with its pivot near the Mackenzie delta. When the rotation is restored, however, geological discrepancies are evident between Devonian and older rocks across the conjugate margins, suggesting an earlier history of drifting for the AA. Early Paleozoic correlations appear improved if the AA is placed, polar margin to polar margin, against northern Ellesmere Island and Greenland, where in the middle Paleozoic, it was sheared sinistrally along the Canadian margin to its pre-rotated position opposite Banks Island.

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Late Tertiary Sediment Basin on Continental Slope off Western Nova Scotia

The continental slope off Nova Scotia was shaped during the Cenozoic by progradation, erosion, and intrusion by salt-cored diapirs termed the "Sedimentary ridge." No evidence has previously been reported that Cenozoic sediment accumulation on the slope landward of the Sedimentary ridge was affected by sea-floor deformation owing to growth of diapirs.

As part of a regional survey, seismic stratigraphy in reflection profiles shot on the slope between 61° and 64°W was tied to wells on the upper slope and shelf. Dip profiles show three reflector sequences, each about 0.5 sec two-way travel time thick, which terminate in a seaward direction against diapirs of the Sedimentary ridge. Whereas reflectors within the upper and lower sequences dip at least 2° seaward, reflectors within the middle sequence lie flat, lap out onto an unconformity postdating the Eocene-Oligocene canyon-cutting event along the Scotian shelf, and are truncated seaward by a sharp Pliocene-Pleistocene(?) unconformity. Neither rotation along listric faults nor back-tilting by uplift in the Sedimentary ridge can account for the geometry and along-strike continuity (200 km) of the middle sequence. It is proposed that sediments forming the flat reflectors were ponded landward of a sea-floor ridge in the present position of the Sedimentary ridge. The dam was formed in the late Paleogene by sediments uplifted above linear salt ridges. Subsequently, erosion removed both the dam and the outward portion on the ponded sediments, and diapirs rose from the salt ridges.

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Role of Minerals in Formation of Hydrocarbons During Pyrolysis of Organic Matter—a Material Balance Approach

Monterey Formation and Green River Formation kerogens (types II and I, respectively) were isolated, mixed with common sedimentary minerals, and pyrolyzed under dry and hydrous conditions for various times and temperatures. Analysis of all the pyrolyses products were conducted to perform a material balance and to infer reaction kinetics and mechanisms.

Material balance of the pyrolyses products, in the presence and absence of minerals, reveals that the kerogen degradation results in the formation of bitumen rich in high molecular weight compounds in the initial stages, followed by additional cracking of kerogen and bitumen. However, amount and type of hydrocarbons in the pryrolyses products of kerogen in the presence of montmorillonite are markedly different from those produced by heating kerogen alone or with other minerals. The initial amount of products in the presence of montmorillonite, and in particular the quantities of low molecular weight hydrocarbons, are higher than those in the presence of illite, calcite, and kerogen alone. The composition of these low molecular weight compounds is dominated by branched hydrocarbons, indicating catalytic cracking via carbonium ion mechanism, which is initiated on acidic sites of the clay. Compositional differences are evident also in the distribution of n-alkanes and in the pristane/phytane ratio. The catalytic effect of montmorillonite, however, disappears in the presence of excess water.

These differences may have important implications for the composition and quantities of petroleum generated from source rocks with different mineralogies.

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Oligocene Vicksburg Sandstones of TCB Field—a South Texas Diagenetic "Jambalaya"

Tijerina-Canales-Blucher (TCB) field of Kleberg County, Texas, has produced significant amounts of hydrocarbons from Oligocene Vicksburg sandstones at depths between 8,500 and 11,500 ft. TCB Vicksburg sandstones were deposited in deltaic to shallow-marine environments as evidenced by various sedimentological and biological indicators. Diapirisim of Jackson shale coupled with growth faulting generated highly faulted, rollover elongate anticlines. These faulted, elongate highs along with stratigraphic pinch-outs form the main traps in TCB field.

Detailed examination of cores from six different Vicksburg sand-shale intervals aided in delineation of a complex diagenesis related to depositional environment, lithology, burial, and thermal history of the region. The sandstones vary in lithology from lithic to feldspathic lithic arenites and wackes. A volcanic source during Vicksburgian time is indicated by the presence of high percentages of volcanic-rock fragments. This overabundance of labile constituents is the prime factor that resulted in the "jambalaya" of diagenetic complexities.

Porosity in the TCB Vicksburg sandstones is almost entirely secondary and was generated predominantly by the dissolution of feldspars and volcanic-rock fragments. Permeability was greatly enhanced by dissolution of recrystallized clayey matrix and carbonate cement. An overall smectite-illite signature pervades the vertical section, with an extremely well-developed authigenic imprint of highly crystalline chlorite, kaolinite, illite, and many other mineral species superimposed onto the primary signature, especially with depth. The best TCB reservoirs have the largest average grain size and had the greatest amount of feldspars and volcanic-rock fragments prior to diagenesis. Evolution of secondary porosity was directly related to the generation and migration of hydrocarbons through these reservoirs.