and (2) Lm + 2 H^+ = Kao + 2 Q + Ca^{++}. At diagenetic temperatures, equilibrium (1) has a steep slope on a T-X_{CO_2} diagram, indicating that the boundary between zeolite and clay minerals during diagenesis is more strongly controlled by fluid composition than by temperature. Equilibrium (1) and (2) along with the complimentary equilibrium (3) Cc + 2 H^+ = Ca^{++} + CO_2 + H_2O can be plotted on an isothermal projection. This projection shows that either an increase in X_{CO_2} or a decrease in pH can cause the breakdown of laumontite. Destruction of Lm by reaction (1) leads to a volume decrease of 10%, whereas Lm elimination by reaction (2) leads to a volume decrease of 28%. During diagenesis, as a result of decarboxylation reactions, previously formed laumontite can be destabilized, creating secondary porosity. In contrast, the development of secondary permeability and ultimately the recreation of reservoir potential will be a function of aluminum mobility. Whether secondary porosity and permeability develop in laumontite-rich sedimentary rocks will be dependent on the sequence, rates, and magnitude of the laumontite-forming and organic maturation reactions.

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Primary Migration in Guaricema Field Area, Sergipe-Alagoas Basin, Brazil

The Guaricema field is situated in a structural low containing a thick deposit of deep-water marine shales. Oil and gas are produced from an isolated lenticular sand body of Paleocene age. In this particular geological situation a local source for the oil can be tentatively assumed.

The Guaricema area contains a fair volume of good mature source rocks in close association with the reservoir. The organic carbon content is above 1.0% and the organic extract averages 4,400 ppm.

Gas chromatograms and carbon isotopes data characterize the oil as mature and derived predominantly from marine sapropelic organic matter. Excellent correlation between the oil and bitumen extracted from the adjacent shales shows those shales are the source rocks for the oil.

The composition of the extracts also provides evidence of primary migration by systematic changes toward the reservoir ("chromatographic effect"). In particular, the amount of resins and asphaltenes decreases drastically. Close to the reservoir, the organic extracts are similar to the reservoir oil.

The total volume of effective source rocks in the Guaricema field area was estimated in 3.9 km^3. The shales still contain 50,000,000 m^3 of oil. As the original oil in place in that field was 16,000,000 m^3, we concluded that the primary migration was very effective, exceeding 20%.

The high efficiency of the primary migration was probably favored by the close association between effective source rocks and reservoir. Both lateral and vertical primary migration were effective.

Any mechanism to explain the primary migration in the Guaricema area must account for the high efficiency here evidenced, including the ability of causing much more concentration than dispersion of the hydrocarbons. Migration in an oil phase seems to be the more likely mechanism.

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Origin of Mid-Atlantic Barrier Islands and Implications for Petroleum Exploration

The resemblance in plan between Cherokee shoestring sands in southeast Kansas and existing barrier islands around the New York Bight suggests that a genetic interpretation of Mid-Atlantic barrier islands may aid in exploration and development of linear oil-bearing sands. Mid-Atlantic barrier island chains are elongate sand bodies with typical dimensions of 5 to 25 mi (8 to 40 km) alongshore, less than 1 mi (1.6 km) across shore, and 10 to 40 ft (3 to 12 m) thick. These barrier islands develop and are maintained by the wave-driven longshore distribution of sands from a source. For Mid-Atlantic barrier islands, there are no rivers acting as sediment sources and the direct contribution of eroding bluffs is relatively unimportant. For the most part, the sources of the sand are the existing beach and nearshore. Shoreline changes over the past 200 years show that the longshore distribution is episodic, probably reflecting shifts in angle of wave attack or the uncovering of previously buried nearshore sand bodies more than sea-level rise. The historic charts clearly show that large sand deposits overwhelm any sea-level rise effects on a time scale of decades to centuries (Fire Island, Sandy Hook, Fishing Point, and others). These sand bodies advance onto and are backed by relatively fine-grained material with a high organic content, suggesting that source material is not lacking. They will have a relatively good chance of being preserved in the rock record under prevailing transgressive conditions. Of immediate use for petroleum exploration is the center-line offset of individual barriers within the chain. Center lines of the largest and most active barriers extend seaward of smaller barrier islands on the downdrift side. Also, barrier islands develop toward the low latitudes, reflecting the effect of waves generated by storms in the high latitude seas. Barrier islands on a worldwide basis appear limited to the leeward side of continental land masses.

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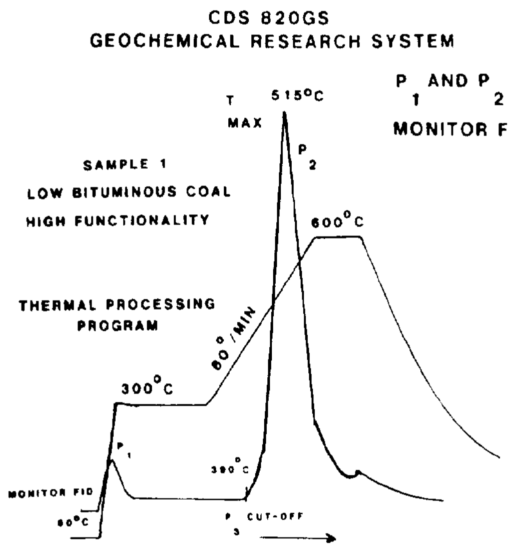
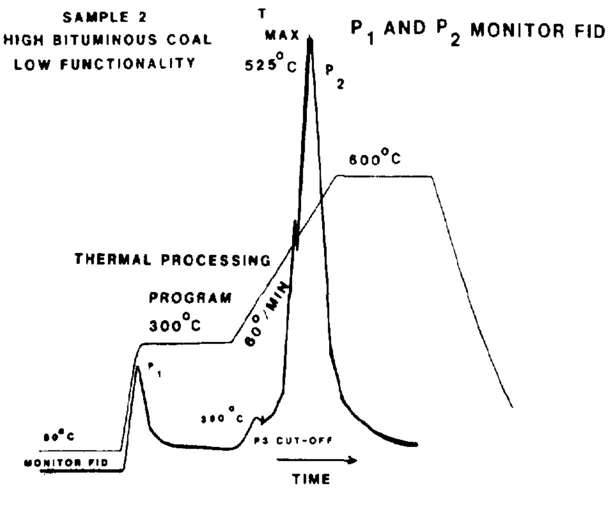
Geochemical Research with Advanced Pyrolysis/Concentrator Technology

Source-rock studies to determine potential fuel-bearing and processing characteristics demand reliable analytical data both in the field and laboratory. The CDS 820GS Geochemical Research System has been designed and engineered to provide concerted analytical information, the thermal distillation profile





(P_1, P_2, P_3), and on-line high-resolution FID capillary gc analysis of the P_1 and P_2 composites. P_3 is determined by thermal treatment of the source rock to 390°C by internal trapping and subsequent desorption into a chromatographic column with thermal conductivity detection for carbon dioxide and other evolved gases. These data provide valuable insight into the sample composition, maturation, relation to process yields, and pollution/transport mechanisms.

Illustrations will be given of the organic analysis of kerogens, oil shales, coals, and sediments. The growing significance of analytical pyrolysis combined with concentrator technology will be demonstrated in applications of these advanced configurations dedicated to the geosciences.

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Temperature Anomalies and Gulf Coast Structures

Temperature anomalies associated with various structures in the Gulf Coast are interpreted to be the result of fluid migrations from depth. Pressure and salinity data are also part of an exploration model where hot, fresh, hydrocarbon-laden waters are believed to be migrating up faults. Traps in the vicinity of these migrations are of special interest to the explorationist because they are more likely to be charged with hydrocarbons.

The part of southeastern Louisiana studied has twelve areas of possible subsurface fluid migrations. Eight hydrocarbon fields are in the vicinity of these migrations. The areas of migration are most likely to occur at areas of structural expansion, i.e., grabens, crests of diapirs, and most importantly, intersections of faults.

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Margin Types: Their Characteristics and Potential

Offshore exploration has tested passive, convergent, and transform margin types. Passive margins are characterized by an initial rift structure, commonly involving nonmarine sediments, sometimes evaporites, and an overlying mostly marine sedimentary terrace of clastics and/or carbonates. Potential has proved variable. Significant hydrocarbons have been found in MacKenzie Delta, Gulf of Mexico, offshore Newfoundland, northwest Europe, Gulf of Suez, India, Indonesia, Australia/New Zealand, Brazil, and central west Africa from Ivory Coast to Angola. To date, little success has been obtained on the passive margins of the rest of Africa, South America south of Brazil, the east coast of the U.S., and most of Australia/New Zealand.

Convergent margins are characterized by an arc-trench system with intervening fore-arc basin and subduction complex. Sediments of fore-arc basins are predominantly marine volcanogenic clastics derived from the magmatic arc. The subduction complex is a tectonically imbricated package composed predominantly of volcanogenic clastics, but may incorporate significant amounts of deep-sea cherts, limestones, red clays, and slices of oceanic crust. Potential appears poor with the only significant hydrocarbons discovered in this setting being in southern Alaska and northern Peru.

Transform margins are relatively limited worldwide and are characterized by sharp fault-bounded basins with clastics derived from adjacent sides and carbonates developed in situ. Compressive structuring locally accompanies basin evolution. Potential is variable. Significant hydrocarbons have been found in this setting off southern California, Trinidad, northern Brazil, Ivory Coast, and Sakhalin Island, but none so far off western Canada, the northern Caribbean, or western Madagascar.

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Geological Development, Origin, and Energy and Mineral Resources of Williston Basin, North Dakota

The Williston basin of North Dakota, Montana, South Dakota, and south-central Canada (Manitoba and Saskatchewan) is a major producer of oil and gas, lignite, and potash. Located on the western periphery of the Phanerozoic North American craton, the Williston basin has undergone only relatively mild tectonic distortion during Phanerozoic time. This distortion is largely related to movement of Precambrian basement blocks.

Oil exploration and development in the United States portion of the Williston basin from 1972 to present have given impetus to restudy of basin evolution and geologic controls for energy resource locations. In consequence, oil production in North Dakota, for instance, has jumped from a nadir of 19 million bbl in 1974 (compared to a previous zenith of 27 million in 1966) to 32 million bbl in 1979 and 40 million bbl in 1980. Geologic knowledge of carbonate reservoirs has expanded accordingly.

Major structures in the basin, and the basin itself, may result from left-lateral shear along the Colorado-Wyoming and Fromberg zones during pre-Phanerozoic time. Deeper drilling in the basin has established several major new structures with indications of others. Most structures probably result from renewed movement or "tensing" of pre-Phanerozoic faults. Meteorite impact events have been suggested as the origin for one or two structures.

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Origin of Quebrada Arriba Oolitic Ironstone (Eocene), Venezuelan Andes

The Quebrada Arriba Formation consists of alternating beds of chamositic oolite, limestone, sandstone, and shale. The oolites consist of a framework of originally calcareous ooids, fossils, and intraclasts set in a calcareous cement, all virtually replaced by chamosite, siderite, hematite, pyrite, and silica. Tex-