

It is generally believed that growth faults act as primary conduit to the migration of hydrocarbon from the source to the reservoir rock. These faults and their associated structures often provide closures for hydrocarbon traps as exemplified in the Niger delta and Gulf Coast region. However, the relation of the growth-fault building mechanism to the migration and entrapment of hydrocarbon has not been fully understood.

A model of the influence of growth-fault building mechanism on the distribution and accumulation of hydrocarbon is presented. Fundamental to the model is a quantitative analysis of the criteria for failure. This failure is shown to occur in the so-called "plane of weakness" of the rock. When sliding accompanies the failure, the plane is commonly referred to as the slip plane. The criteria for failure in the presence of pore pressure and cracks have been studied and used to model the source rock. Hydrocarbon, which is "squeezed" out from the source rock as a result of the failure criteria, follows the plane of weakness in migrating to the reservoir region.

Therefore, an understanding of these directions and a knowledge of the geology of the reservoir region will be helpful in identifying new possible targets within a growth-fault zone and in re-examining areas within the zone that were thought to be barren.

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Petroleum Trap Associations: a Basis for Systematic Exploration

A strategy that considers "all possible" trap types in each volume of potentially petroliferous rocks becomes increasingly attractive as the remaining petroleum prospects become more elusive. This approach calls for cataloguing systematically the numerous lithologic configurations possessing trap-forming potential that may result from the basic processes of erosion, deposition, diagenesis, and deformation, as experienced by the particular strata.

These varied lithologic configurations are then considered in terms of their areal and time-stratigraphic associations. A wide variety of oil and gas entrapments is commonly related to one or more large-scale trap-forming features, such as a paleodrainage system or a salt dome. Traps associated with such features commonly develop during intervals of exceptionally rapid change, certain of which may be regarded as distinct trap-forming events. Some changes, like river avulsion, may be caused by internal processes, whereas others, like particular (series of) changes in sea level, originate outside the local systems and so may affect extensive regions. The objective is to predict "all" the potentially trap-forming lithologic configurations that might occur on each feature at the stratigraphic position of each event.

However, the accumulation-forming potential of these configurations and events must also be considered. This is revealed most directly by studies of existing production, which may then be used to guide exploration for related accumulations and to predict "new" types and locations of entrapment. Since the trap-forming features and events are frequently related to the other prerequisites for petroleum accumulation, consideration of accumulations provides some integration of all the prerequisites.

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Dolomitization of Brassfield Formation

The Brassfield Formation (Lower Silurian), which crops out in southwestern Ohio, through parts of Indiana and Kentucky, to western Tennessee, is a transgressive sequence consisting of in-

terbedded shales, limestones, and dolostones. Shales dominate the eastern edge of the outcrop, whereas carbonate sediments are characteristic of the western and southern exposures. A detailed study of outcrops in southwestern Ohio shows that two separate dolomitizing processes have altered the rocks. Elsewhere, the Brassfield Formation appears to be dolomitized by a single process. In southwestern Ohio, initial dolomitization was restricted to the basal Belfast Member and probably occurred penecontemporaneously in a supratidal environment similar to a modern sabkha. Dolomite in the Belfast member occurs as small (10 to 40 μm), cloudy, anhedral crystals. Thinly laminated sediments with a few gypsum casts are characteristic of this unit.

Regional dolomitization was a later diagenetic event related to the formation of a freshwater and seawater mixing zone beneath a landmass created by upwarping of the Cincinnati arch and Nashville and Ozark domes. Intensity of dolomitization in the outcrop belt is controlled by the proximity of the original carbonate sediments to the source of dolomitizing fluids in the mixing zone. The Brassfield is undolomitized away from these structural highs. Dolomite from this portion of the formation is typically large (>10 μm), limpid, euhedral rhombs replacing bioclasts and sparry calcite cement.

This "Dorag" type of dolomitization suggests the presence of landmasses in the areas of the Cincinnati arch and the Ozark and Nashville domes during the time of dolomitization of the Brassfield Formation.

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Zoning in Chesapeake Bay Dredge Piles

Chesapeake Bay economics requires channel dredging to maximize its potential in trade. Because of environmentalists' objections, aspects of dredge spoil disposal have received much attention and have held up dredging operations. The effects of heavy metals is an important factor in these environmental concerns.

The most recent and popular method of disposal involves the dumping of a sediment slurry, via conveyor, into a contained, nearshore or onshore dumpsite. This creates piles of sediment above water, incident to the bay. This method of dumping provides a model for some basic sedimentary and geochemical principles: sorting by grain size owing to differing settling rates, and resultant sorting of metals owing to affinities of these metals to a specific grain fraction. Vertical zoning of metals with depth is also possible, due to supergene enrichment. These three processes are investigated by this project with the intention of providing information to help in structuring the long term use and development of the bay.

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Facies-Controlled Diagenesis and Reservoir Character, Entrada Sandstone (Late Jurassic), Durango, Colorado

The Entrada was deposited as part of a Late Jurassic erg that covered much of the western United States. Depositional environments of the Entrada include: (1) small-scale, coarse-grained eolian dunes, (2) eolian sand sheet, (3) large-scale eolian dunes, and (4) water-laid sands. Quartz and potassium feldspar overgrowths are the most abundant cements, followed by dolomite, calcite, and kaolinite.

Current reservoir models for eolian depositional environments suggest that well-sorted dune sands should have higher permeability than the finer grained and poorly sorted sand sheets. However, in the Entrada, no difference in permeability was

detected between the facies, owing to the high percentage of preserved intergranular porosity in the sand sheet. Intergranular porosity is preserved by the development of thick clay coats, composed of illite and smectite, which inhibited porosity reduction by quartz and potassium feldspar overgrowths.

The clay coats are derived from mechanically infiltrated wind-blown clay deposited penecontemporaneously with the sand. This type of clay deposition is common in modern deserts. The thickest clay coats develop in facies where the grains undergo the least abrasion, such as sand sheets and interdunes. Therefore, upon lithification, sand sheets and interdunes will retain a high percentage of their intergranular porosity and will not act as permeability barriers to fluid migration.

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Electron Microprobe Study of Mg Distributions in Recent Mg Calcites and Recrystallized Equivalents from Miocene of Eniwetok Atoll

To determine the effect of early freshwater diagenesis on Mg distributions in former high Mg calcite (HMC) cements, Mg distributions were determined by electron microprobe analysis of two groups of samples as follows: (1) HMC in limestones not yet exposed to fresh water, and (2) HMC and recrystallized equivalents after freshwater exposure. Mg varies little in pristine HMC, and traverses through the cements show no trends or large-scale zonations. Mg content is not related to inclusion abundance. Former HMC from the Miocene of Eniwetok Atoll, most of which are now radiaxial, prismatic calcites, have a much greater variation in Mg content, and traverses through the calcites display definite trends. Generally, the Mg content of the calcite is inversely correlated with abundance of inclusions.

The small variation in Mg content in original HMC cements is a valuable point to be aware of when interpreting Mg trends in recrystallized equivalents. Because Mg content can be related to inclusion abundance in recrystallized, former HMC, but not in pristine HMC, Mg trends in the altered materials most likely reflect dissolution/precipitation processes, not original Mg trends. A likely cause for the low Mg content associated with inclusion-rich growth layers in the recrystallized Mg calcites is relatively high rates of dissolution and reprecipitation in these relatively permeable layers. In some places, the cloudy growth layers and increased permeability are due to infestation by endoliths. Such organisms may often cause the cloudiness observed in other radiaxial calcites.

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Attempted Heuristic Approach to Total Potential Estimation of a Petroleum Basin

Several methods have been described in the literature which attempt to estimate the total hydrocarbon resources of large terrains, based on the concept of the petroleum basin. The approach described here employs heuristic procedures which incorporate optimization methods, and are applied to data files drawn from the world's major petroleum basins. Basin variables used include the area, thickness and volume of the sediments, characteristics of facies models, sedimentary cycles, and sedimentary rates; the historical record of depositional and tectonic events; environmental setting; geothermal gradients; potential of viable reservoir units. A diagnostic relationship is developed from a summation of linear nondecreasing functions, each linked with a specific variable.

The goals of this study include a numerical classification of the petroleum basins of the world, the isolation of variables which are both diagnostic and satisfactory, together with evaluations of their individual information content, and the development of a predictive technique for the estimation of the total potential in newly explored territories.

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Source-Rock Analysis, Bear River Formation, Western Wyoming Overthrust Belt

Source-rock analysis was performed on shales from the Lower Cretaceous (Albian) Bear River Formation in the Darby thrust plate of the western Wyoming overthrust belt. Measurements of total organic carbon (TOC); vitrinite reflectance (R_0); visual kerogen analysis, including determination of thermal alteration index (TAI) and kerogen morphology; and pyrolysis provide information concerning the amount, type, and maturation levels of kerogen in the Bear River shales. TOC analysis indicated that the shales are moderately rich in organic matter (1.0 to 1.5 wt. % TOC). Kerogen morphology (structured) and pyrolysis data (suggestive of type III organic matter) indicated that organic matter in the Bear River Formation is humic and gas prone. TAI and R_0 values suggest that Bear River shales are in the oil-early gas-generating range (0.7 to 1.1% R_0) in the northern and southern parts of the Darby plate whereas organic maturities are substantially more advanced (1.8 to 2.0% R_0) in the central part of the plate.

The levels of thermal maturation, as defined by TAI and R_0 values, were used as constraints on a Lopatin-type time temperature index (TTI) thermal model. The TTI modeling suggests that normal depositional burial could account for the levels of thermal maturation observed in the northern and southern parts of the Darby plate, whereas an additional heat source, possibly burial of the Bear River Formation beneath the Absaroka thrust plate, is necessary to account for the relatively advanced thermal maturation measured in the central part of the Darby plate.

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Dissolution Kinetics of Biogenic Carbonates—Effects of Mineralogy, Microstructure, and Solution Chemistry

Previous models of early carbonate diagenesis assume mineralogy controls alteration sequence, with magnesian calcites dissolving more rapidly than aragonites. Results of this study indicate that: (1) mineralogic effects can be overridden by microstructure; and (2) dissolved magnesium enhances dissolution rates.

The study determined laboratory dissolution rates of biogenic grains found in modern carbonate environments and evaluated the relative importance of grain mineralogy, microstructure, and solution chemistry by determining dissolution rates at various undersaturations in seawater and in freshwater solutions containing different amounts of dissolved magnesium.

Although aragonitic grains dissolved more rapidly than low-magnesian calcites of the same grain size, most aragonites also dissolved as fast, or faster than, magnesian calcites containing 12 to 17 mole % $MgCO_3$. Mineralogy alone, then, is not the sole control on reactivity.

Dissolution rate is also affected by microstructure. Microstructure determines the amount of surface area available for dissolution and may exert greater control over reactivity than