CRETACEOUS DELTAS, ALBERTA

Tectonic divisions of the Precambrian basement of Alberta seem to have exerted geographic control on the emplacement of major deltas of the late Mesozoic. The greater thicknesses of the Albian lower Blairmore delta coincide with the site (in Devonian time) of the west Alberta ridge and the Peace River "high." The thick parts of the latest Cretaceous Belly River and Edmonton deltas show similar disposition. The Dunvegan delta (Cenomanian) pinches out abruptly south of the Peace River arch. The Milk River delta (Campanian) is a feature of the Sweetgrass arch and the lower Edmonton tongue is limited to an area west of the same arch.

Hydrocarbon pools within these deltas are controlled by pre-Cretaceous erosion features and/or by shoreline facies.

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GEOMETRY OF INYO-WHITE MOUNTAINS ALLOCHTHON, EASTERN CALIFORNIA

Approximately 750 sq mi of the northern Inyo and southern White Mountains, eastern California, are cut from a relatively simple, well-exposed, allochthonous mass consisting primarily of late Precambrian and Cambrian rocks. The thrust surface is exposed on both the eastern and western flanks of the Inyo Mountains where mainly Mississippian rocks underlie the allochthon. Although igneous rocks along the north and southeast have intruded the thrust zone, its position can be inferred from great differences in the stratigraphy (on the north) and structure (on the southeast) across the interpreted thrust. On the southwest, however, the allochthon is structurally continuous with the southern autochthon. The entire eastern and southern margins of the allochthon are folded down and under, suggesting eastward and southward movement. Apparently rotation occurred, probably in the Late Triassic, east of Independence, California, in the vicinity of the connection between the allochthon and autochthon. Movement northeast of Independence in the latitude of Tinemaha Reservoir has been a minimum of 15 mi. A large N-S-trending anticline and an adjacent syncline (which parallel most of the small folds) are the major structures within the allochthon. Superimposed on these north-south folds are E-W-trending warps involving the thrust plane.

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SEDIMENTARY AND FAUNAL ASSOCIATIONS OF PROTECTED CARBONATE SHELVES AND PLATFORMS

Protected carbonate shelves and platforms exhibit faunal and lithologic uniformity through time and space. Organic reefs of varied origin (stromatoporoid, rudist, coral) have sedimentologically and faunally similar backreef and lagoonal deposits. Backreef deposits, by definition, are dependent on organic reefs for their origin. Lagoonal deposits, however, primarily reflect restriction of circulation and are independent of the type of circulation barrier (reefs, islands, shoaling water). Thus, backreef deposits indicate presence of reefs, but lagoonal deposits reveal only the environmental character of the shelf or platform.

Backreef deposits—skeletal sands and gravels originating through breakdown and transport of reef organisms—reflect relatively high-energy nearreef environments. Though generally characterized simply as debris deposits, these materials form well-defined sedimentary bodies. Transport by sheet flow across the reef or by tidal currents in interreef channels results in formation of skeletal sand banks, islands, downwind offreef drape, coarse rubble piles, and tidal deltas. Reef migration and lagoonward expansion of the reef flat may incorporate these deposits in the reef mass, accounting in part for the large amount of loose debris in reefs. More detailed investigation of lateral and vertical relations in modern environments should lead to recognition of these sedimentary bodies in ancient rocks.

Lagoonal deposits reflect restriction of circulation, and lagoons commonly are characterized as sediment traps for fine-grained carbonates. Geometry, lithology, and faunal content of lagoonal deposits reflect depth, lagoonal circulation, and ecology of lagoonal organisms. Facies belts paralleling bathymetric contours in atoll lagoons, and paralleling strike of carbonate-shelf lagoons reflect the effect of depth. The generally simple pattern of lagoonal deposition is modified by sedimentary accumulations such as mud mounds, islands, and their intertidal and supratidal facies, tidal deltas, and oolite bars. Climate and tectonics influence relative abundance of different types of lagoonal sediments. Increased restriction, arid climate, and low coastal relief lead to formation of vast supratidal sabkhas, lagoonal evaporites, and reflux dolomitization. Exchange with the open sea promotes organic productivity and formation of skeletal sediments. Terrigenous influx results in complex terrigenous-carbonate facies.

Sparse paleontologic data reveal consistent faunal associations in lagoonal and backreef deposits of diverse origins and ages. Foraminifera, mollusks, and algae dominate these faunas. Ostracods also are characteristic. Devonian reefs are unique in that lagoonal deposits are dominated by abundant fragile branching stromatoporoids. The striking similarity of lagoonal faunas through time should provide a superb framework for ecologic and evolutionary studies.

Detailed resolution of carbonate subenvironments has been attempted most commonly in relatively thin, shelf-carbonate sequences. More detailed resolution of backreef and lagoonal subenvironments and sediment bodies is obtainable by more thorough definition and by application of available recent models.

Investigation of vertical and lateral variation in lagoonal carbonates should provide useful data on shelf history. Effects of sea-level change, climatic variation, growth and destruction of barriers, and variation of sediment sources may be revealed more explicitly in these relatively uncomplicated sediments than they would in the complexly varying facies of the shelf or platform edge. Consideration of recent models suggests possible reinterpretation of development in several ancient carbonate complexes.

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TECTONIC HISTORY OF NORTHERN ALASKA

(No abstract submitted)

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PETROLOGY OF PENNSYLVANIAN CARBONATE BANK AND ASSOCIATED ENVIRONMENTS, AZALEA FIELD, MIDLAND COUNTY, TEXAS

The Azalea carbonate biogenic bank developed on a broad shallow shelf during early Strawn deposition.

Petrologic study of cores and well cuttings defined 3 major facies. The "deeper water" micrite is dark brown with scattered fossil fragments and was deposited in water from 50 to 200 ft deep. The biogenic bank facies is composed of biosparite to biosparudite containing platy algae, fusulines, bryozoans, gastropods, pelecypods, brachiopods, and some crinoid columnals. The "sheltered" micrite contains numerous small unidentifiable foraminifers deposited behind the bank, and a few very local biogenic mounds. These mounds seem to be analogous with the mangrove islands found in Florida Bay.

Bank development was confined to the west edge of an Atokan structural terrace where oscillation waves were impinging upon the rising sea floor. Turbulence, shallow water, and the associated supply of nutrients provided necessary ingredients for prolific growth of organisms which formed the biogenic bank.

Excellent hydrocarbon production has been obtained from the bank across 13 mi of its length. Recently production was extended 1¾-mi south and an extension is being drilled 1½-mi north. There is a good possibility of additional biogenic banks having developed on the broad Strawn shelf.

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Discriminant Analysis Versus Factor Analysis of Grain-Size Data from Different Environments and Sedimentary Structures

Grain-size data analyzed by multivariate computer techniques allows (1) discrimination of environment of deposition and (2) recognition of sedimentary structures. Multiple discriminant analysis where used in conjunction with variables derived from ¼-phi-sieve grain-size analysis was found to be the most useful multivariate technique.

Grain-size samples from 3 environments (Arkansas River, Great Sand Dunes National Monument, Colorado, and Gulf Coast beaches) were used as "known" environments in discriminant analysis. With the intention of classifying 49 samples from Bijou Creek, Colorado, they were listed in the discriminant analysis program as "unknowns." Thirty-six of 39 "unknowns" were correctly classified by the program as river sediments. Q/mode factor analysis correctly classified 32 of the Bijou Creek samples with known river samples.

Variations in grain-size distributions within a given environment were studied in an Arkansas River sand wave. Foreset beds, climbing ripples, and horizontal laminations were designated as "known" sedimentary structures. By use of multiple discriminant analysis 20 of 21 samples from a second sand wave were classified correctly. Using Q-mode factor analysis all but 3 samples were classified correctly.

By analyzing separately each of the 2 or 3 populations appearing as straight lines on cumulative plots on normal probability paper, greater discrimination between environments was obtained than by using standard grain-size parameters calculated by assuming each sample represented a single population.

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Present Knowledge of Fundamental Processes of Oil and Gas Origin and Migration Applied to Petroleum Prospecting

There are 2 approaches to petroleum prospecting with organic geochemistry. The essential problems with direct methods are the process and the importance of migration to surface and the occurrence of hydrocarbons of superficial origin. Indirect methods are based on the knowledge of the laws of (1) distribution of organic matter as a function of paleogeographic and paleoclimatic conditions; (2) transformation of organic matter into petroleum under temperature and pressure conditions, as shown by laboratory analysis and experiments on samples from sedimentary basins; and (3) migration of petroleum from the source rocks to the reservoir and eventually alteration caused by temperature, pressure, and underground waters.

The foregoing knowledge may be applied to determine areas favorable to the transformation of organic matter into oil and/or gas and the time of formation of petroleum, compared with the time of sedimentary or structural trap formation.

These results may be obtained more particularly by mathematical models processed on computers.

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Pleistocene Calcarenite Lithosomes of Bermuda

Bermuda's subaerially exposed limestones consist of eolianites, littoral calcarenite lithosomes, and accretionary soils deposited during Pleistocene high sea levels. The geometry and structure of these deposits were studied to evaluate sea-level fluctuations during Pleistocene high stands, and to provide criteria for recognizing the eolian-marine facies in surface and subsurface rocks of earlier age.

Eolianites are dune ridges trending parallel with the present coastline and arranged in decreasing age from the center of the Bermuda islands outward. Eolianites are subdivided into 2 structural lithosomes: foreset wedge and windward-topset wedge. The foreset wedge is characterized by strata steeply inclined (35°) landward and concave seaward and downward. Foreset curvature is used to divide the wedge into a row of adjoining lobate bodies that represent the hillocky coastal dunes from which the dune ridge was constructed. The windward-topset wedge is characterized by complexly festooned cross-stratification in the seaward part and more regular, seaward-dipping, gently inclined (5–15°) cross-stratification near the dune crest.

Littoral calcarenites that overlie or are transitional with windward eolianite strata are termed "seaward shore" whereas those that onlap foresets are called "inland shore." Seaward-shore calcarenites are subdivided into (1) depositional coastline deposits that represent beaches fed by reef-derived detritus, and (2) erosional coastline deposits that represent pocket beaches fed by erosion of headlands. The former are wedge-shaped bodies of regular, seaward-dipping, gently inclined cross-strata and interfinger with eolianites. The latter are conglomeratic pods overlain by accretionary soils and found between eolianites.

Accretionary soil is unbedded, uncemented, organic-rich calcarenite containing land snails and rhizoconcretions. The soil records invasion of vegetation and land crabs onto freshly deposited calcarenite. Environments of soil development include the supralittoral of pocket beaches, interdune swales, and the seaward slopes of inactive, unlithified dune trains.

Analysis of the carbonate eolian-marine facies in Pleistocene and older rocks can provide data necessary to interpretation on a worldwide basis of (1) sea-level