ognition is enhanced by color differences between paleosols developed on the scoured and scour-fill deposits, is a valuable indicator of climatically and/or tectonically controlled base level changes in continental basins. Because paleosols preserve the record of nondeposition and nonerosion and are useful in identifying periods of degradation, their analysis is essential to reconstructing the complete geologic history of alluvial sediments.

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Puerto Rico Trench: Site of a Shallow-Water Tertiary Basin and Regional Tectonic Implications

Until late Eocene time, the Bahamas platform extended to the present Virgin Islands, as demonstrated by magnetic, gravity, and refraction data. This interpretation is confirmed by the presence of widespread outcrops of middle Cretaceous through early Pliocene shallow-water bank carbonates below 5,200 m depth in the trench. Crustal thickness beneath this bank is 18-25 km. Igneous and metamorphic rocks from the base of the trench's southern slope are chemically very different from subduction-zone rocks.

Waters of the carbonate bank (300 × 100 km in size) transgressed southward after early Eocene time. During late Eoene time, the bank's southern margin was near today's shoreline where down-to-the-north growth faults formed. Along the bank's northern margin, block faulting produced a graben above the site of the modern Puerto Rico Trench. During middle Eocene to early Pliocene time, shallow-water deposition extended from a position presently 5,200 m deep in the trench to central Puerto Rico, an exceptionally stable block at least 100 km wide.

During middle Eocene time, the Beata Ridge dextral shear cut the trench off north of Hispaniola. In early Pliocene time, the Mona Canyon dextral fault zone cut across the trench, and strong northward tilting commenced. The trench's present southern slope is mainly a dip slope, inclined about 5°. The Puerto Rico Outer Ridge formed by lateral and upward movements of mantle materials that withdrew from beneath the sinking trench. Petroleum prospects presently are limited to the Tertiary (4,000 m thick) and to a coastal zone 20-25 km wide (to 2,000 m water depth). Traps are mainly fault seals and stratigraphic pinch-outs.

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Expert System for Computer Interpretation of Beach and Nearshore Facies

A user-friendly, rule-based expert system has been designed for interpretation of lithofacies characteristics of beach and nearshore depositional environments. Recently, similar expert systems have been widely applied in medicine, business, and mineral exploration.

The expert system runs on a VAX 780 (trade name). By incorporating knowledge and understanding of an expert, the system can interact with a user the way an expert consultant would. Interaction consists of a series of questions about lithology, sedimentary structures, and bioturbation of the lithofacies observed in outcrop or core. Uncertain responses are allowed and incorporated into the reasoning. Dialogue varies in different consultations because questions asked by the system depend on users' responses to previous questions. The result is an evaluation of the likelihood that the deposit under consideration is actually a beach or nearshore deposit. Significant lithofacies characteristics, the reasoning used in reaching the conclusion, and pertinent references are provided.

Expert systems for other depositional environments are being designed. As their availability increases, geologists without easy access to experts on a particular depositional environment will have expert consultants as close as a computer terminal. Also the ability of the system to explain its reasoning and provide references lends the system to instructional uses.

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Impact of Early Diagenesis of Eolian Reservoirs, Great Sand Dunes National Monument, Colorado

Dune and associated alluvial and playa deposits at Great Sand Dunes National Monument, Colorado, provide an excellent opportunity to study early diagenetic development of vertical and horizontal permeability barriers in recent eolian deposits (> 10 ka). Cements observed include calcite, aragonite, protodolomite(?), amorphous silica, iron hydroxide, smectite, trona, and halite. Cementation is controlled by the availability of water, with several hydrologic subenvironments producing different cements.

Evaporative cementation in dunes adjacent to playas is commonly dominated by trona and halite, but calcite, aragonite, and amorphous silica also bind the sediment. These cements are generally most concentrated in fine laminations where capillary action has pulled water into dunes. Iron hydroxides, calcite, and amorphous silica precipitate at the interface between ground water and streams or lakes, where the pH gradient may exceed 5 pH units (pH 5.7-11.5). Subsequent movement of the ground-water table can result in cross-cutting cement zones.

Early cementation in dunes prevents deflation and provides a mechanism for preservation of the reservoir unit. Intense cementation may permanently occlude porosity, or leaching may reestablish well-interconnected porosity. An understanding of the extent and composition of early cement zones can be used to improve hydrodynamic models for production and enhanced recovery.

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Source Rock Characteristics, Los Molles and Vaca Muerta Shales, Neuquen Basin, West-Central Argentina

Major hydrocarbon-producing trends of the Neuquen basin occur along its northeastern margin (Eastern Shelf) and along an east-west-trending structural high in the southern half of the basin (Neuquen Dorsal). Sediment thickness increases northward from the Neuquen Dorsal and westward from the Eastern Shelf into the Neuquen Embayment, a region that has been relatively unproductive for hydrocarbons.

Major source rocks are the Lower to Middle Jurassic Los Molles Formation and the Upper Jurassic to Lower Cretaceous Vaca Muerta Formation. Los Molles shales are immature to moderately mature on the Neuquen Dorsal: vitrinite reflectance (R_o) = 0.3-0.8%; thermal alteration index (TAI) = 1+ to 2; total organic carbon (TOC) = 2.0-5.0%. However, they are severely altered in the deepest part of the Neuquen Embayment (R_o = 2.5-3.0%; TAI = 3+ to 4; TOC = 1.1%). Organic matter is woody on the Neuquen Dorsal but is coaly in the Neuquen Embayment. Clay minerals are smectite and mixed layer illite-smectite on the Neuquen Dorsal whereas illite and chlorite are present in the Neuquen Embayment.

Similarly, Vaca Muerta shales are immature on the Neuquen Dorsal and along much of the Eastern Shelf (R_o = 0.3-0.5%; TAI = 1 to 2−), but are mature throughout the Neuquen Embayment (R_o = 0.7-1.3%; TAI = 2-3). The lower part of the unit is a bituminous black shale (TOC = 2.5-6.5%). The dominant visual kerogen type is amorphous (AI). Clay minerals change from smectite to mixed layer illite-smectite with decreasing expandability toward the deepest part of the Neuquen Embayment.

The lack of correlation between areas of source rock maturity and major hydrocarbon production suggests long-distance fluid transport out of deep portions of the basin.

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Geochemical Conditions in Sediment Containing Gas Hydrates of Active and Passive Continental Margins

Two sites of the Deep Sea Drilling Project in contrasting geologic settings provide a basis for comparison of the geochemical conditions associated with marine gas hydrates in continental margin sediments. Site 533 is located at 3,191 m water depth on a spitlike extension of the continental rise (Blake Outer Ridge) on a passive margin in the Atlantic Ocean. Site 568, at 2,031 m water depth, is in upper-slope sediment of an active accretionary margin (Middle America Trench) in the Pacific Ocean. Both sites are characterized by high rates of sedimentation (greater than 30 m/m.y.), and the organic carbon contents of these sediments generally exceed 0.5%. Anomalous seismic reflections that crosscut reflections from sedimentary layers and parallel reflections from the sea floor suggested the presence of gas hydrates at both sites. During coring, small samples of gas