iting all the complexity of real processes and some of the control of the laboratory.

A variety of structures was observed along stream courses. With few exceptions, all of the structures resulted from infrequent floods and were developed during waning phases. In contrast, most of the bedding was deposited during maximum flood conditions. Erosional structures observed include various types of scours, rills, tool marks, microterraces, and mud balls. Structures produced by transportation and deposition were ripple marks (10 varieties), lineations (3 varieties), and imbrication. Postdepositional structures include desiccation cracks (6 varieties), surface markings, salt-crust features, algal mats, and sand volcanoes. Bedding types observed were horizontal parallel and discontinuous, small- and medium-scale trough cross-stratification, medium- and large-scale low angle wedge cross-stratification, inclined channel fill-bar complex, ripple stratification, high angle avalanche front cross-stratification, and convolute bedding. Within the channel, inclined bedding is dominant, but on bars, low angle cross-stratification is the most abundant type of bedding.

Several factors combined to control the occurrence of specific structures and bedding types. Stream velocity is the most important factor, but particle size, time, water depth, and local channel irregularities are also significant.

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SUBMARINE SLOPE EROSION ALONG PERMIAN BANK MARGIN, WEST TEXAS

Recent sea floor investigations, such as those of the western Atlantic-Blake Plateau region by Heezen and Stetson and coworkers, indicate extensive erosion by deep ocean currents on flat surfaces and on steeper submarine slopes. Evidence of small-scale submarine erosion of lithified crusts or skeletal material is increasingly being recognized, but few examples of ancient unconformities are known that represent appreciable erosion in a deep marine environment. Forming the 2 major unconformities of the Leonardian and Guadalupian strata of the Guadalupe Mountains of Texas required extensive erosion; that this erosion and the creation of numerous small channels and diastems in associated strata occurred in a continually submerged, relatively deep, marine environment best fits the present geologic data.

The 2 unconformities are roughly parallel. They form the upper and lower boundaries of the dark basinal carbonates of the Cutoff Formation. The lower unconformity, disconformable shelfward, steepens basinward to 5–10° and truncates over 200 m of essentially flat-lying Victorio Peak bank margin carbonates before flattening basinward. This unconformity probably inherited the relief of a gentler bank margin depositional profile. Erosion steepened and caused bankward slope retreat for possibly hundreds of meters. The upper unconformity locally intersects the lower and is onlapped by about 300 m of the Brushy Canyon Formation, composed largely of deep water sandstones.

These unconformities and associated diastems are generally smooth, sharp surfaces, showing scant evidence of the environment of erosion, but broad gentle undulations, and spoon-shaped, possibly closed depressions, some with tens of meters of relief, appear characteristic of both unconformities. Several V- to U-shaped basin-trending channels are present locally.

The mid-Permian bank margin of the classic Guadalupe Mountain area appears to furnish an outcrop analog for some of the processes of both deposition and erosion along deep submarine slopes. The possibility that deep marine erosion created many unconformities of the geologic record should be considered seriously.

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SEDIMENTARY ENVIRONMENTAL CONTROL OF SANDSTONE-TYPE URANIUM DEPOSITS

Uranium deposits of the Rocky Mountain area are present in fluvial sandstones that were derived from granitic highland source areas and deposited in adjacent intermontane basins. The sandstones are arkosic to arkose in composition and contain a small percentage of carbonized plant debris and pyrite, medium grained to conglomeratic in size, subrounded to angular in shape, and are poorly to moderately sorted. The sandstones intertongue and are interbedded with green mudstone.

The host sandstone sequence represents a change in tectonic and/or climatic conditions. A local or regional unconformity is present at the base of the sequence and the character of the rocks is commonly substantially different. The climate was temperate and humid, and the groundwater level was very near the surface. The oxidation-reduction potential was low, which caused the carbonization of woody debris and the formation of pyrite, a condition also favorable for the precipitation of uranium and the other commonly associated metals. The depositional pattern of the aggrading streams was influenced by both tectonic and topographic elements of the area being buried.

Following deposition and burial further tectonic events induced changes in the hydrodynamic system which caused an invasion of the reduced sediments by an oxidizing cell that obtained much of its energy from the oxidation of the pyrite. The oxidizing cell mobilized the uranium and other susceptible elements and swept them ahead. Where the cell encountered resistance from variations in thickness of the sandstone units its progress was impeded, therefore areas of pinchouts or intertonguing of sandstone and mudstone tend to be favorable areas for the localization of uranium mineralization.

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LOWER CRETACEOUS ROCKS IN GULF COASTAL PLAIN OF UNITED STATES

Rocks of Early Cretaceous (Comanchean) age underlie most of the Gulf coastal plain. Their thickness varies from zero at the updip subsurface pinchout in the eastern region and less than 2,000 ft at the outcrop in central Texas to about 7,000 ft at the downdip limit of control.

Carbonates make up most of the section west of the East Texas embayment; alternating carbonates, terrigenous clastics, and some anhydrite compose the section in eastern Texas and adjacent parts of Louisiana and Arkansas; and sandstone and shale, with some beds of limestone and anhydrite, represent the Lower Cretaceous in the eastern region. The percentage of carbonates increases seaward in all segments of the Gulf Coast.

Deposition was in shallow open-sea to restricted marine, deltaic, coastal-interdeltaic, and coastal-plain

environments. Subsidence was generally at the same rate as sedimentation, and all sediments were deposited near sea level. The shoreline fluctuated greatly in the eastern clastic province but shifted little in the western carbonate region after the Early Cretaceous transgression. Deltas were constructed in several segments of the Gulf Coast during earliest Cretaceous, and in the central and eastern regions during several later regressive intervals.

The tectonic-sedimentation history of the Gulf Coast Lower Cretaceous was optimum for the development and preservation of abundant organic matter adjacent to deltaic sandstone and porous carbonate rocks, creating favorable conditions for petroleum occurrence.

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NEW GEOLOGIC MAP OF UNITED STATES—PROCEDURES AND TECHNIQUES USED IN AAPG GEOLOGICAL HIGHWAY MAP PROJECT

One of the AAPG projects is the preparation of a new Geological Map of the United States with a superimposed highway network. The map, on a scale of 1: 1,875,000, will include the 48 conterminous states. It is being published in 11 parts, each covering a region of approximately 270,000 sq mi, printed on a 28 × 36-in. sheet.

Six regional maps have been published and the remaining 5 are 25–75% complete. A new base map has been prepared from information furnished by the USGS. Information from the USGS, the various state geological surveys, and other sources is synthesized to produce the various elements on the map.

Approximately 50 overlays are prepared for the front side of each regional map. Good registry is achieved by use of a pin registry system. About 50 colors are used on each regional map; over 100 colors will be used in the series. The maps are printed on a 4-color press.

Upon completion of the series AAPG will have (1) a geologic map of the United States; (2) about 50 related columnar sections; (3) a geologic cross section network of about 19,000 mi in length; (4) a set of paleogeographic maps of the United States by epochs showing deposition, uplift, and igneous activity; and (5) a subjective tectonic map of the United States.

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TECTONICS AND SEDIMENTATION IN RELATION TO OCCURRENCE OF PROLIFIC CRETACEOUS OIL FIELDS

Many large new discoveries of oil and gas during the past few years have been made in Cretaceous strata. These fields occur in many parts of the world and have very similar reservoir and entrapment characteristics.

The worldwide orogeny near the end of the Early Cretaceous produced sharp uplifts, folding, epeirogenic warps, and a general marine regression to create a complicated paleogeography. Subsidence along shelf edges allowed accelerated reef growth, evaporites were deposited in the marginal supratidal sabkhas, and sandstones derived from granitic terrane or reworked from newly uplifted older strata were widely distributed. These features were subjected to erosion in many areas and then rapidly overlapped by the widespread Albian to early Late Cretaceous marine transgression which created 4 types of traps in which Cretaceous oil and gas accumulated: (1) Lower Cretaceous sandstone overlain by upper Lower Cretaceous evaporites (Cabinda B field, offshore west Africa), (2) upper Lower Cretaceous shelf carbonates (offshore Iran and southern Persian Gulf), (3) upper Lower Cretaceous or lower Upper Cretaceous deltaic and littoral sandstones overlain by deeper water marine shale (Bell Creek, Montana; Oriente Plain, Ecuador-Colombia; Western Desert, Egypt; Barrow Island, Australia; Tyumen Province, western Siberia), and (4) folded and eroded oil-producing Triassic, Jurassic, and Lower Cretaceous beds unconformably overlain by Albian to Upper Cretaceous strata (northern Alaska).

The late Early Cretaceous tectonic history indicates that numerous large petroleum accumulations in Lower Cretaceous to Cenomanian strata await discovery throughout the world.

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ORGANIC INFLUENCES ON CARBONATE CEMENTATION

The influence of organic matrices in the secretion of polymorphs of calcium carbonate by mollusks is well known. Recent work on the ultrastructure of coralline algae indicates that an organic matrix also must be involved in the secretion of high-Mg calcite by these plants. The matrices of coralline algae are on a much lower level of organization than the matrices of the mollusks.

Two genera of coralline algae have been studied using the scanning electron microscope. The genus *Lithophyllum* is characterized by a smooth lamellar ultrastructure which is parallel with the growth surface. The genus *Goniolithon* displays a rough lamellar ultrastructure in which the lamellae are parallel with the cell walls and consist of randomly oriented, blunt prisms of calcite.

It is known that organic molecules in solution are adsorbed onto mineral surfaces. Such adsorbed molecules could act as simple organic matrices and control the mineralogy of so-called "inorganic cements." Experiments have been conducted using completely inorganic chemical systems and systems of mixed organic and inorganic solutions. These experiments indicate that the presence of organic molecules in the system does exert a definite influence upon the mineralogy of the precipitated cements. Both calcite and aragonite cements have been produced in the laboratory under ambient temperatures and pressures.

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WATER CONTENT, VOID RATIO, AND SPECIFIC GRAVITY CALCULABLE FROM BULK DENSITY MEASUREMENTS OF COHESIVE MARINE SEDIMENTS

Bulk density is a property of importance in the study of consolidation and other geotechnical aspects of marine and freshwater sediments. It is readily measured by weight/volume or nuclear methods. In addition, several other important geotechnical properties may be computed from the measurement of bulk density.

An empirical relation exists between bulk density (γ) and water content (w) for water-saturated marine sediments. A polynomial expression has been calculated by regression techniques to fit measurements of these parameters on over 1,500 samples of cohesive