and moisture content which may be geologically significant. The newer photographic methods from earth orbiting satellites provide broad regional coverage that may reveal major geologic trends and features not apparent on conventional photography.

Airborne infrared scanners image the thermal radiation patterns of the earth's surface. Geologic applications that have been demonstrated for this new technology are (1) mapping faults, (2) distinguishing different rock types, (3) recognition of subtle structural patterns, (4) mapping near-surface groundwater distribution, (5) monitoring of volcanic areas, (6) detection of geothermal resources, and (7) monitoring of arctic sea ice.

Radar is a day or night technique that penetrates fog or clouds to provide strips of imagery with broad regional coverage and a uniform oblique illumination of the terrain. Radar has generated imagery of areas that hitherto have not been photographed from the air because of persistent cloud and fog cover such as in eastern Panama. The major geologic advantage of radar imagery is the enhancement of faults, fractures, and lineaments that may be obscure on other forms of imagery. The polarization capability of radar can discriminate subtle surface textural differences.

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DISTRIBUTION OF CARBONATES IN DEEP-SEA SEDIMENTS

Carbonate sediments, which consist largely of the skeletal remains of microplankton (calcareous nannoplankton, planktonic foraminifers, pteropods and heteropods) cover nearly 47% or 126 million sq km of the ocean floor. Their distribution is particularly dominant in the warm-water belt between approximately 45°N and 45°S and over submarine topographic elevations such as the mid-oceanic ridge systems and isolated seamounts. This distributional pattern is affected both by conditions controlling production of microplankton in the overlying surface waters and by their postmortem dissolution or destruction in the water column, either at the sediment-water surface or within the sediment column. In areas where the dissolution rate of carbonates exceeds supply, a "compensation condition" is reached and, in general, carbonates are not accumulating in depths greater than 4,000 m. Because of low productivity of calcareous microplankton in surface waters coupled with greater water depth, the lowest sedimentation rates of biogenous carbonates occur under the North and South Pacific central water masses. A general distribution pattern of carbonate sedimentation in the past can be pieced together on the basis of nearly 1,000 pre-Pleistocene piston cores and from the results of the U.S. Deep Sea Drilling Project. A considerable part of the abyssal floor once received calcareous sediment. Carbonate sediments were later replaced by clays as the basin deepened and the dissolution rate exceeded supply. The resulting facies boundary is broadly time-transgressive with increasing age away from the axes of the mid-oceanic ridge systems.

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INTERSTITIAL WATER COMPOSITION AND GEOCHEMISTRY OF GULF COAST DEEP SHALES AND SANDSTONES

Interstitial water from shales and sandstones shows a marked contrast in concentration and composition. Sidewall core shales were taken every 500 ft between 3,000 and 14,000 ft from a well in Calcasieu Parish, Louisiana, which encountered abnormally high fluid pressures just below 10,000 ft. Significant differences between the concentrations of water from normally pressured sandstones (63,000–180,000 mg/l TDS) and high pressured sandstone (16,000–26,000 mg/l TDS) were noted. Shale pore water has a lower salinity than the water in the adjacent normally pressured sandstone, but the concentrations are more similar in the high pressure zone. Shale pore water generally has a concentration order of $SO_4^- > HCO_3^- > CL^-$, whereas, water in normally pressured sandstone has a reversed concentration order. Water in high-pressured sandstone has low salinity with the HCO_3^- and SO_4^- concentrations being intermediate between the water from normally pressured sandstone and that from shale.

Conversion from predominantly expandable to nonexpandable clays accelerates near the top of the high-pressure zone which appears correlative with a major temperature gradient change, an increase in shale porosity (decrease in shale density), a lithologic change to massive shale, an increase in shale conductivity, an increase in fluid pressure, and a decrease in the salinity of the interstitial waters. These differences and correlations may have a bearing on the processes which alter subsurface waters, cause electric log responses, and could allow an understanding of the diagenesis and migration of petroleum.

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PETROLEUM POSSIBILITIES OF CENTRAL AND SOUTH AFGHANISTAN

Afghanistan is situated within a broad mobile belt extending mainly east-west between the old shield of Fennosarmatia in the north and Gondwanaland in the south. Four major geotectonic units separated by deep-seated fault systems can be recognized. These units are: (1) North Afghan-Tadjikian unit, (2) East Iran-Central Afghan unit, (3) East Afghan-West Pakistan unit, and (4) marginal region of the Indian shield.

In central and south Afghanistan the following blocks can be distinguished: East Iran-Central Afghan unit with the Farah block, Helmand block, and Seistan block; East Afghan-West Pakistan unit with Nooristan block; and marginal region of the Indian shield with Katawaz block.

None or only poor prospects exist for the discovery of economically exploitable occurrences of petroleum in the Farah, Helmand, Seistan, and Nooristan blocks. Petroleum possibilities are assumed to exist in the Katawaz block of southeastern Afghanistan.

The Katawaz block is the only one of southern Afghanistan in which a maximum of 9,000 m of Paleozoic, Mesozoic, and Paleogene sediments have been deposited on the basement. The facies are predominantly marine.

Potential reservoir rocks are probably represented by clastic strata deposited at the Cretaceous-Tertiary transition and by sandstones intercalated in the Paleogene sequence. Good to excellent trapping conditions could exist in regularly folded Oligocene anticlines as much as 50 km long. Depositional wedges within the subsurface Mesozoic and Paleogene formations could be present.

Seismic reconnaissance surveys would provide more

precise data pertinent to the existence of favorable structures.

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CALCIFIED ALGAL FILAMENTS IN REEFS: CRITERION OF EARLY DIAGENESIS

Calcified algal filaments are a prominent and probably diagnostic feature of the extensive syngenetic submarine cementation in recent Bermudan reefs. The filaments occur within millimeter- to decimeter-size cavities of the reef frame to depths of at least 12 m; they range from 20 to 300μ in diameter and are up to 5 mm long. The filaments are wormlike threads with lateral branching and commonly form an irregular meshwork which lines or fills the cavities; the meshwork commonly incorporates fine sediment that is in turn cemented.

SEM photographs show that the original filaments are enveloped by crusts, 5–150μ thick, of bladed to fibrous, outward-growing crystals that bear rhombs at their terminations. The internal casts of the filaments are inward-growing equant and bladed crystals. X-ray diffraction analyses indicate that the crystals are magnesium calcite with 16 mol % $MgCO_3$.

The filaments remaining after decalcification are *Ostreobium* sp., a widely distributed boring green algae characterized by variations in diameter of the filaments from 1–20μ, by a lack of transverse partitions, and by local swellings of the filaments. Individual filaments show both the boring habit and incrustation with magnesium calcite.

Whether the outward-growing crust around the filaments is the result of vital activities of the alga, photosynthesis, or boring, and whether the filaments provide an active organic matrix or a passive substratum to localize calcification have not been determined yet. However, it is clear that this type of cementation is submarine and early diagenetic; hence, similar calcified filaments in ancient reefs provide a criterion for and measure of early diagenesis.

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CRETACEOUS LITHOCLASTS IN MODERN BEACH AND RIVER SANDS, VERACRUZ, MEXICO

Abundant Cretaceous carbonate lithoclasts have been found in modern volcanic beach and river sands between Tecolutla and Punta Delgada, Veracruz, Mexico.

The major rivers (Río Nautla and Río Misantla) drain a volcanic terrane which also has outcrops of Lower Cretaceous cherty micrite (Tamaulipas Formation). The stream sediments are composed primarily of volcanic rock fragments and quartz except just downstream from the carbonate outcrop where lithoclasts may make up 50% of the stream sediment. The lithoclast content then drops to 10% at the river mouth.

Micritic lithoclasts make up 35–60% of the beach sands, the rest being volcanic rock fragments and quartz. The lithoclast content increases irregularly from south to north, but drops to 20% or less at the river mouths. Volcanic rock fragment trends are opposite. Wind concentrates the lithoclasts in dunes and the upper beach backslope. The lithoclast percentage is directly proportional to grain size.

The lithoclasts probably were delivered to the coast at a time when the gradient was steeper and/or the climate drier. They are presently being mixed with volcanic debris brought in by the river system and a northward-flowing longshore current.

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GYPSUM—ENVIRONMENTAL INDICATOR IN EVAPORITES

Crystal habit and textural relations of early gypsum, or pseudomorphs after early gypsum, can provide useful indices of subenvironments of evaporite deposition. Attention is directed to the environmental significance of such features of the gypsum as crystal habit, primary versus replacement origin, free versus attached growth, mechanical force of crystal growth, and orientation.

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DELTAIC DEPOSITS OF UPPER PART OF DAKOTA FORMATION (UPPER CRETACEOUS), CENTRAL KANSAS

Sedimentary deposits within the upper 40–100 ft of the Dakota Formation exposed in Russell County, Kansas, record deposition in an environmentally diverse deltaic setting developed during the initial stages of the Greenhorn marine cyclothem. The lower two thirds or more of the Dakota (200–300 ft thick in central Kansas) consists predominately of nonmarine kaolinitic mudstone and discontinuous channel sandstone lenses; however, the upper part contains a complex of fluvial-deltaic, delta-plain and marginal-marine lithofacies, which grade upward into the shallow-water marine Graneros Shale. Such lithofacies have been mapped in detail and can be differentiated according to macroinvertebrate and trace-fossil assemblages, sedimentary body geometry and lateral depositional relations, sedimentary structures, and petrology.

The sedimentary complex in Russell County is dominated by an elongate fluvial-deltaic channel sandstone which changes within 30 mi from a highly meandering, trough-shaped fluvial sandstone body containing freshwater mollusks to a tabular-wedge shaped, delta-front sandstone body containing freshwater to brackish-water macroinvertebrates and a variety of trace fossil types. Kaolinitic floodplain deposits containing abundant plant fossils most commonly are laterally associated with channel sandstones; however, within the upper 20–30 ft of the formation, freshwater lignitic coal-swamp facies and freshwater to brackish-water sideritic clay-ironstone swamp facies are common. Locally, laminated to highly burrowed delta-marine and strandline marine sandstones are present. These contain a diverse association of marine macroinvertebrates and an abundance of trace fossil types. The deltaic facies grade upward into the fossiliferous, glauconite-rich marine sandstone and montmorillonitic shale of the Graneros.

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BUDGET OF CALCIUM CARBONATE SEDIMENTATION, SOUTHERN CALIFORNIA CONTINENTAL BORDERLAND

Although calcareous organisms are abundant in temperate waters of the southern California continental borderland, $CaCO_3$ is a relatively minor constituent of the sediments. Noncarbonate dilution provides only a partial explanation. Estimating rates of particulate $CaCO_3$ mass transfer to or from that