

bution by several causes, volcanic maxima can be correlated between cores separated by up to 2,000 n. mi. Paleomagnetic, micropaleontologic, and sedimentologic methods have been used.

The glass shards are mostly transparent, bubble-walled or platy in shape, and are silt size or smaller. The grain-size distribution of glass strongly parallels that of other sedimentary constituents wherever submarine transport or prolonged bioturbation has occurred, as determined by X-ray radiography. Concentration of glass also varies systematically with minor sedimentation-rate fluctuations, as independently shown by variations in microscopic manganese nodules and ice-rafted debris concentrations. Utilization of fine volcanic glass by siliceous plankton has resulted in productivity and diversity changes, and, perhaps, a corresponding modification of the glass distribution. High-power transmission and scanning electron microscope methods show that the relative amounts of glass finer than 10 microns decreased rapidly during volcanic episodes.

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SEDIMENTATION ON CRETACEOUS OCEAN RIDGE, TROODOS MASSIF, CYPRUS

The igneous rocks of the Troodos massif have been interpreted as an uplifted segment of Cretaceous ocean crust, formed at a spreading ridge. If so, the sediments overlying them should be similar to those forming at ocean ridges and to Tertiary basal sediments found by JOIDES drilling. Directly above the Troodos pillow lavas are iron- and manganese-rich mudstones ("umbers") that are closely comparable to the iron-rich sediments associated with the latest stages of volcanism on present ridges. They are enriched in trace elements, including copper, molybdenum, lead, zinc, and vanadium. These mudstones pass upward into Campanian radiolarites and radiolarian mudstones with a diverse and well-preserved siliceous microfossils. Silica diagenesis can be compared with that of deep-sea cherts. In the simpler sequences, the radiolarian rocks are overlain by Maestrichtian chalks.

In some areas, illite-montmorillonite clays above the radiolarian mudstones include major developments of *mélange*, with transported blocks of diverse Mesozoic sedimentary and igneous rocks. These include quartz sandstones of continental derivation. Chalks also overlie the *mélange*. The umbers, radiolarites, and chalks are interpreted readily as oceanic sediments, and the presence of the *mélange* implies proximity of a continental margin.

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COAL GASIFICATION DEVELOPMENTS

The production of pipeline quality gas from coal will become an important source of supplementary gas by 1990 when more than 3 Tcf/year are expected to be available. By the year 2000 the total may reach 8 Tcf/year; that is, 40% of present gas consumption. Elements such as coal quality and cost, plant location, water environment protection, and others contribute to the cost of gas.

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STRATIGRAPHY AND DIAGENESIS OF NIAGARAN PINNACLE REEFS (SILURIAN) IN NORTHERN MICHIGAN BASIN

In the Michigan basin, the Middle Silurian Niagaran reef facies directly underlies the Upper Silurian Salina evaporite facies. The basal Salina Formation includes the A₁-evaporite, subjacent to the A₁-carbonate and the A₂-evaporite in succes-

sive order. Subsurface study of 40 drill cores disclosed that most of the Niagaran pinnacle reefs in the inner-basin slope environment ceased growth by A₁-evaporite time and were regenerated during deposition of the A₁-carbonate.

The uppermost section of the algal stromatolite and algal boundstone facies at the top of the pinnacle reefs was deposited contemporaneously with the A₁-carbonate of the off-reef section. The algal-stromatolite facies of the A₁-carbonate overlies the A₁-evaporite on the reef flanks and extends laterally to the off-reef facies in the vicinity of the pinnacle reefs. The general lithology of the A₁-carbonate in the off-reef sections differs greatly from the lithology of the A₁-carbonate reef facies.

Some of the pinnacle reefs apparently continued to grow during the early formation of the A₂-evaporite. There is no significant erosional contact between the A₂-evaporite and the algal stromatolite at the top of the reef. Furthermore, LLH- and SH-type algal stromatolites show repeated stages of growth *in situ*, within the lowermost few feet of the A₂-evaporite section.

A vadose zone representing subaerial exposure is present in the pinnacle reefs at the top of the organic reef facies, which overlies the basal biohermal facies. This zone is characterized by a more complex sequence of diagenesis than either the basal biohermal facies or the uppermost algal stromatolite facies.

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UNSOLVED PROBLEMS CONCERNING ORIGIN AND MIGRATION OF PETROLEUM

Current research suggests that most of the hydrocarbons in petroleum are formed from the organic matrix of sedimentary rock at depths greater than 5,000 ft. The increased generation of light hydrocarbons with depth is offset by decreases in the permeability of source beds and in the volume of migrating fluids. Empirical field studies may outline source-reservoir relations, but the mechanisms by which the hydrocarbons originate, migrate, and accumulate still are poorly defined.

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CALICHE SOIL HORIZONS ON OOLITIC SHOALS AND CARBONATE MUD MOUNDS IN CARBONIFEROUS (NEWMAN LIMESTONE) OF EASTERN KENTUCKY

A sequence of oolitic calcareous grainstone shoals and calcareous wackestone and packstone-bank and interbank deposits is exposed near Olive Hill, Kentucky. The shoals and banks underwent periods of exposure, as they are capped by beds that represent stages of deposition or caliche weathering in the supratidal zone. The caliche weathering zones are similar to those found on Caribbean Islands and in the southwestern United States.

The first type of caliche zone is analogous to the subaerial crusts of the Caribbean area. These crusts are brecciated, often silicified, laminated calcareous mudstones which formed on and within the shoals and mud mounds. They are present as beds or coat fractures which transect bedding planes. Petrographic characteristics include microbrecciation, grains coated with laminated or dense micrite, extensive micritization, pelletoid fabrics, root tubules, and micrite and yellowish-brown spar cements.

The second caliche type, similar to those of the southwestern United States, is a nodular, brecciated calcareous mudstone that developed from supratidal and intertidal calcareous muds. The basal part of this caliche unit is a fossiliferous, but intensely brecciated, parent rock; this zone grades upward into a nodular sequence which may be capped by a thin-brecciated, laminated crust. Original depositional fabrics have been obliterated in the nodular section; the nodules are composed of micropor containing breccia clasts and root tubules, and are disrupted by subhorizontal fractures. Both caliche types display