vated hexagonal apertural crown; and *M. horodyski* has an inflated, turbanlike triangular margin at the oral end. All forms possess an equilateral triangular, or, more rarely, a circular operculum.

Associated microfossils include the acritarchs *Chuaria circularis* and *Trachysphaeridium levis* and a cyanophytic assemblage of solitary and colonial forms. The melamocyrillid acritarch community is significant for three reasons: (1) these forms apparently represent a morphologically and biologically advanced grade of organization heretofore unrecognized in Precambrian microfossils; (2) they could prove useful for regional and perhaps global biostratigraphic correlation of upper Precambrian strata; and (3) they provide another example of the usefulness in studying shale environments, in addition to silicified stromatolitic chert environments, to gain a better understanding of the biologic diversity of late Precambrian seas and of the dating of significant evolutionary events.

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Upper Triassic Radiolaria from Eastern Oregon and Queen Charlotte Islands, British Columbia

Radiolarian-bearing rocks have been collected from eastern Oregon (Rail Cabin Formation) and the Queen Charlotte Islands, British Columbia (middle member of the Kunga Formation). The Rail Cabin Formation consists predominantly of 365 m of thin-bedded, manganiferous argillite. The middle or black limestone member of the Kunga Formation consists of 210 to 280 m of thin-bedded, black carbonaceous limestone with minor amounts of black argillite.

The Rail Cabin Formation can be subdivided into two zonal units based on radiolarian biostratigraphy: a lower *Mostlerium* Zone (?Karnian, early Norian to late middle Norian) and an upper *Pantanellium silberlingi* Zone (late middle to late Norian). Samples from the middle member of the Kunga Formation contain radiolarians which are indicative of the *Pantanellium silberlingi* Zone. Norian ages for both radiolarian zones have been confirmed primarily by associated pectinacid bivalves.

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Developmental Phases in Lagoonal Patch Reefs—Implications for Paleozoic Bioherms, or New Models for Reefs

Observation of modern reefs indicates that lagoonal patch reefs may provide a more useful model for Paleozoic bioherms than conventional fringing or barrier-reef models.

Most Paleozoic bioherms develop within inland basins or seaways surrounded by continental masses. Adjacent lands contribute varying quantities of fine clastic material to "reef"-derived carbonate rocks. Thus, bioherms are commonly associated with micrite or calcareous shales and mudstones. Few Paleozoic bioherms occur on coarse-grained carbonate substrates similar to those of modern fringing or barrier reefs. Rather, the bioherms generally appear to have had a mud substrate like that common in modern lagoonal settings.

Similar development of modern lagoonal reefs and Paleozoic bioherms further strengthens the proposed model. Development of many Paleozoic bioherms progresses from an initiation phase of substrate stabilization, to a diversification phase, and finally to a termination phase dominated by a single group of organisms. Modern lagoonal patch reefs have been observed to develop in an identical manner in response to rapid fluctuation in sedimentation, a common condition in the lagoonal environment.

In addition to substrate and developmental phases, there are other implications of a lagoonal model for Paleozoic bioherms. Reduced light penetration causes modern lagoonal coral and algal associations to occur in shallower water than predicted. Also, increased suspended matter results in dominance of sponges over corals in the lagoon.

Recognition that lagoonal patch reefs exhibit developmental phases and substrate characteristics similar to those described for many Paleozoic bioherms demonstrates the potential importance of replacing conventional models with lagoonal patch reefs when examining Paleozoic bioherms.

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Influence of Rate on Demand and Use of Natural Gas in California

In the past 2 years innovative changes in rate structure for customers of California's utilities have led to significant changes in demand and end uses of natural gas in the state. Passage of the Miller-Warren Lifeline Act in 1975 has led to subsidies to residential users that have been balanced by inversion of rate schedules for large users and higher rates to interruptible industrial customers. Fuel switching from natural gas to other fuels, principally oil, has been extensive in the last few years owing to the depressed prices associated with No. 6 and No. 2 fuel oil on the West Coast. Because 87% of California gas is imported from Canada and the southwest on all-year contracts, summer surpluses are materializing. A benign 1977-78 winter, together with loss of summer industrial customers has led to load management problems which were solved by increased use of natural gas for electrical generation in 1977 and 1978.

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Vitrinite Reflectance, Present Rock Temperature, Laumontite Occurrence, and Burial History in Los Angeles and Ventura Basins, California

Coordinated research on vitrinite reflectance, rock temperature, first occurrence of laumontite, and burial history at five sites in the Los Angeles basin and one in the Ventura basin resulted in significant findings regarding late Miocene and younger rocks. Data from 17 boreholes (reaching as deep as 5,800 m), including 110

samples of conventional core, were studied. We believe that the present temperatures are maximal in the history of these late Miocene and younger rocks. The determined gradients are 24 to 35°C/km and 0.033 to 0.090% vitrinite reflectance per kilometer.

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Ichnology and Depositional Environments of Upper Cretaceous Chalks, Southwestern Arkansas (Annona Formation; Chalk Member, Saratoga Formation)

Both Annona and Saratoga chalks were deposited during transgression of middle to outer-continental-shelf environments. The basal contact of each chalk is a discontinuity surface underlain by marl. At these contacts chalk was piped across the discontinuity into marl through omission and postomission-suite burrows. Taxonomic composition of chalk-filled burrows below the Annona basal contact changes along a 60-km outcrop belt from dominance by *Thalassinoides* in the northeast to dominance by *Zoophycos, Planolites,* and *Chondrites* in the southwest. Such change indicates that this discontinuity surface was formed on a relatively steep slope which dipped southwest. Conversely, taxonomic composition of chalk-filled burrows below the Saratoga basal contact is unchanging (primarily one species of *Thalassinoides*) over a 90-km outcrop belt, thus indicating that this discontinuity was formed on a relatively shallowly sloping surface.

The basal 0.2 to 2.0 m of each chalk is a condensed bed rich in phosphate nodules and glauconite. Saratoga chalk was deposited at shallower depths, is generally much coarser grained, and contains more terrigenous detritus than Annona chalk. Saratoga quartz silt and sand may have been transported from a more shoreward area by poststorm seaward-directed currents.

The trace-fossil assemblage within the Annona, consisting primarily of *Planolites, Zoophycos,* and *Chondrites,* is similar to that documented from modern deep-sea carbonate oozes. Bioturbation within the Saratoga chalk is preserved only as mottles. Thixotropic preservation and large size burrows in each unit indicate that during deposition these chalks had very soft substrates and that oxygen content was not limiting.

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Retrogradational Shelf Sequence—Upper Cretaceous (Campanian-Maestrichtian) Cape Sebastian Sandstone, Southwestern Oregon

In the tectonically active Circum-Pacific belt, thick retrogradational ("transgressive") sequences are not uncommon, in contrast with the Cretaceous of the Western Interior. Retrogradational sediment packages reflect rapid sedimentation rates but even more rapid rates of relative sea-level rise. A well-exposed and convincingly documented example is the Cape Sebastian Sandstone, a 250-m-thick, fining-upward sequence representing foreshore to offshore accumulation.

Progressively increasing depth of deposition is reflected in both physical and biogenic sedimentary structures in the Cape Sebastian Sandstone. The basal, shelly boulder conglomerate is overlain by trough-cross-bedded pebbly sandstones, plane-laminated coarse-grained sandstones, and graded conglomerates. A single, subvertical trace-fossil type is locally abundant. These sediments represent foreshore to nearshore depositional environments.

The middle and bulk of the formation comprises hummocky cross-stratified sandstones. Grain size, frequency of pebble lenses, and thickness of hummocky laminae decrease upward. Burrowed zones, diversity of burrows, plane-laminated zones, plant debris, and oscillation-ripple preservation increase upward. These sediments reflect storm-influenced, inner-shelf sedimentation.

The uppermost part of the formation consists of alternating laminated, fine-grained sandstones and progressively thicker, burrowed sandy siltstones. Increased trace-fossil size and diversity, as well as abundant plant debris, characterize these sediments, which represent an outer-shelf sedimentary environment.

Modern examples of the described structures have been observed off the Oregon and California coasts, corroborating the hypothesis that the Cape Sebastian Sandstone represents a retrogradational shelf sequence. Also, evidence for Late Cretaceous faulting in southwestern Oregon supports the proposition that thick, retrogradational sequences may be deposited in tectonically active regions.

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Hurricanes and Rainfall—Key for Dolomitization in Tidal Flats of Western Andros, Bahamas

The geomorphology, sedimentology, and diagenesis of the tidal flats of western Andros, from Williams Island to Wide Opening, are controlled by hurricanes which transport pellet mud from a subtidal accumulation zone to the supratidal zone where diagenetic processes begin under humid, tropical weather conditions.

The directions of hurricane tracks (statistically determined) since 1871 show preferential orientations which coincide with hummock orientations. Thus, hummocks are interpreted as "traînées cycloniques," or hurricane trails.

Between these hurricane trails (hummocks), seawater and rainfall fill tidal and polyhaline (18.00 g/L to 30.0 g/L) estuaries and channels, as well as tidal and mesohaline (5.00 g/L to 18.00 g/L) basins. Below sea level and away from tidal influences, oligohaline lakes and ponds (0.00 g/L to 5.00 g/L) contain living Charophytae.

Diagenesis with lithification, cementation, or dolomitization occurs around the hurricane trails, particularly in white, thick dolomitic polygons of dry sediments. It thus appears that the very early dolomitic diagenesis in the Bahamian tidal flats can be correlated with (1) a high supratidal position resulting from hurricane action and, consequently, (2) the phreatic lenses of the tidal flats which produce oligohaline and hypersodic lakes and ponds rich in Na^+, Ca^{++}, K^+, and HCO_3^- ions. An intermediate phase could either be a transitory mag-