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Model for Interstitial Sulfate Reduction and Methane Production

Interstitial sulfate and methane profiles measured from a piston core taken near the Mississippi River mouth indicate that sulfate is reduced to near-zero concentrations between 1.5 and 2.0 m depth and that methane consequently increases. In the sulfate-reducing zone, $\delta^{13}\text{C}$ values of the methane decrease downward from -53 to -80 parts per thousand versus PDB. From these observations, a comprehensive kinetic model has been developed incorporating the effects of diffusion, the sediment accumulation, and the effects of bacteria on sulfate and methane. The model, in which isotopic variations of methane are considered to be the key, indicates that methane is microbially consumed in the sulfate-reducing zone and is extensively produced below the zero-sulfate depth. Rates of production and consumption of methane, as well as reduction rates of sulfate, can be estimated from the model.

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Environmental Geology of Continental Margin Off Central and South Texas in Atlas Format

Integrated environmental studies keyed to understanding fundamental processes and their interrelations were conducted from 1974 through 1977. Most of the aspects investigated were sampled seasonally to provide data on variations within each year and among the 3 years studied.

The geologic and related hydrographic, biologic, and chemical data have been compiled in an atlas format consisting of topical overlays so that interrelations are apparent. Three atlases, each covering a geographic area of $2^\circ \times 1^\circ$, have been completed: Port Isabel, Corpus Christi, and Beeville. Each, in addition to bathymetry and the lease-block grid, consists of seven topical maps: location of oil and gas fields and production installations; water circulation and rates of sedimentation; trace-metals content and texture of surficial bottom sediments (plus seasonal variations); nature of shallow subsurface sediments and biogeology; post-Wisconsin sedimentation patterns and tectonism; late Pleistocene and Holocene depositional environments; and structure of the continental terrace with emphasis on the chronology of faulting and seafloor stability.

Results of the study indicate that water circulation is strongly seasonal, but both local variations and differences in surface and bottom movement are evident. Sedimentation rates have been relatively high throughout the Holocene, averaging almost 1 m/1,000 years; rates now are as much as 9 mm/year locally, based on ^{210}Pb dating. Seasonal differences in both the texture and trace-metals content of surficial bottom sediments are characteristic and probably can be related to variations in infaunal activity and movement of bottom sediments. Faulting has migrated progressively seaward across the shelf with time; movement during the Holocene has been mainly near the shelf edge. Slumping has

been extensive along parts of the outer shelf and on the upper continental slope.

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Lithofacies Analysis of Castile Formation, Delaware Basin, Texas and New Mexico

Walther's law of correlation of facies can be illustrated by the facies associations of the Castile Formation (Upper Permian) in the Delaware basin of Texas and New Mexico. Two major stratigraphic successions are represented by two lithofacies composed of calcite-anhydrite laminations in the western part of the basin intercalated with carbonate-laminated, anhydrite-halite bands in the eastern two-thirds of the basin. Organically rich layers are common to all the laminae types. The laminations were formed simultaneously over a large area of the basin at a relatively constant rate. The alternating laminae of the two components forming side by side in the two lithotopes (areas of uniform deposition) are interpreted as representing an annual layer of sedimentation, a varve. The lateral and vertical persistence of the varves provides the best model of rock correlation where time lines are well established by applying statistical-correlation techniques to stratigraphically correlated laminations. All the primary characteristics of the two lithofacies—their gross appearance, sonic and electric-log properties, trace-element contents, petrologic variations, and component associations—are significant in determining the depositional environment of the Delaware basin.

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Melamocyrrillium—New Acritarch Genus from Kwagunt Formation (Late Precambrian), Chuar Group, Grand Canyon Supergroup, Arizona

Distinctive, well-preserved, and abundant microfossils of uncertain taxonomic and biologic affinity have been discovered in acid-resistant residues and thin sections from shales of the Walcott Member of the Kwagunt Formation (late Precambrian) of the eastern Grand Canyon, Arizona. These forms are referred to the new acritarch genus *Melamocyrrillium*; however, these present forms are morphologically different from previously reported acritarch genera and do not comply with any existing, suprageneric, acritarch classification scheme. *Melamocyrrillids* are organic-walled, opaque, unilocular and apparently unicellular, bulbous- to lachrymiform-shaped, vesicular, solitary microfossils. They range from 32 to 170 μm in length and have a length-to-width ratio ranging from 1.0:1 to 2.7:1 ($N=600$). Symmetry is bilateral or, more rarely, radial (longitudinal axis of symmetry). Furrows, basal scars, and evidence of surficial processes are lacking; chain and colonial forms are absent. The wall is dense, thick (5 to 7 μm), apparently unilayered, and has a psilate to faintly microgranular texture. Excystment is by a pylome. Three species are recognized: *M. fimbriatum* is characterized by a fringe which skirts the oral end; *M. hexodiadema* has an ele-

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 *Chuarica circularis* and *Trachysphaeridium levis* and a cyanophytic assemblage of solitary and colonial forms. The melamocryllid 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, manganeseiferous 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