duction. Braided streams breached low areas along the algal-mound trend and deposited distal fan-delta sediments on the shelf basinward of the mounds. Coarse conglomeratic sandstones were deposited directly on carbonates, but do not show a progradational, coarsening-upward sequence. Carbonate deposition recommenced following waning of clastic influx and subsidence of the fan delta. Algal mounds developed preferentially on shallow platforms built by the previous cycle of clastic deposition. Distal parts of the two youngest fan-delta cycles were reworked along strike, and terrigenous grains were oolitically coated in high-energy oolite shoals.

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Environmental Adaptations of *Elphidium subarcticum*

Elphidium subarcticum Cushman, a free, benthic, hyaline foraminifer, has been observed in several localities encrusted with extraneous material and adapted to an attached mode of life. The protozoan appears to secrete an organic sheath upon which foreign material is either agglutinated or precipitated. Several forms were acidized and one that was heavily encrusted and firmly attached on its side to a quartz grain left an internal residue of an organic matrix and a cyst-like sheath of flexible organic material. This sheath is composed of loosely interlocked, silt-sized quartz particles. Scanning-scope photos of the unacidized encrusted form reveals a random arrangement of carbonate particles of various sizes.

E. subarcticum may be strengthening its test in response to stresses in the environment. The attachment of the foraminifer on rock fragments is interpreted as an adaption in a high-energy environment.

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Field and Experimental Studies of Biogeochemical Processes Governing Diagenesis in and near Reefs, Gulf of Elat, Red Sea

Carbonate cementation in the surface layer of reefs and beachrock eliminates porosity and partly replaces detrital quartz grains. The uptake and release of CO_2 by photosynthesis and respiration in reef communities cause a shift in the carbonate buffer system of seawater. Field studies and experimentation show minimum values of CO_2 (1.9 mmol/l) and HCO_3^- (2.4 Meg/1) in association with maximum values of pH (10) and O_2 (> 100% saturation) in waters covering corals and alga prior to sunset. The converse is true for these variables prior to sunrise, when minimum values of pH (7.6) and O_2 (< 66% saturation) occur with maximum values of CO_2 (2.7 mmol/l) and HCO_3^- (2.8 Meg/1). Experimental tanks containing plain seawater showed almost no diurnal variability in pH (a constant 8.0) or O_2 (~ 58% saturation) measurements. Seawater adjacent to reef biomass with elevated pH and supersaturated with calcium carbonate is pumped into the underlying reef rock and beach rock where carbonate precipitation and quartz dissolution occurs. As the system equilibrates, pH values progressively decrease.

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Oblique Ripples on Permian Point Bars in North-Central Texas: Helical Flow or Boundary Effect?

Fine-grained point-bar deposits are well-exposed both in cross section and in exhumed epsilon cross-beds. Above a basal lag of intrabasinal caliche and mudstone clasts, the epsilon cross-beds consist of cross-laminated very fine sand grading laterally and upward into mud. The epsilon cross-beds dip from 10 to 25°, are up to 2.5 m high and 15 m wide, and show a meander radius of curvature of 45 to 500 m, as measured on aerial photographs.

Sandstones in the epsilon sets are almost invariably structured into straight to slightly sinuous-crested ripples which are oriented obliquely, from 25 to 50°, to the main channel axis as inferred from the strike of the epsilon surface. The obliquity of these ripples greatly exceeds that of basal fluid flow related to a helical cell based on theory as well as observations of both experimental and natural stream conditions. An earlier study of the Muddy River, Wyoming, explained oblique bed forms by variation in boundary shear-stress.

The steep transverse slopes, probably resulting from the fine-grained sediment load of the Permian rivers, are associated with increasing downstream sediment transport and ripple migration rates at progressively lower levels on the point bar. Thus bed-form orientation in this situation may reflect boundary conditions rather than the local flow directions.

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Tectono-Climatic Model for Origin of Devonian-Mississippian Black Gas Shales of East-Central United States

Devonian-Mississippian black gas shales in east-central United States form a distinctive stratigraphic interval reflecting low clastic input, high organic productivity, and anaerobic conditions in a stratified inland equatorial sea. These conditions apparently originated because of interactions between tectonic and climatic factors unique to North America at this time.

The "Black-Shale Sea" developed over an expanse of slowly subsiding craton west of the Acadian mountains. These mountains provided the major source of clastics to the sea and periodically formed high orographic barriers crossing the paleoequator. Subsidence on the adjacent craton, particularly in the marginal foredeep (Appalachian foreland basin), accompanied uplift in the Acadian range. When uplifted, these mountains created barriers to moisture-laden, easterly trade winds, forming a rain shadow west of the mountains and reducing clastic input to the "Black-Shale Sea." Clastic input reduced, deposition of organic-rich muds dominated. Concomitant subsidence caused this sediment-starved sea to transgress over the Catskill delta and other parts of the craton.

During tectonic quiescence, subsidence slowed and the mountains were erosionally lowered sufficiently that the trade winds crossed and delivered precipitation to the mountains causing increased clastic influx and westward deltaic progradation into the "Black-Shale Sea." Seven major cycles of alternating black shale and deltaic clastics occur in the Catskill delta. Few of the progradations migrated beyond the foredeep, hence, sediment-starved conditions persisted in western parts of the sea.

The equatorial nature of the sea and progressive deepening within it created a stratified water column (pycnocline) that prevented oxygenation of deeper bottom waters. Organic-rich muds deposited there were preserved in the anaerobic conditions that resulted. Eventually, the sea deepened sufficiently that upwelling phosphate-rich, oxygen-poor, oceanic waters entered locally from the continental margin.