base is consistent. Strong regional trends are also present for the calcium carbonate fraction and the aragonite/calcite ratio on the shelf south of Cape Hatteras. The existence of a nearshore zone of present sediment reworking, longshore clastic transport, and skeletal comminution is implied by the low $CaCO_3$ values along the coastline.

Generally, the combination of cluster, ordination, and trend surface analysis proves to be an excellent strategy for the extraction of sedimentary trends, particularly where local variations obscure the regional gradient.

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Equilibrium in Modern Coral Reefs, Western Gulf of Mexico—Role of Ecology and Ostracod Microfauna

Two groups of modern patch reefs exist off Veracruz, Mexico. Terrigenous sediments of the Rio Jamapa are being deposited between the two complexes. Longshore drift of these sediments is causing declining coral growth on the southern group (Anton Lizardo), whereas corals on the northern group (Veracruz) are thriving. These differences in coral vitality should be reflected in the water chemistry and microfauna. Environmental data (depth, salinity, pH, temperature, Eh, and dissolved oxygen) were collected and treated as random samples from populations whose normality was established by chi-square goodness-of-fit tests. Chi-square testing at the 0.01 level demonstrated that, out of the six sample populations, only depth, pH, and dissolved oxygen were distributed normally. Depth, pH, and dissolved oxygen data were assembled into two populations representing the Veracruz and Anton Lizardo groups. This permitted us to test the null hypothesis that the variances of the respective populations were equal ($F = 0.005$ level). The variances were found to be equal. T tests (0.01 level) on the population-means of depth, pH, and dissolved oxygen of both Veracruz and Anton Lizardo groups disclosed that there is no significant difference between the two groups of reefs in terms of these characteristics. However, the mean-percent relative abundance of the most common ostracod species (*Loxocorniculum tricornatum*) on both reef complexes is significantly different. Ostracod species dominance also differs radically between the two groups. Therefore, ostracod species abundance and dominance are more sensitive indicators of reefal equilibrium than the environmental parameters themselves.

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Nature and Field Application of Plumose Structures

Development of plumose structures in brittle rocks has been investigated by analogy to fracturing experiments on glass and ceramic bodies. Plume morphology shows that structures commonly lumped as plumose are a composite of discrete features, formed at all scales, during fracture propagation.

Inclusion hackle forms when an advancing planar fracture front becomes locally distorted at an inhomogeneity. The planar fracture, locally split by the inclusion, does not rejoin in a single plane behind the inclusion. This causes the lagging fracture portion to curve into the leading one forming a steplike tail elongate in the propagation direction. Twist hackle forms when a fracture front abruptly encounters changed stress directions along an extended frontal section. The entire fracture front breaks into individually advancing en echelon twist-hackle faces, each face perpendicular to the new resultant principal tension. Faces diverge and are elongate in the propagation direction. The faces form hackle steps by curving into each other to complete separation. Velocity hackle, uncommon in rocks, forms at a limiting propagation velocity.

Plume axes mark areas of greatest tensile stress and lightest propagation velocities. Plume asymmetry indicates intrastratum fracturing stress distributions. Axes consistently at the top or bottom of each stratum in a layered sequence indicate overall downward and upward (perhaps basement induced) propagation directions respectively. Recognizing twist-hackle faces and steps as differently oriented planes produced by a single fracture event eliminates identification and misinterpretation of false fracture sets.

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Fractographic Distinction of Coring-Induced Fractures from Natural Cored Fractures

Fracture surface structures (hackle plumes, arrest lines, origins) on coring-induced petal-centerline and disc fractures from three Appalachian Devonian shale cores indicate fracture sequence and propagation directions, relative propagation velocities, and tensile-stress distributions at failure.

Surface structures on coring-induced fractures are symmetrically and dimensionally related to the core. In contrast, surface structures on natural fractures, originating away from the core, are asymmetric and oversized. Plume asymmetry shows that stress intensity across natural fractures varied vertically during propagation.

Curviplanar petal-centerline fractures are propagated downcore as shown by convex downward arrest lines and hackle plumes that diverge downward about the core axis. Inclined petal sections curve to vertical from core margin toward core center. Some petals continue to spread vertically downcore, forming the centerline section. Petal-centerline fractures can change downcore from one preferred orientation to another, indicating differing orientation of stresses and thus of any fractures induced in a stimulation program. Petal curvature, absence of cored origins, and the 15-cm curvature radius of closely spaced arrest lines show that petal-centerline fractures originated in front of the bit's cutting surface. Chipped right-hand core to fracture margins, produced by plucking action of the bit, and arrest line-hackle morphology show these fractures were drilled through after propagation.