and a small percentage of planktonic Foraminifera. *Globorotalia fohsi, G. mayeri, G. menardii,* and other planktonic species are sinistrally coiled. The change from random to predominantly sinistral coiling coincides approximately with the inception of Harang deposition (±12-14 m.y. B.P.). The faunal assemblages indicate a muddy-water, outer neritic to bathyal environment, and suggest a cool water mass. The apparent anomaly of a cold-water fauna in this stratigraphic position in this area might be explained by upwelling, paleogeographic changes, and/or significant Miocene refrigeration.

During the time span that includes Harang deposition, continental glaciation in Antarctica, cold-water invertebrate faunas, cool-climate floras, and other evidences of cool climate in many parts of the world indicate mid-Miocene refrigeration. Although some conflicting evidence also exists, we conclude that the distinctive characteristics of the Harang biofacies are related to a cool water mass which was part of a worldwide cooling phenomenon.

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Recent work in the Canadian Cordillera has led to the formulation of several models for its tectonic evolution. These models can be tested by relating the structural evolution of the crystalline core zones and fold belts to the depositional record of the orogenic foredeeps and successor basins. They require a comprehensive understanding of paleodrainage. The arcuate geometry of orogenic belts places the principal structural constraint on the evolution of late orogenic drainage patterns. Like other mountain belts, the two orogens of the Canadian Cordillera (Pacific orogen in the west, Columbian orogen in the east) consist of a chain of structural salients and reentrants. During the growth of folds and thrust faults, the structural reentrants constituted the shortest connection between the rising core zones and the subsiding foredeeps and successor basins. Streams issuing through the reentrants, therefore, were the first to capture the longitudinal drainage which evolved during the growth of the fold belts and became the most important suppliers of clastics to the late-orogenic basins. This "reentrant principle" can be illustrated on a regional tectonic scale with the Peace, Liard, Eagle Plain, and Chukachida reentrants of the Columbian orogen. Local examples are used from near Crowsnest Pass, the Spatsizi Plateau, and the Fraser River. From the structural salients, predominantly small, though locally vigorous, streams issued directly into the late orogenic basins. Therefore, simple straight drainage lines connecting source areas and clastic basins were probably valid only for the earliest stages of uplift in the Canadian Cordillera. Later growth of folds and thrust faults produced curved or even U-shaped river systems, which merged near reentrants and effected thorough mixing of compositionally diverse sediment loads.

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RELATION OF INVERTEBRATE DEATH ASSEMBLAGES TO LIVING BENTHIC COMMUNITIES IN RECENT CARBONATE SEDIMENTS ALONG EASTERN YUCATAN COAST

The fidelity of the fossil record for paleoecological studies often is questioned. This investigation attempted to determine how well communities of living benthic organisms are represented by the assemblages of dead remains accumulating in the sediment, *i.e.*, future fossil assemblages.

Fifty quantitative samples were collected with a diver-operated suction dredge from various shallow-marine environments near Isla Cancun and Isla Contoy, Quintana Roo, Mexico. Virtually all the geologically preservable megafaunal remains in the sediment consisted of mollusks, and 290 molluscan species were identified in the samples. Although nearly three fourths of the species were collected only as dead shells, almost all live individuals were represented by dead shells of their species in the same sample.

A series of Q-mode and R-mode cluster analyses, utilizing 5 different similarity coefficients and data based on the presence or absence and relative abundances of species, demonstrates that the same general associations of samples and organisms occur, whether living animals or dead remains only are considered. Chi-square association tests between pairs of samples collected 5 m apart reveal that the death assemblages in both samples of each pair are similar, whereas the living communities are not.

The death assemblages apparently reflect the in-place accumulation of remains of living benthic communities during sedimentation as patchily distributed populations of organisms migrate across the bottom, leaving a record of their mortality behind them in the sediment.

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CHANNELIZED SUBMARINE CARBONATE-DEBRIS FLOW, CRETACEOUS, MEXICO

Carbonate platforms, fringed by rudistid reefs, rose to more than 1,000 m above contemporaneous basinal carbonates in the middle Cretaceous of central Mexico. The platforms are surrounded by halos of debris forming wedges which extend as much as 5-15 km from the platform margin. An exception to the wedge morphology is a breccia-filled channel exposed in section perpendicular to the paleoslope, 1 km from the marginal escarpment of the El Doctor platform, Querétaro, Mexico.

The main part of the channel deposit is 225 m wide and 16 m thick. Breccia clasts are 75% basinal components (pelagic limestone and chert) and 25% platform derived. The bedded clasts form flat plates up to several meters in maximum dimension. A few clasts are deformed, indicating that they were at most slightly lithified and presumably of low density; nevertheless, most are neatly stacked with little distortion. Unstable clast postures, with long axes approaching normal to bedding, and imbrication are common. Content of dolomitized muddy matrix is low; the deposit is grain supported.

The morphology of the breccia deposit and truncation of pelagic limestone at the channel edge demonstrate erosional competence of the depositional mechanism. Locally in the channel base an incipient slump of slightly folded pelagic limestone and chert indicates slope instability and suggests a mechanism for incorporating basinal carbonates in the breccias. In the top few meters of the deposit, breccia grades upward into fine-grained, skeletal-fragment packstone, which extends several hundred meters beyond the channel limits as thin, graded bed. At least 3 episodes of channel fill are suggested by internal structure.

This evidence places the following constraints on the depositional process—high competence (large clasts, erosion), high viscosity (unstable clast postures), low turbulence (slight deformation and platy form of unconsolidated clasts), high clast concentration (grain support, clast interaction) and channelization (form of deposit, multiple episodes). A high velocity submarine debris flow is suggested. The nonchannelized part of the last depositional episode is a typical turbidite.

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DISCOVERY AND DEVELOPMENT OF SAWTELLE OIL FIELD, CALIFORNIA

No abstract available.

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QUANTITATIVE PETROLOGY AND DEPOSITIONAL ENVIRONMENTS WITHIN ESSENTIALLY ISOCHRO-

NOUS UNITS OF DETRITAL SEDIMENT, UPPER DEVONIAN, NEW YORK

Previously studied sedimentary environments and time-stratigraphic relations in the Sonyea Group (Upper Devonian) and adjacent units of New York provide an excellent framework for examining the effects of transport distance and environment of deposition on sediment composition and texture within an essentially isochronous unit of detrital sediment.

Samples for this study consist of 250 thin sections from 54 exposures and 12 environments of deposition, ranging from nonmarine to marine-slope and basin. Preliminary petrographic analyses reveal the following basinward trends: (1) fine-grained, foliated metamorphic rock fragments, a common constituent of the nonmarine sediments, are almost totally absent from sediments of the marine shelf, slope, and basin; (2) mean size of quartz grains ranges from fine sand in nonmarine environments to coarse silt in basin turbidites, whereas the maximum size ranges from granule to fine sand; (3) percentages of matrix range from 20% in nonmarine to over 80% in prodelta sediments; (4) rock fragments, including polycrystalline quartz, vary from 50% in nonmarine sediments to 4% in basin trubidites; and (5) monocrystalline quartz ranges from 23% in nonmarine sediments to over 40% in delta-front sediments.

In addition to these general trends, different sedimentary environments with similar mean sizes of quartz grains are distinguished on the basis of differences in petrology and size distributions of quartz grains. For example, fluvial floodplain, estuary, delta-channel, and delta-front environments, all having a very fine mean size of quartz grains, show significant differences in percentages of quartz, rock fragments, and matrix, or in the nature of the size distributions of quartz grains.

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JURASSIC PROXIMAL AND DISTAL CARBONATE TURBIDITES OF CENTRAL HIGH ATLAS MOUNTAINS, MOROCCO

The Lower Jurassic sediments of the High Atlas Mountains of Morocco were deposited in a northeast-southwest-oriented trough approximately 100 km wide and 800 km long. The trough margins are characterized by carbonate and marl shelf deposits, whereas the central, axial part is characterized by offshore, deeper water carbonates and marls. The depositional history of some of the deeper water sediments can be determined from a thick, carbonate, turbidite sequence flanking the southern High Atlas shelf. Within this section (800 m thick), it is possible to trace a sequence from proximal turbidites near the base through progressively more distal turbidites in the upper part of the section. Distinctive turbidite units are observed and, when lithology and unit geometry are traced up through the section, distinct changes can be recognized. There is a reduction in bed thickness and grain size, a change in intraclast types, and an increase in bedding regularity; well-developed laminae are more common and beds become well graded.

This turbidite sequence represents deposition from successive turbidity currents. The vertical changes from proximal to distal turbidites record either a deepening of the trough, a change in location of the sediment-source area, or a combination of both these factors.

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EPA REGULATIONS AFFECTING OIL INDUSTRY

No abstract available.

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LATE PALEOZOIC CLASTIC WEDGES IN APPALACHIAN PROVINCE

Late Paleozoic clastic wedges, arrayed from north to south along the western edge of the Appalachian tectonic welt, differ in age as well as spatial relations. The northern, Catskill, wedge is the oldest and apparently was derived from the north, whereas the succeeding Warrior-Arkoma wedge was apparently derived from a southern or Ouachita source. The youngest, Pocahontas and Dunkard, wedges are located between the older two and were derived from only a relatively small area in the central Appalachian Blue Ridge and Piedmont. Although the style of sedimentation differs among these large sedimentary prisms, all were governed by similar tectonic controls of differential subsidence and growth faulting. Significantly, the trend of tectonic complexes from which the sediments were derived is nearly at right angles to most of the present structures and suggests predrift tectonic connection.

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EROSIONAL ORIGIN OF INNER SHELF SEDIMENTS—EVIDENCE FROM NORTH FLORIDA

Study of 194 vibratory cores (4–20 ft long) from the Atlantic inner shelf off central and northern Florida indicates that most of the Holocene shelf sediments were derived from erosion and reworking of shelf substrata, and that direct fluvial contribution attending the last rise in sea level was negligible. Erodable, unconsolidated, and semi-lithified Tertiary and Pleistocene deposits are present in localized exposures or lie at shallow depths beneath the inner shelf surface in many places. All these older sediments contain ample quantities of fine to coarse quartz sand. Selective removal of the finer constituents of these older deposits, such as small Foraminifera, silt-size dolomite rhombs, and terrigenous muds, by erosion and reworking during Holocene transgression, can readily account for the veneer of fine to medium orthoquartzitic sand that mantles the inner shelf.

Progressive upward depletion of these characteristic fine constituents within the Holocene sand body is evidence of continuity with the underlying source strata. In addition, species of large, durable Foraminifera and phosphorite grains, both typically abundant in the Tertiary substrata, are present throughout the Holocene sand body. Although ultimately derived through the large Piedmont-drainage rivers in Georgia, the present shelf assemblage is indicative of mixed local sources. An erosional origin further explains the observed characteristics of the surface sediment: low feldspar, high phosphorite, and unstable heavy mineral assemblage, and pronounced rounding of quartz grains. In contrast, direct fluvial mechanisms of deposition do not account for such characteristics.

The last major rise in sea level was evidently a period of extensive erosion for the Atlantic shelf, in addition to being a transgression with discontinuous deposition as Curray has suggested.

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EVOLUTION OF SANTA BARBARA BASIN-WESTERN TRANSVERSE RANGES, CALIFORNIA

The modern Santa Barbara basin displays the east-west structural grain of the Transverse Ranges. Plate-tectonic theory suggests this grain evolved late in Tertiary time. However, Paleogene and early Neogene paleostructural and paleogeographic reconstructions suggest an Early-Middle Tertiary inception of the western Transverse Range province. Episodic diastrophism indicates that this evolution was also irregular.

Generally northwest-trending Paleocene shorelines in the eastern Santa Monica Mountains have been mapped by Campbell and Yerkes. This earliest Tertiary record is largely missing in the western Transverse Ranges, However, by middle to late Eocene time, a more westerly alignment is evidenced by the southward "flowing" proximal submarine fans of the Matilija