tion can be made of the post rift, thermal-subsidence history using multichannel seismic data. Stratigraphic control for Cretaceous and younger reflectors observed in these seismic profiles is available from the Continental Offshore Stratigraphic Test GE-1 well on the landwardside and from an eroded exposed escarpment on the seaward edge of the basin. The Jurassic age assignments were based on correlations with Jurassic sea level history.

When a different and simplified technique is used, the subsidence due to stretching and cooling, but not to sedimentation, during the pre-, syn-, and post-rift periods combined, can be obtained by calculating the depth of basement that would exist without a sedimentary load. Unlike the other east coast basins, in the Blake Plateau basin this unloaded basement depth indicates local maximum values in both the subsidence due to stretching and cooling and in sedimentary thickness. These maxima occur where the gravity model shows a transition to increasing crustal thickness seaward and near the southwest continuation of the trend of the East Coast Magnetic Anomaly, which marks where, on the rest of the margin, the stretched continental crust finally separated and new oceanic crust began to form. Rifted crust of the Blake Plateau basin never failed, and generation of new oceanic crust seems finally to have begun far to the east, east of the present Blake Plateau and almost against the West African craton.

The presence of rift-stage crust on either side of this aborted break, and lack of an extensional basin on the opposing African margin south of Senegal basin, and the paleoreconstruction of the area imply that the Blake Plateau basin continued to be rifted after the rift-to-drift transition had taken place in the basins to the north. This extended period of rifting may be responsible for the anomalous width of the Blake Plateau basin and for continued volcanism (dike injection?) which produced the unusual thickness of its rift stage crust.

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Sand Bodies on Muddy Shelves: A Model for Sedimentation in Western Interior Cretaceous Seaway, North America

The continental shelf on the western margin of the Cretaceous Interior seaway was a muddy surface which bore abundant northwest-southeast trending sand bodies, up to 20 m (65 ft) thick and many km long (Medicine Hat, Mosby, Shannon, Sussex, Duffy Mountain, and Gallup Sandstones). These features resemble the storm-built or tide-built sand ridges reported from the modern Atlantic continental shelf, or from the Southern Bight of the North Sea. However, whereas modern sand ridges may rise from the Holocene transgressive sand sheet through overlying Holocene mud deposits to be exposed at the present sea floor, no modern examples are known where sand ridges are completely encased in mud, as the Cretaceous examples seem to have been.

Hydrodynamical theory suggests that special circumstances may make it possible to build sand bodies from a storm flow regime whose transported load consists of sandy mud. Under normal circumstances, such a transport regime would deposit little clean sand. The sea floor is eroded as storm currents accelerate, but erosion ceases when the boundary layer becomes loaded with as much sediment as the fluid power expenditure will permit (flow reaches capacity). Deposition of the graded bed occurs as the storm wanes; the resulting deposit is liable to consist of a sequence of thin shale beds with basal sand laminae. However, slight topographic inequalities in the shelf floor may result in horizontal velocity gradients so that the flow undergoes acceleration and deceleration in space as well as in time. Fluid dynamical theory predicts deceleration of flow across topographic highs as well as down their down-current sides. The coarsest fraction of the transported load (sand) will be deposited in the zone of deceleration, and deposition will occur throughout the flow event. Relatively thick sand deposits, 20 to 50 cm (8 to 20 in.) can accumulate in this manner. Enhancement of initial topographic relief results in position feedback; as the bed form becomes higher, it extracts more sand from the transported load during each successive storm. Individual storm beds may tend to fine upward (waning current grading), but the sequence as a whole is likely to coarsen upward, reflecting increasing perturbation of flow by the bed form as its amplitude increases.

Stability theory suggests that the end product of these processes should be a sequence of regularly spaced sand ridges on the shelf surface. However, sand bodies are localized in stratigraphic position and lateral distribution within Cretaceous shelf deposits. Upward-coarsening sequences are a widespread phenomenon in the Western Interior Cretaceous System, and the sand bodies appear to constitute localized sand concentrations within more extensive sandy or silty horizons. Especially widespread upward-coarsening sequences appear to be due to the close coupling between activity in the overthrust belt to the west and sedimentation in the foreland basin. In the proposed sequence of events, a thrusting episode increases relief in the source terrane as well as the load on the crust. Sedimentation at first dominates over subsidence, and initially the shelf on the western margin of the basin becomes shallower. As it does so, intensified wave scour on the shelf floor increases the amount of bypassing, which results in the deposition of increasingly coarser sediment, culminating in a sandy horizon. As relief in the hinterland wanes, subsidence overtakes sedimentation and the shelf subsides. Renewed thrusting begins the cycle anew.

In a second mechanism for the formation of upward-coarsening sequences, tectonic uplift affects parts of the shelf as well as the hinterland. The initiation of Sevier or Laramide structural elements beneath the shelf, and the remobilization of other, older structures, creates submarine topographic highs. These highs cause slight sand enrichment over broad sectors by means of the process described above. The development of sand-enriched areas on the shelf floor by both mechanisms leads to the flow-substrate feedback behavior that builds large scale, elongate bodies of clean sand.

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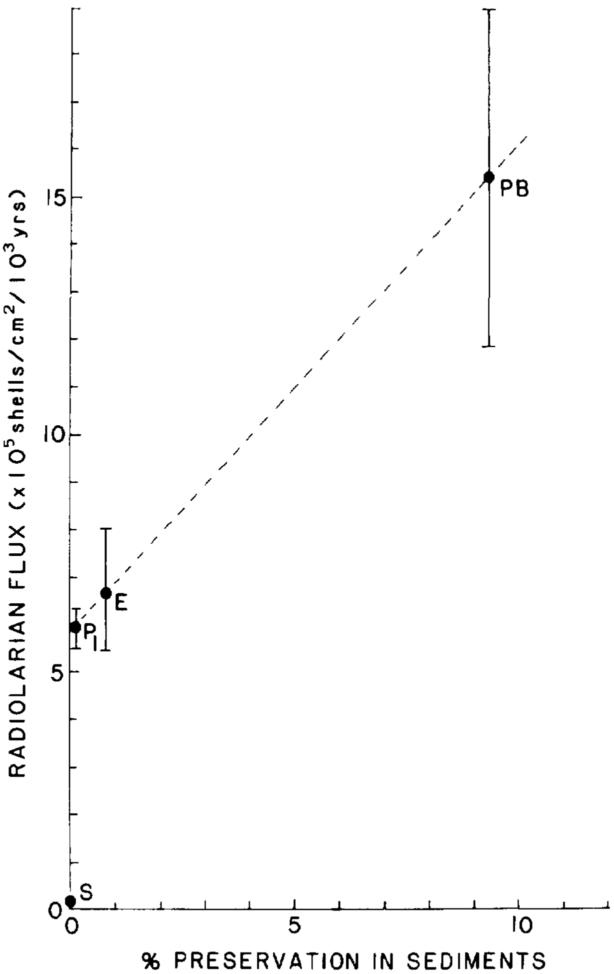
Radiolarian Biocoenosis-Thanatocoenosis Relationship in Pelagic Oceans

Detailed fluxes of radiolarian biocoenosis including 420 species have been measured by PARFLUX sediment trap experiments in the Sargasso Sea (Station S), western tropical Atlantic (E), central tropical Pacific (P_1), and Panama basin (PB). The samples were collected at 3 to 5 trap depths in the mesopelagic and bathypelagic zones during 2 to 4 month deployments. The measured fluxes of total Radiolaria in the unit of $\times 10^5$ shells/$cm^2/10^3$ yr at each station were: (E) 5.83 to 8.66; (P_1) 0.21 to 6.22; and (PB) 10.72 to 19.40. In all cases, the suborder Nassellaria represented the most contributions in number of shells (60 to 73%), followed by Spumellaria (18 to 36%). Paeodaria, a soluble end member, represented 1 to 8% in the flux of the shell number, although it contributed up to 23% in SiO_2 mass fluxes owing to the large shell size. Comparisons of these fluxes with the Holocene accumulation rates yielded the percentage of preservation of total Radiolaria: (S) 0%, (E) 0.8%, (P_1) 0.004%, and (PB) 9.3%. The extent of preservation appears to be proportional to the extent of fluxes to the sea floor (see figure). Differential preservation of the species is evidently taking place. For example, Spumellaria, a solution resistant end member, represents 29.2% preservation, whereas Nassellaria and Phaeodaria represent 2.8% and 0%, respectively, in the core tops from the Panama basin. Clearly, thanatocoenosis in the Holocene sediments is drastically different from the living counterparts in the overlain water column. Major dissolution depth of spumellarian and nassellarian shells is at the sea floor. Phaeodarian shells dissolve in the water column as well as at the sea floor.



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Origin of Natural Gas, San Juan Basin, New Mexico

The Lower Cretaceous Dakota Formation produces gas, gas-condensate, and at the basin margins, gas-rich oil. The coal-bearing Upper Cretaceous produces gas with little or no condensate. Delta ^{13}C(PDB) values for methane, measured in dry and condensate-bearing gases, average -43.3 ± 3.4°/oo, indicating derivation from sapropel and petroleum, not coal. Locally, isotopically identical methanes occur in all productive formations over a stratigraphic interval of 1,500 m (4,900 ft). Gas chromatography revealed close similarities in ratios involving the subsidiary alkanes of gases in the Dakota, Mesaverde, and Pictured Cliffs Formations. Both lines of evidence demonstrate extensive vertical migration. In the Dakota Formation there is an approximate gradient from the center of the basin to the margin in the $\delta^{13}C$ values of methanes: from -37.7°/oo (Ro = 1.9%) to -51.9°/oo (Ro = 0.7%).

The mean $\delta^{13}C$(PDB) value of three basin-margin oils is -27.7 ± 0.2, whereas the condensates of the central portion of the basin average -27.2 ± 0.6. These facts are interpreted in terms of a derivation of gas condensate from oil. Condensates and oils were compared on the basis of the detailed composition of their gasoline fractions, particularly in terms of paraffinicity (heptane and isoheptane values). Allowing for natural fractionation, the paraffinicity values were very similar, indicating that the condensate liquids and oils had almost identical thermal histories, rather than the oils being of normal thermal aspect and the condensates mature or supermature. This suggests that most of the condensates sampled were formed by merely physical processes. Abundant gas, generated in the central supermature basin region is postulated to have caused entrainment of oil liquids (condensate) in solution, and to have migrated to cooler reservoirs, both vertically and updip. Apparent gas migration pathways are traceable in fluid property (GOR) data in the Chacon Dakota field.

Deuterium/hydrogen ratios were determined in methanes from Dakota and Mesaverde reservoirs in the high-rank, basin-center region. Although both formations contain Type III kerogen or coal, delta D (SMOW) values of -164°/oo and -167°/oo, respectively, are compatible with those of other dry, mature petroleum gases. When considered in conjuction with the carbon isotope ratios, the values did not indicate derivation of the methanes from coal, though some admixture could have occurred.

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Foraminiferal Evidence for Sources and Timing of Mass-Flow Deposits South of Baltimore Canyon

Shallow seismic reflection surveying of the continental rise between Accomac and Baltimore Canyons shows stratified layers overlying an unstratified interval believed to be mass-flow deposits. Planktonic and benthonic foraminifera from 43 piston cores and grab samples, collected between 150 and 2,360 m (492 and 7,743 ft) depth, have been used to interpret the source and age of unstratified sediments along canyon axes.

Five mappable seabed faunal distributions characterize the outer shelf, slope, and upper rise. Multiple regression was used to relate Rose bengal stained assemblages as well as total sediment assemblages to water depth, median grain size, bottom temperature, and oxygen content in order to index the subsurface samples to these modern physical parameters.

Major lithologic and micropaleontologic contrasts characterize the sediment columns from the canyon axes: soupy, olive clays with foram assemblages similar to living populations overlie firm, gray to rusty-brown clays with Pleistocene planktonic foraminifera and benthics today found in upper slope areas. This, combined with the presence of sand layers bearing shelf forams, suggests that the mass-flow deposits are related to slope failures in response to glacially lowered sea levels.

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Depositional Environments and Sedimentary Processes in Chile Trench

The Chile Trench is a long, linear basin that concentrates clas-