Analyses of variations in the entire assemblage with time were conducted on samples from several onshore localities. These were conducted by counting more than 40 important family and generic groups. The results reflect the fluctuating role of oceanic processes in the Neogene shelf environments. Abundance and diversity increase (particularly in the rarer nassellarians and in apparently deeper dwelling forms) in the intervals interpreted to have been strongly influenced by oceanic processes (i.e., upwelling of subsurface waters). Abundance and diversity decrease, and dominance by certain spumellarians increases in the intervals believed to represent shallower, lower salinity and/or more terrestrially influenced environments, as interpreted from independent paleontological and sedimentological evidence.

These results are consistent with the idea that both coastal upwelling and deltaic progradation were significant processes in the Neogene development of the U.S. mid-Atlantic continental margin. Their relative importance at any given time or locality appears to have been determined by paleobathymetry and amount of terrigenous influx, resulting from effects of changes in sea level and local tectonic conditions.

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Concepts and Creativity (AAPG Presidential Address)

No abstract.

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Reference-Rotated Eigenshape Analysis of Sands and Sandstones

Sedimentary particles with minor differences in overall shape are selectively sorted according to shape during transport. Krumbein in 1942 demonstrated a difference in fall velocity for "disks" and "rollers," and Nagle in 1967 showed that right and left pelecypod valves transported by the same longshore current ended up at different locations along a beach. Selective shape sorting of sand-size particles occurs at various rates and in distinct patterns during different modes of transport, but the subtle shape differences are hard to recognize by conventional techniques. Visual comparison methods for "roundness" and "sphericity" have such low accuracy and reproducibility as to be virtually meaningless. Also, two particles can have equal sphericity and roundness and yet be of different overall shape. The Corey shape factor (widely used by civil engineers) with its various modifications is inadequate for subtle shape variations. In two-dimensional maximum projection, simple symmetrical shapes (i.e., ellipse) are fully defined by two measurements: length of major and minor axes. Less symmetrical shapes (i.e., oval or kidney bean) need more than two measurements. Griffiths in 1967 stated that n measurements are needed for an irregular shape (where n is not known in advance).

Eigenshape analysis is a method of reducing a large number of measurements (i.e., 36 radial lengths at equal angular increments) to the minimum number of linear combinations needed to portray a significant proportion (80 to 90%) of observed shape variation. Reference-rotation is needed for sand grains in order to compare the wide variety of shapes that occur; when comparing only similar objects, reference-rotation may not be necessary. Unlike Fourier shape analysis, which as currently used involves only small-scale irregularities, Eigenshape analysis is a new approach to quantifying larger scale shape characteristics.

Laboratory experiments designed to simulate shape-sorting effects of sediment transport (slow versus fast fall velocity in a sedimentation tube; inner versus outer ring in a gold prospecting pan) separated quartz sand samples composed of grains of the same sieve size into two subsamples. These showed recognizably different assemblages of shape types by Reference-Rotated Eigenshape Analysis. Similar Eigenshape distinctions were observed when the same size fraction of two sands with different Eigenshape "signatures" were mixed in 2:1 ratio and then separated by selective shape sorting as above.

Eigenshape analysis achieved similar results with thin-section input data. Artificial rocks were made with the above sands by "lithifying" with epoxy resin. Thin sections were made perpendicular and parallel to "bedding" and at other orientations. Eigenshape analysis was performed on the grains as seen in section (not "maximum projection"). Results from bedding-parallel sections most closely resemble results from loose-grain mounts.

Inferences about provenance, transport mode, transport distance, mixing from different sources and/or different transport histories, and depositional environments are made from Eigenshape analysis results. The intrinsic R-mode factor analysis approach helps untangle these intermixed effects.

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Upwelling Deposits: Nature of Association of Organic-Rich Rock, Chert, Chalk, Phosphorite, and Glauconite

An association of organic-rich sediment with phosphorite and glauconite is commonly found in modern coastal upwelling zones. The three lithologies do not always occur together, but where they do, they lie in a characteristic facies pattern, with organic-rich sediment in the center, surrounded by a phosphorite facies which is, in turn, rimmed by a glauconite facies. A fourth lithologic element of upwelling deposits is biosiliceous ooze. Biosiliceous ooze is most commonly composed of diatoms, which evolved in the Cretaceous Period. Radiolarian oozes tend to occur in the deep sea, under divergence zones in the open ocean. Despite the predominance in modern upwelling zones of diatoms, the association of chert, organic-rich rock, phosphorite, and glauconite is common in older rocks as well; the chert in these rocks is radiolarite or spiculite. A possible fifth element of upwelling deposits is calcareous ooze; phosphatized and/or glauconitized and cherty chalks are common in the fossil record, as are organic-rich chalks. The relationship of chalk to upwelling is obscure because in modern upwelling zones, siliceous organisms are far more abundant; calcareous and siliceous phytoplankton appear to occur almost mutually exclusive of one another. By analogy with the sediments under modern upwelling zones, the presence or absence in rocks of each of the five lithologies—organic-rich rock, phosphorite, glauconite, chert, and chalk—provides clues to the nature of individual upwelling deposits. The presence or absence of each lithology, particularly chert versus chalk or the presence or absence of phosphorite, can also provide clues to such parameters as temperature and water mass characteristics.

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Sandstone Diagenesis and its Variation with Deltaic Depositional Environments, Upper Cretaceous, Southern Rio Escondido Basin, Coahuila, Mexico

Prodelta, delta-front, and delta-plain sandstones and shales were deposited in a wave-dominated lobate delta in the Rio Escondido basin during Campanian and Maestrichtian time. The