Distinguishable associations of shape categories are quantitatively related to specific environments. Shape sorting, in combination with size sorting (different responses to transport processes), may extend the discriminating power.

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Global Atmospheric Circulation in Mesozoic and Cenozoic

Paleogeographic maps provide the minimum information needed to model global atmospheric circulation, that is, the size and distribution of landmasses, oceans, epeiric seas, and mountains. Numerical atmospheric circulation models require data, e.g., sea surface temperature, that are frequently unavailable in the rock record. Therefore, models of past atmospheric circulation must rely on paleogeography as the primary data base. The technique of modeling circulation on the basis of paleogeography alone is qualitative and necessitates some assumptions about certain parameters, e.g., the equator-to-poles temperature gradient. However, this technique has proved viable for the Paleozoic, and therefore it has been used to construct global circulation models for the Mesozoic and Cenozoic. The evolution of the circulation patterns since the Permian included, among other features: (1) the breakup of the Permian and Triassic cross-Pangea temperature gradient; (2) the destruction of the Permian monsoonal circulation and its eventual re-establishment late in the Cenozoic; and (3) the re-establishment of circum-polar winds, which last occurred in the Devonian. The circulation models are tested with data on the distribution of climatically controlled sediments, e.g., coals, evaporites, and carbonates, and with biogeographic patterns. The limitations of the qualitative modeling technique can be determined by comparing the late Cenozoic circulation maps with those generated by more quantitative techniques.

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Upwelling and Phosphorites in Paleozoic

The prevailing hypothesis concerning the origin of some major phosphorite deposits is that they were deposited in upwelling zones. To date, tests of this hypothesis have used criteria effective on a local scale rather than a global one, partly because reliable paleogeographic maps have not been available until recently. Good paleogeographic maps are essential because one must be able to model global atmospheric circulation patterns to predict the locations of upwelling currents, which are wind-driven. We know that today upwelling occurs primarily on west-facing coasts at about 30° latitude. Insofar as we have been able to identify such coasts in the past, attempts at predicting phosphorite localities have been successful. However, several other types of upwelling zones, unimportant to phosphorite deposition in the present world, were more important in the past when the continents were distributed differently. These other upwelling zones include zonal coastal upwelling, equatorial and high-latitude symmetrical divergence, and radial divergence. We will present atmospheric circulation and upwelling models for the Paleozoic constructed on global paleogeographic maps. The correspondence between the predicted upwelling zones and the locations of the major Paleozoic phosphorite deposits is highly significant ($p \ll .005$) for the Paleozoic as a whole, as well as for individual Paleozoic time periods, particularly the Cambrian and Lower Carboniferous.

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Reef Facies of Winnipegosis Formation (Middle Devonian), Williston Basin, North Dakota

The Winnipegosis Formation is a carbonate unit deposited in the Elk Point basin during the Middle Devonian. The Elk Point, a narrow, elongate basin extending southeastward from northern Alberta-Northwest Territories through central Saskatchewan and southwestern Manitoba to northeastern Montana and most of North Dakota, was flooded during the Kaskaskia transgression. The Winnipegosis Formation in the North Dakota part of this basin represents a transgressive-regressive stratigraphic sequence. The Winnipegosis has been studied on the basis of well cores from the Williston basin area of North Dakota. The following depositional environments are recognized: a carbonate platform in west and southwest, a platform-restricted basin in north-central, and a reef in east-central North Dakota.

The reef environment, where highly productive, has been studied in south-central Saskatchewan (Winnipegosis Formation) and northern Alberta (Keg River, an equivalent formation). To date there has been no production from the reef facies in North Dakota and only limited production from the platform environment. The reef facies is a porous and permeable dolomitized limestone; dolomitization is so extensive that the original fabric can seldom be discerned. Organisms that were present are now recognized as ghosts, as distinctive porosity patterns, and rarely as recognizable skeletons. In many parts of the reef facies, it is difficult to reconstruct the original fabric. Interpretation of the reef environment in the Winnipegosis Formation is based on comparisons of highly dolomitized fossils in the reef facies with fossils found in other facies, with fossils better preserved in less altered parts of the reef facies, with previously described reefs in Canada, and with fossils present in the reefs that crop out in Manitoba.

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Sedimentary Facies and Depositional Environments of Late Wisconsinian Glacial-Marine Deposits in Central Puget Lowland, Washington

Marine sedimentary deposits associated with relative sea level changes and the waning late Wisconsinian Cordilleran ice sheet are widely exposed above present sea level in the central Puget lowland. Some of these deposits, commonly referred to as glaciomarine drift, are traditionally interpreted as having been deposited as a rain of sediment from floating ice in water depths greater than 70 m. Deposits previously included in this drift include till-like diamictons, pebbly silt, massive well-sorted silt, and laminated silt and sand. Other glacial-marine or marine deposits include massive to crudely stratified sand and various mixtures of sand and gravel.

Recent studies indicate that all these deposits are broadly contemporaneous (14,000 to 12,000 ^{14}C yr B.P.) and that they represent a wide variety of depositional environments, many of which involved no glacier ice. In addition to marine environments receiving debris from floating ice, depositional settings may also include: (1) marine beach; (2) tidal flat and