microspar. Much of the sandy carbonate is "wackestone" and "packstone," some with poorly organized lamination probably resulting from wave action. Many sandy carbonate units lack internal structure or exhibit only bioturbation.

In the Provo area, Butterfield Peaks Formation sandstone deposition appears to have been dominated by eolian processes and shallow marine currents related to the Pennsylvanian trade wind regime. Paleocurrent indicators (mostly sandstone foresets) show a strong unimodal pattern from north to south in present coordinates, which corresponds with expected Pennsylvanian trade wind directions from published paleomagnetic paleolatitude reconstructions. Subaerial and marginal-marine deposition seems to have been dominated by siliciclastic sand, with carbonate deposition limited, for the most part, to open marine environments. This contrasts with the Butterfield Peaks section 70 km (43 mi) south in the southern East Tintic Mountains. Much less siliciclastic sand is present there, both as sandstone and as a component in carbonate rocks. Marginal marine carbonate facies, such as mudstones to wackestones with fenestral fabric and brecciated textures, are present. Apparently a less-abundant supply of sand allowed the development of these facies instead of overwhelming them, as seems to have been the case farther north.

Despite the repetitive nature of the clastic-carbonate alternations, and widespread Middle Pennsylvanian cyclic deposits in other areas, stepwise Markov chain analysis suggests that true cyclic successions cannot be demonstrated mathematically in the Provo-area Butterfield Peaks Formation. The semi-ordered succession present appears to be a function of the interaction of glacio-eustatic sea level fluctuation, tectonically induced rapid episodic subsidence, high rate of carbonate production, and facies shifts between carbonate and clastics partly controlled by wind-influenced delivery of siliciclastic sand and silt.

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Peat Deposits in the Mississippi River Deltaic Plain

Buried peat zones represent former marsh and swamp surfaces formed by cyclic sedimentation processes. They originate approximately at mean sea level and provide modern analogs for coal-forming environments.

To better understand variations in stratigraphy and organic and mineralogical properties between peats in different deltaic settings, two basins were chosen for study: Vermilion Bay and Barataria basin. The first area represents a blanket-peat-forming environment; the second exemplifies interdistributary peat accumulation.

The stratigraphy of the upper 4 m (13 ft) of the western Vermilion Bay area is that of a freshwater swamp (> 35% organic matter and abundant cypress wood fragments). Due to marine inundation, the present surface is covered with a saline marsh. The swamp deposit at 1 m (3 ft) depth possibly correlates with a marsh deposit at the same depth in eastern Vermilion Bay, where three depositional cycles, each containing blanket peats, can be recognized in the upper 9.5 m (31 ft) of the subsurface. The Barataria interdistributary basin displays a great horizontal and vertical organic matter variability. Hence, stratigraphy cannot be determined, but organic-rich pockets up to 4 m (13 ft) thick are known to exist. In addition, the Pleistocene surface deepens from −2 m (−6.6 ft) in western Vermilion Bay to −50 m (−165 ft) in Barataria basin as a result of differential subsidence and surface irregularities.

Characteristically, the peats average 90% moisture, 80% organic matter (20% ash), and a bulk density of 0.12 g/cm^3, the latter two numbers based on dry weight. When these data are related to depth, it appears that compaction during the first few thousand years after deposition is minimal. The frequency distribution of organic matter percentage ranges, for all sediments, shows that in eastern Vermilion Bay 15% of the material is peat; by comparison, in Barataria basin, 5% of all material is peat.

Preliminary results from mineralogical and elemental analyses of fresh and brackish peats indicate the presence of clay minerals, quartz, pyrite, gypsum, siliceous spicules, and smaller amounts of the trace mineral rutile. Minerals appear to vary with the type of peat. Elemental inorganic compositions also vary with depositional setting and post-depositional salt-water encroachment.

Peat deposits in the deltaic plain show a great variability in stratigraphy and characteristics due to four conditions: (1) difference in depositional setting; (2) depth to the Pleistocene; (3) intermittent interruption of marsh growth by influx of detrital clastics; (4) marine inundation of freshwater peats.

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Coastal Barrier and Inner Shelf Lithosomes Related to Shoreface Erosion

Along the Atlantic coast of Delaware lies a lagoon-barrier, headland, and spit complex which has transgressed landward during the Holocene Epoch. The shoreface is relatively steep with major erosion occurring from 0 to −10 m (−33 ft). In addition, erosional recession of the lagoon barrier and headland coast varies from 1 to 3 m (3 to 10 ft) per year averaged over the past 150 years. The inner shelf from −10 to −30 m (−33 to −100 ft) is also undergoing modification as the transgression continues. The net result is a sequence of Holocene depositional lithosomes in the valleys of the pre-Holocene (late Wisconsinan age) land surface. These valleys were cut by the ancestral Delaware River and its tributaries. Extensive surveys of the Delaware inner shelf with high-resolution seismic profiling tied in with vibracoring have allowed delineation of the three-dimensional character of the Quaternary erosional and depositional events controlling the Holocene coastal units. The separate and distinct sedimentary environmental lithosomes of the various coastal environments form irregularly shaped depositional units that are in some places presently undergoing erosion in the shoreface and in other places are being buried by thin transgressive sands on the inner shelf. Erosion during storm periods occurs to depths of greater than 30 m (100 ft), as evidenced by outcrop of Pleistocene sedimentary units along the former pre-Holocene interfluves that have been transgressed and are now exposed on the inner shelf.

Forty-two vibracores were drilled in the shoreface in water depths of 2 to 10 m (6.6 to 33 ft). These cores encountered a great variety of stratigraphic units including Holocene Epoch barrier sands, lagoons, spits, and marshes, as well as Pleistocene sediments of the pre-Holocene headlands, originally deposited in similar coastal sedimentary environments. The present depositional shoreface sands range in thickness from 20 cm to 1.5 m (8 in. to 5 ft). In some areas, slumping or soft sediment flow is indicated.

Thus, the ravinement surface along the Atlantic coast of Delaware underlies extremely thin depositional sands in the shoreface and adjacent inner shelf. Potential preservation of coastal lithosomes in this setting is highly variable, dependent on pre-Holocene topography in many places. The transgressive sequence studied is the result of migration of coastal environments from a position near the axis of the Baltimore Canyon trough geosyncline approximately 50 km (31 mi) to the east at a