Subsurface study of the Palo Duro basin, Texas Panhandle, indicates that strata of Pennsylvanian age were deposited in a variety of clastic and carbonate environments. Up to 2,400 ft (720 m) of sediment was deposited with maximum accumulation along a NW-SE-trending basin axis. Major rock types include alluvial-fan and fan-delta sandstone and conglomerate, shelf and shelf-margin carbonate rock, and basinal shale and fine-grained sandstone.

Erosion of Precambrian basement in the Amarillo and Sierra Grande uplifts supplied arkosic sand ("granite wash") to alluvial fans and fan deltas along the northern margin of the basin. Distal-fan sandstones are interbedded with thin shelf limestones; basinward of clastic deposition, shallow-shelf carbonate sediment was deposited across most of the basin. Basinal shales are present only in a small area just north of the Matador arch. Late in the Pennsylvanian, increased subsidence deepened and enlarged the basin. Ultimately, the basin axis trended east-west with a narrow northwest extension.

Along the eastern and southwestern margins of the basin, superposed shelf-limestone buildups form an abrupt, massive shelf edge. Along the northern part of the western shelf, however, two shelf margins are recognized, indicating that a younger shelf edge retreated westward as much as 18 mi (29 km). An increase in clastic deposition combined with continued subsidence may have caused the retreat of the limestone shelf margin. Basin filling occurred mainly during periods when clastic sediment entered the basin through feeder channels at the northern and eastern ends of the basin.

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Chronicle of Miocene, Phase III: Middle Miocene Events

Studies of climate evolution and Cenozoic cooling published in the past several years strengthen our previous paleontologic and stratigraphic models for significant refrigeration accompanied by lowered sea level during the middle Miocene (± 15 to 12 m.y.B.P.).

Currently, there is general acceptance of a eustatic lowering of sea level during late Miocene (Messinian) time (±7 to 5 m.y.B.P.) which caused the isolation and evaporation of the Mediterranean Sea, and this has been attributed to a peak in Cenozoic glaciation. We, however, have proposed that there was, during progressive Cenozoic cooling, a sharp dip in temperature as early as Langhian time (± 15 to 14 m.y.B.P.). We also suggested that a short-span eustatic lowering of sea level accompanied this cooling.

Available evidence suggests that the general middle Miocene rise in sea level that resulted in widespread marine transgression was modified by the cooling event that caused a relatively short-lived eustatic sea-level drop.

These concepts are supported by recent oxygen-isotope and continental-migration studies, and by sedimentologic evidence from Deep Sea Drilling Project cores from many parts of the world. Oxygen-isotope studies on tests of planktonic forams have revealed that there was significant buildup of Antarctic ice in the middle Miocene which represented a major glaciation event in the Southern Hemisphere, and that during this time a Circum-Antarctic circulation similar to that of today was established. The isotope data are in agreement with interpretations of paleo-oceanographic and sedimentologic data.

In the Northern Hemisphere, the North Atlantic–Arctic circulation that led to the initial freezing of the Arctic Ocean was well established by Miocene time.

Our models were developed from subsurface paleontologic and stratigraphic data derived from Gulf Coast (south Louisiana) wells. We interpret the sedimentologic data from DSDP cores to be evidence that supports the concept of worldwide middle Miocene cooling.

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Trace-Fossil Evidence for Deep-Water Sedimentation in Cretaceous Arc-Trench Gap, South-Central Alaska

The Matanuska Formation (Albian-Maestrichtian) in the Talkeetna Mountains, Alaska, contains marine siliciclastic sediments apparently deposited in an east-west-trending trough extending across south-central Alaska. This trough was situated between a magmatic arc on the northeast, indicated by the Gravina-Nutzotin andesitic volcanics, and a deep-sea trench on the south, indicated by the thick Valdez Group metasediments in the Chugach and Kenai Mountains.

Along the southern edge of the Talkeetna Mountains, the arc-trench gap sequence represented in the Matanuska Formation contains biogenic and physical sedimentary structures suggestive of deposition on a submarine slope at bathyal (or greater) depths. Turbidite sedimentation is typical, and trace fossils of the *Nereites* ichnofacies are common. An ideal cycle consists of a complete Bouma sequence. Although complete cycles are common, the turbidites in any given outcrop are rarely uniform with respect to bed thickness, sand/shale ratio, and completeness of the cycle. The sole of each turbidite sand is commonly marked with horizontal trails (e.g., *Nereites, ?Paleodictyon, Planolites, Urohelminthoida,* and *Zoophycos*) as well as groove casts and load structures. The occasional presence of wood suggests proximity to land, but the trace-fossil assemblage and Bouma sequences indicate bathymetric conditions deeper than a shallow shelf.

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Neogene Calcareous Nannoplankton Biostratigraphy in Eastern Mediterranean

Calcareous nannoplankton biostratigraphy has been worked out in the eastern Mediterranean using deep-sea sediments recovered from DSDP Leg 42A Sites 375 and 376. These two drill sites were located approximately 55 km west of Cyprus on the Florence Rise. Sediments, ranging in age from early Miocene (*Helicosphaera ampliaperta* Zone) through Holocene (*Emiliania huxleyi* zone), contain sufficient age-diagnostic species to recognize essentially all of the low-latitude nannoplankton