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Overview of the Central North American Basins and Their Relation to Deep Crustal Structure

As our knowledge of deep structure of major central North American basins has increased, it has become clear that they have experienced long and complicated tectonic histories. A knowledge of these histories is especially important to efforts to formulate exploration strategies for deeper horizons and frontier areas. Regional geophysical and geologic studies of these basins indicate that Precambrian features have often exerted considerable control on basinal development (e.g., Anadarko basin, Rome trough, Rough Creek graben, Pedregosa basin). A particularly important tectonic event was the Eocambrian continental breakup which extensively rifted the southern margin of North America. Although this rifting event is manifested in various ways, its extent can be estimated by mapping the deep-seated crustal anomalies which probably formed at this time. Although age relations are uncertain in most cases, deep-seated anomalies are associated with the Arkoma basin, Anadarko basin, Illinois basin, Mississippi embayment, and Permian basin. There are many similarities in the development of these basins, but they all can be shown to have unique tectonic histories.

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Scheck Breccias from Devonian Reef Complexes of Canning Basin, Western Australia

Late Frasnian and early Famennian marginal-slope deposits of the Canning basin reef complexes include distinctive red open-framework breccias, characterized by red micritic clasts cemented by white calcite spar. They closely resemble the Adneter Scheck breccias in the Jurassic Adnet Limestone of the Austrian Alps.

Scheck breccias from the Canning basin are largely confined to red stromatolitic and terrigenous marginal-slope sediments having depositional slopes of 10-14°, which were deposited in water depths of some tens to hundreds of meters. Individual breccias beds are strongly lensoid, with concave, locally scoured bases. They are between 10 and 100 cm (4 and 39 in.) thick, and are composed predominantly of irregular red micritic clasts reworked from associated nodular limestones.

Breccias are clast-supported and may be inverse-to-normally graded, normally graded, or massive.

The proposed depositional mechanism began with slumping of muddy sediment containing abundant early-cemented nodules. This initiated bimodal density-modified grain flows. Nodules were supported by dispersive forces, and deposited by frictional freezing as the depositional slope decreased, producing clast-supported graded sequences. The finer sand and mud fractions continued downslope as turbidity currents, leaving behind minor perched mud trapped in the open-framework breccias. Early cementation by radiaxial calcite prevented further sediment infilling.

These Devonian scheck breccias are characteristic components of condensed sequences, as shown by conodont dating. They represent infrequent events; only about one bed of breccia was deposited for every 10 m (33 ft) of section (in about 300,000 years) over a vertical section of about 200 m (660 ft).

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Late Quaternary Geology of Louisiana-Mississippi Continental Shelf and Upper Slope

A high-resolution seismic-reflection survey was conducted in an area east of the Mississippi River delta along the Louisiana-Mississippi continental shelf and slope. Seismic data showed that the topography and subsurface sediment characteristics of the shelf and upper slope are the result of depositional sequences. These depositional sequences are delta outbuilding over transgressive sediments with intervening periods of erosion during low sea level stands. On the shelf, little evidence of structural deformation caused by faults, diapirs, and shallow gas is present. In contrast, the upper slope has occasional diapirs with associated faulting. The upper slope also has a few faults and scarps resulting from down-to-basin sediment movement. Surface sediments over the entire area relate to several depositional periods.

Minisparker (400-joule) profiles reveal at least 7 regressive and transgressive sequences. The oldest recognizable surface is an erosional surface. This erosional surface is overlain by transgressive sediments that downlap onto it near mid-shelf. The late Wisconsin is represented by 3 regressive stages. These stages are the result of fluctuations in sea level. The first two stages are characterized by deposition on the shelf, and the subsequent erosion of these deposits by stream channeling as sea level lowered. This fluvial system constructed a relatively large delta which prograded beyond the shelf-break. The delta construction is a complex set of prograding and onlapping sequences. The third stage of this regressive sequence occurred during the farthest retreat of sea level. This stage was the deposition of sediments on the upper slope, which onlap the previously prograded delta. The regression was followed by a rise in sea level which deposited transgressive sediments on the inner shelf. A sea level fluctuation during this sequence exposed part of the shelf. This paleosurface is possibly the Pleistocene-Holocene boundary. The most recent sequence was the deposition of the St. Bernard delta on the inner shelf.

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Biostratigraphy of Echinoid Spines, Cretaceous of Texas

Echinoid (sea urchin) spines from Cretaceous strata have widely varying morphology. They are common, and most are small enough to be recovered from well cuttings. Many forms have restricted ranges; consequently, echinoid spines have substantial biostratigraphic utility.

There have been established 115 form taxa of echinoid spines and 14 form taxa of ophiuroid-asteroid spines for the Cretaceous of Texas. The specimens used for establishing the form taxa were processed from 533 outcrop samples (78 localities) from 30 Cretaceous formations, each with a well-defined age based on faunal zones of ammonites and Foraminifera. A dichotomous key in 9 parts and a catalog of scanning electron micrographs (87 plates) have been set up to assist identification of the form taxa.

Range charts for the echinoid and ophiuroid-asteroid form taxa have utility throughout the Cretaceous of much of the Gulf Coastal area. The most precise zonation has been possible for the Albian.

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Role of Depositional-Depth and Source-Terrain Uplift Rates on Sedimentation Patterns in Back-Arc Basins of Western Pacific

Nine depositional systems occur in Deep Sea Drilling Project (DSDP) cores recovered from western Pacific back-arc basins. These include submarine fan, debris flow, silty basinal turbidite, biogenic pelagic silica, biogenic pelagic carbonate, redeposited carbonate, pyroclastic, hemipelagic clay, and pelagic clay depositional systems. Correlation of deposition of these systems to times of basin rifting, associated island arc andesitic volcanism, and uplift of source terranes shows that only biogenic carbonate, pelagic clay, submarine fan, and debris flow processes of sedimentation are correlated to specific tectonic processes. Basin subsidence history controlled by heat flow dissipation controls the preservation potential of biogenic carbonates and pelagic clay. Rate of tectonic uplift in andesitic volcanic sources controls the volume and preserved frequency of turbidites on submarine fans and associated debris-flow wedges. A time delay in fan and debris flow sedimentation following maximum uplift in source terranes is governed by development of mature drainage systems and sediment yield into the back-arc basins.

The other depositional systems are deposited independent of rifting, subsidence, or uplift history because their distribution is controlled more by regional volcanism, wind dispersal, climatic change, latitudinally-defined biologic productivity, and slope instability. The variety of stratigraphic sequences in back-arc basin DSDP cores can be explained better in terms of all these changing variables coupled with tectonic processes. The combination of depositional depth and source-terrane uplift rate are the only tectonic processes which directly influence specific sedimentation events in this particular domain.