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Evolution of Sedimentary Systems During Mesozoic and Cenozoic in Southern Alaska—An Overview

The evolution of sedimentary systems during the Mesozoic and Cenozoic in southern Alaska can be divided into six episodes, each representing a tectonic cycle that is presently recorded, with varying degrees of clarity, as a plutonic belt containing related sedimentary rocks that are bounded by unconformities or faults. These six episodes or tectonic cycles, which are sequential but sometimes overlap, occurred during the: (1) Permian(?) through Early Jurassic, (2) Early Jurassic into Early Cretaceous, (3) late Early and early Late(?) Cretaceous, (4) Late Cretaceous, (5) early Cenozoic, and (6) late Cenozoic.

Each tectonic cycle began with magmatism and volcanism that constructed a magmatic arc with a back-arc and fore-arc basin, outer-arc ridge, shelf, slope, trench, and abyssal plain. Uplift and erosion dissected the magmatic arc and outer-arc ridge, and sediment filled the arc basins, shelf, slope, and trench, and then spilled onto the abyssal plain. Throughout the cycle, tectonism, magmatism, and sedimentation were ongoing at varying intensities, each cycle or episode affected the previous cycle. This evolution can be traced in the composition of the plutonic bodies, conglomerates, and sandstones. Thus, southern Alaska has evolved from young continental and oceanic crust to mature continental crust by magmatism, sedimentation, and accretion.

Paleomagnetic data suggest that much of southern Alaska south of the Denali fault evolved as one or more terranes or plates in southerly latitudes from Permian(?) time that were accreted to North American continental terranes by early Cenozoic time. The temporal and spatial relation of these terranes throughout geologic time in relation to the tectonic cycles is intricate and complicated. The Alaska-Aleutian Range volcanoplutonic arc and the associated Queen Charlotte transition zone transform-fault system have dominated depositional and structural patterns in southern Alaska since the early Cenozoic.

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Geophysical Survey of Anadyr and Navarin Basins, Northern Bering Sea

The Gulf of Anadyr is adjacent to eastern Siberia in the northern Bering Sea. The gulf and adjacent onshore area are floored by Anadyr Basin, a large sediment-filled structural depression that encompasses a total area of more than 100,000 sq km. Navarin Basin lies southeast of Anadyr Basin and encompasses more than 45,000 sq km of the northern Bering Sea shelf, an area tentatively scheduled for leasing for hydrocarbon exploration in 1984. The two basins are separated by a northwest-trending structural high.

During 1980, the U.S. Geological Survey collected 3,000 km of 24-channel seismic reflection gravity, magnetic, and high-resolution seismic reflection data from 22 sonobuoy-refraction stations in the Gulf of Anadyr and the northern part of the Navarin Basin. These data reveal that the offshore area of Anadyr Basin contains 2,000 to 4,000 m or more of strata. Near Cape Navarin, these beds have been broadly folded into large antiforms tens of kilometers across that may be possible traps for hydrocarbons. Onshore in Anadyr Basin, Soviet exploration has located 50 northeast-trending anticlinal structures.

Magentic and seismic refraction data indicate that the Okhotsk-Chukotsk volcanic belt of eastern Siberia extends offshore southeastward along the inner Bering shelf and flanks the northern side of Anadyr Basin.

On the basis of onshore drilling results in Anadyr Basin, we suspect that the offshore section consists of Cretaceous and early Cenozoic rocks that were folded, uplifted, and eroded during late Mesozoic and again during late Miocene to Pliocene time, when the adjacent Koryak range was deformed. Onshore shows of oil in early Tertiary rocks, and gas shows in Miocene sandstone suggest the presence of adequate source beds in the onshore area of Anadyr Basin. These beds may extend to the offshore basin and into nearby Navarin Basin. Numerous shallow acoustic anomalies, which were detected from records in the Gulf of Anadyr, are probably due to shallow gas accumulations.

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Model for Estuarine Transgression Based on Facies Variants in Nearshore of Western Delaware Bay

Delaware Bay is an example of a pre-Holocene river valley and tributary system gradually being inundated during the Holocene Epoch transgression. The stratigraphic record left as the coastal environments shift landward in response to the transgression provides keys to understanding a number of coastal processes and morphic variables which affect the completeness of the transgressive sedimentary record. These include: irregularity of the pre-Holocene surface being transgressed, variation in wave energy as determined by fetch and climate, availability of sediment source for littoral transport, and rates of compaction and subsidence. A number of specific coastal sites illustrate the high degree of variability in the subsurface stratigraphic record including the extremes of incision of a pre-Holocene headland and migration of a thin barrier over 30 m of mud. Cross-sectional interpretations based on core data show the geometric variability of the resultant sedimentary units varying from sheetlike estuarine silts to irregular barrier remnant deposits to thick sequences of lagoonal/marsh muds. Using site specific examples and incorporating all the variables inherent in the preservation of the many sedimentary environmental units, a generalized model for an estuarine transgression has been developed. The Delaware coast is an excellent area from which to form this model since an extraordinarily high diversity of processes and stratigraphic factors have been introduced. Therefore, application of the model to other modern and ancient estuarine strandline and nearshore areas becomes possible. Predictions concerning the nature and rate of coastal change of variable oceanic-estuarine systems have been made using the model.

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New Insights into Devonian Oil Shale Resource of Eastern United States

The Devonian oil shales of the eastern United States constitute one of the nation's major energy resources. New process technology applicable to these shales increases the percentage of organic carbon extracted thereby doubling the yield of oil per ton. The process uses hydrogen at temperatures of 500 to 730°C and pressures of 20 to 50 atm. Experimental work in equipment capable of processing up to one ton of shale per hour has confirmed the technical and economic feasibility of above-ground hydroretorting of Devonian oil shales. Investigation of more than 550 samples from some 150 locations in 13 states indicates that IGT's HYTORT™ process can give organic carbon recoveries from 2 to 2.5 times those of conventional retorting, resulting in yields of 25 to 30 gal/ton at many localities, compared with 10 to 15 gal/ton using Fischer Assay.

Resource estimates are based on above-ground hydroretoring and four criteria: overburden less than 200 ft (59 m), stripping ratio less than 2.5 to 1, shale thickness of 10 ft (3 m) or more, and organic carbon at least 10% by weight. Resource estimates include: Kentucky 190 billion bbl, Ohio 140 billion bbl, Tennessee 44 billion bbl, Indiana 40 billion bbl, Michigan 5 billion bbl, and Alabama 4 billion bbl. Seven other states have been sampled but recoverable resources were not identified. The total recoverable resource exceeds 440 billion bbl of synthetic oil if all near-surface shales of more quality were mined for above-ground hydroretorting.

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Oxygen Isotope Record of Ice Volume History: 100 M.Y of Glacio-Eustatic Sea Level Fluctuation

The $\delta^{18}O$ values for shallow-dwelling planktonic foraminifers vary as a function of global ice volume and local temperature. By using only sites which have been shown to have had a stable sea surface temperature during late Pleistocene, we propose to constrain paleotemperature to near-constant modern values. For such sites, variation in $\delta^{18}O$ of shallow-dwelling planktonic foraminifers is thus constrained to reflect variation in global ice volume.

With regard to average values, we suggest the earth has had a significant ice budget since the Cenomanian (approximately 100 m.y. ago). Thus, variation in the average state of the global ice budget is a likely cause for interregional unconformities.

It is possible to evaluate the stability of continental ice caps by sampling short intervals of core in extreme detail. Our preliminary isotopic results show that high-frequency variation of ice volume persists throughout the last 40 m.y. at no less than 25% of the late Pleistocene amplitude. This implies that high-frequency sea level fluctuations of at least 30 m are superimposed upon longer term trends.

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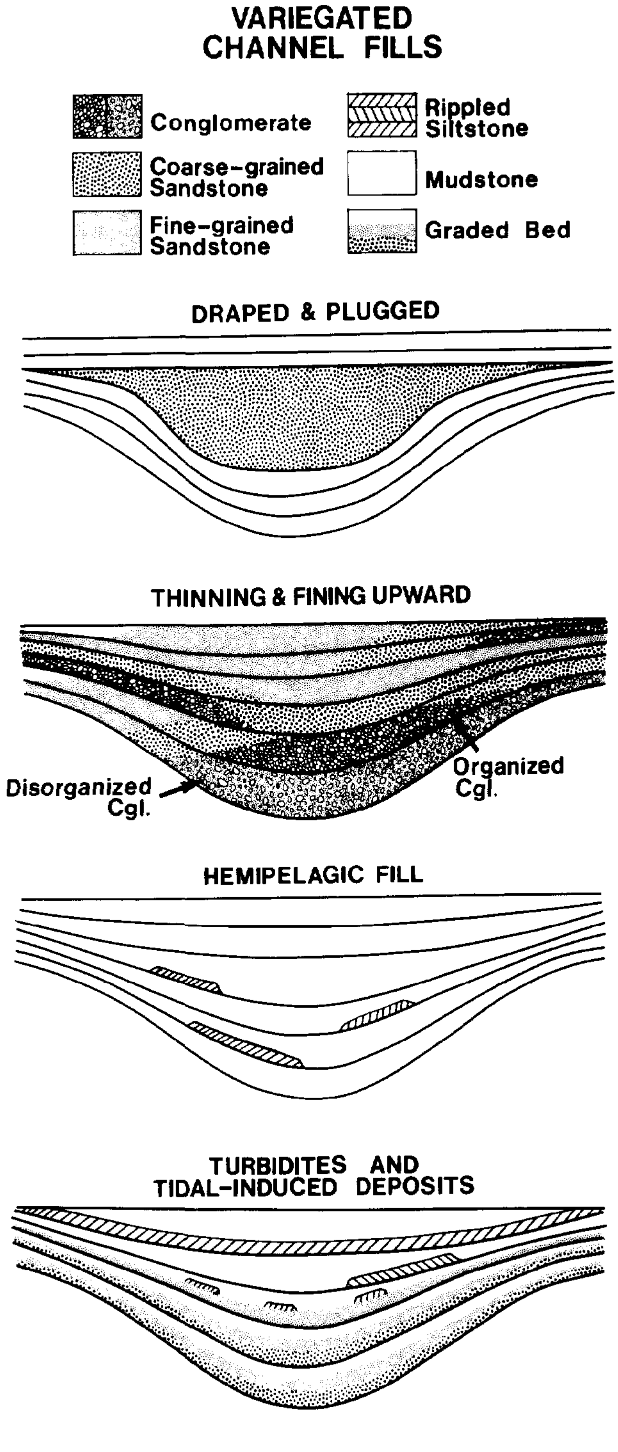
Shelf-Edge Conduit: Channelized Sediment Transport Across Eocene Fore-Arc Basin Margin, Southern California

A complete shallow-to-deep marine transition is exposed in Eocene rocks at San Diego, California. Well-exhibited facies relations, precise biostratigraphic control, and paleobathymetric indicators allow comparison of these continental margin outcrops with similar sequences most commonly observed only by seismic-stratigraphic methods. Even in this active tectonic setting, eustasy appears to be the dominant factor in cutting shelf-edge unconformities, forming and reactivating submarine canyons, and controlling the distribution of facies down the shoreline-to-basin conduit.



Broad, shallow outer-shelf channels funneled coarse-grained littoral sediments to the gullied upper slope and canyon head. These channels were filled with massive to laminated sandstone and shell lag, bioturbated mudstone, and rare slump-folded mudstone. An early Eocene canyon head was cut at the shelf edge during a eustatic lowstand, then eroded landward during subsequent sea level rise. The canyon is floored with a thick, massive sandstone that may be amalgamated or crudely graded, containing clasts of canyon-wall debris up to 6 m long in cross section, as well as conglomeratic to pebbly or gravelly sandstone. It exhibits convolutions, flame structures, and other evidence of rapid