multi-element taxonomy is that it provides a more natural basis for specific and generic concepts, and a foundation for discussions of functional morphology, paleoecology, phylogeny, and conodont biostratigraphy.

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Genesis of Sand Ridges on Storm-Dominated Shelves—Status Report

Sand-ridge topographies are relatively common on storm-dominated shelves, as well as on tidal shelves. The definitive studies of fluid process and seafloor response have not yet been undertaken, but enough data are now available to construct reasonable models of ridge genesis and design experiments. Any model for ridge formation must explain the following observations. (1) Ridges form a 20 to 40° angle with the coast that opens into the prevailing direction of storm flow. (2) Sand waves on the sand ridges form 85° angles with the coast. (3) The coarsest sands are on the up-current side of sand ridges and the finest sands are on the down-current side.

A mean flow model is based on J. D. Smith's stability analysis of sand beds at low Froude numbers. Because of a phase shift between bottom topography and flow parameters, maximum shear stress occurs on the up-current slopes of bottom perturbations, hence their crests must aggrade. The skew with respect to the coast is explained as a shearing out of the bed form by the increasing efficiency of transport as the beach is approached and wave re-suspension of sediment intensifies.

A shear wave model attributes sand ridges to stationary, eddy-like instabilities in inner-shelf flow that result from an onshore-offshore velocity gradient over a sloping bottom. In this model, ridge orientation is determined by the orientation of the long axis of the eddy. Studies in progress should allow us to discriminate between these two models of sand-ridge formation.

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Rationalization of Koyukuk "Crunch," Northern and Central Alaska

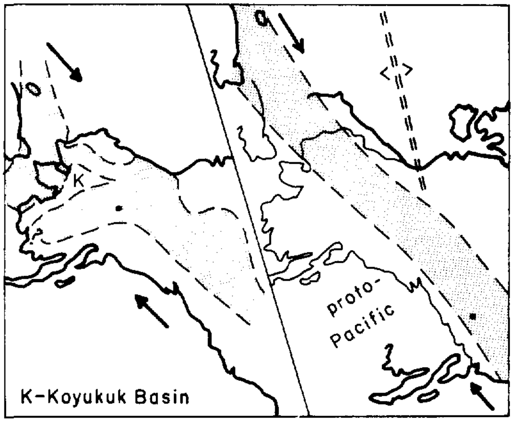
Rocks of northern Alaska may have had tectonic continuity with rocks of central Alaska. The present syntaxis would have formed along with those at the ends of the Brooks Range in response to right-lateral drift between the Arctic and outboard plates. The Cretaceous Koyukuk basin is interpreted to have been "crunched" between the northwestern and southeastern syntaxes.

Palinspastic data suggest that (1) the Fairbanks area was once south of the Prince Rupert area, (2) the Arctic Alaska basin separated the Ellesmerian-Antler orogene from the proto-Pacific ocean, and (3) Cretaceous foreshortening against this continental edge resulted in construction of the Brooks Range foldbelt and the flanking Koyukuk and Colville basins. Space is sufficient to accommodate later accretion of Wrangellia and other lithospheric "crumbs" to Alaska.

This surmise, which could be tested by analysis of paleomagnetism, accommodates more observations that the Patton-Carey alternative of rifting followed by partial closing of the Koyukuk basin sphenochasm. It would also explain or clarify the following: (1) the 135° acuity (instead of natural, curvilinear trends) for belts of "ophiolite," of glaucophane, of metamorphism, of plutonism, etc; (2) the thrust-superpositions of coeval sequences along the upper Yukon; (3) the absence of tectonic provenances for Cretaceous orogenic deposition in central Alaska; and (4) the young igneous detritus on the west edge of the MacKenzie delta, more than 100 km from the closest source.

If validated, this hypothesis would greatly reduce estimates of the hydrocarbon potential of central Alaska, but would predict extensions of Brooks Range copper and lead-zinc provinces southwestward across the Yukon River and eastward beyond Fairbanks.

Pre-Syntaxis Palinspastics



Inferred Syntaxes

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Interpretation of Fossil Fluvial Bivalve Burrows in Catskill Formation, Based on Analogy with *Margaritifera margaritifera* (L.)

Large burrow structures attributable to the bivalve *Archanodon* are common in sandstones of the Towamensing Member of the Upper Devonian Catskill Formation in Pennsylvania and in its correlatives in New York and New Jersey. These structures show preferential curvature, cross-sectional ellipse parallelism, and internal asymmetric crescentic features. Vectorial analysis of these features has been based upon studies of the behavior of living specimens of *Margaritifera margaritifera* (L.).

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Slope-Centered Processes in Santa Barbara Basin, California Borderland

Three basic types of slope-centered processes are responsible for the infilling of Santa Barbara basin: low-concentration suspenate transport, large-scale glides, and small-scale processes which consist of a continuum of slumps to debris flows. Suspensate transport is concentrated on the northeast part of the basin and is perhaps channeled by the Montalvo trough. Large-scale glides extend across the entire northern slope and are most spectacular in the Montalvo trough where higher sedimentation rates due to suspensate transport seem to speed the process. Small-scale slump to debris-flow deposits can be found at six specific sites. These deposits exhibit fluid escape structures, dish structures, a swirled x-radiograph signature, and in some deposits dramatic, matrix-supported, random fabrics with clasts as large as 4 cm. Laminations provide key markers necessary to discern distortion of sediment in areas of mass movement. The deep basin-floor laminated zone is laminated due to low oxygen content of the water column and deposition of gray layers due to suspensate transport during exceptionally rainy winters. Even parts of this laminated zone appear to be involved in gradual glides. In shallow parts of the basin on the northeast side, laminations are of a different type and are produced by years of suspensate transport. This laminated zone is centered along the axis of the Montalvo trough. High sedimentation rates apparently prevented destruction of the laminations due to bioturbation. Only a relatively small part of the deep basin floor, a flat area which slopes very gradually to the south, is somewhat immune to mass movement. However, fluidal flows generated by mass flows upslope could conceivably reach this area and result in unusually thick laminations.

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Shannon Sandstone (Upper Cretaceous) Offshore Bar Facies Distribution, Salt Creek Area, Wyoming

Four major facies are identified in the Upper Cretaceous Shannon Sandstone Member submarine bar complex where it crops out in the Salt Creek anticline area of Wyoming. The Central Bar (trough and laminated) Facies forms the backbone of the bars. This facies is quartzitic and glauconitic, fine to medium grained and is composed of stacked sequences of predominantly trough-bedded sandstones up to 35 ft (10.7 m) thick. A normal vertical (bottom to top) and lateral sequence of facies is Shelf Siltstone, Interbar, Bar Margin, Central Bar, Shelf Siltstone (burrowed). Shelf Silty Shales (bedded and burrowed) surround the bar complex. In general, the outcrop section is sandier than several of the bar complexes that produce in the subsurface about 35 mi (56.3 km) northeast of the outcrop. Two new subfacies are introduced, the Interbar (sandy) Facies and the Bar Margin (interbedded trough and ripple) Facies.

The mean direction of transport in the trough-bedded Central Bar and Bar Margin Facies in south-southwest, except locally in the top foot or two of the bar where westerly transport directions are observed. If the upper few feet are excluded, the spread of transport directions is commonly less than 45° for individual outcrops and for the area as a whole.

Foraminifera control indicates that the bar sands were deposited at middle-shelf depth. Ammonite zonation by Gill and Cobban provides detailed time stratigraphy and documents that the shoreline, at the time these bar complexes were deposited, was as far as 80 mi (129 km) to the west.

The Eagle sandstone delta complex of south-central Montana is a possible initial source for the sands. Nearly unidirectional currents, in part intensified by storms, are inferred to be the main process involved in deposition of the linear bar complexes.

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Early Paleozoic Conodont Biostratigraphy and Paleogeography of Northwestern Canada

Early Paleozoic rocks in northwestern Canada were deposited on a broad Atlantic type shelf and include platform carbonate rocks and transitional and basinal facies that range in composition from calcilutites to cherts. The Paleozoic history of northwestern Canada began with widespread deposition of Lower Cambrian quartzite and carbonate. In the Middle and early Late Cambrian, shales were deposited in deep troughs and continental areas separated by tectonic arches. During the latest Cambrian and Early Ordovician, platform carbonates were deposited on a broad shelf adjacent to a belt of deep water limestone. Middle Ordovician time was characterized by uplift to the north; carbonate deposition changed abruptly basinward into graptolite shales to the south. Late Ordovician-Early Silurian carbonate deposition on the platform graded basinward into shales and limestones.

The phosphatic microfossil *Mellopegma* occurs in Lower to Middle Cambrian basinal strata while conodonts of the Late Cambrian *Proconodontus* Zone are common to both the platform and the basinal strata. A nearly continuous sequence of Early to Middle Ordovician conodont faunas is found in the platform carbonate rocks. These Mid-Continent type faunas include the Early Ordovician faunas A to E of Ethington and Clark and the Middle Ordovician faunas 1 to 9 of Sweet, Ethington, and Barnes. Coeval basinal and transitional facies of Early and Middle Ordovician age are characterized by North Atlantic type conodonts and a few Mid-Continent forms that sharply decline numerically toward the basin. Late Ordovician conodonts are poorly represented in the platform facies; spot samples from transitional and basinal facies yield predominantly North Atlantic taxa.

Lateral and temporal distribution of conodont faunas from northwestern Canada closely resemble those of coeval faunas reported from the Ibex area of western Utah.

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