ogy, mass transfer, and provide the hydrodynamics for hydrocarbon migration. Facies control the distribution of significant chemical components, including hydrocarbon sources. The tectonic setting controls fracture porosity, thermal gradients, and timing of hydrocarbon migration.

The important diagenetic reactions are interpreted on the basis of five phases: (1) silica, (2) carbonate, (3) clay, (4) organics, and (5) seawater. From the reactions characterizing these five phases, paragenetic sequences can be derived for each of the four solid components (opal, carbonate, clay, and organics) in the presence of seawater as temperature increases. Integration of paragenetic sequences results in an interpretive model of the diagenetic history of the Monterey Formation.

Three significant Monterey facies are: (1) sandstone-diatomite, (2) diatomite, and (3) carbonate-diatomite. The carbonate-diatomite facies in the Monterey has outstanding source rock potential; some of the mud and siltstone contain 18 wt. % organic carbon.

Hydrocarbons evolve when source rocks are buried to or below 6,500 ft (1,981 m). The hydrocarbon migration path is controlled by fracture porosity along active tectonic zones, particularly near fault systems at the margin of the fold (basin). The reaction, organic matter → hydrocarbons, provides pressure buildup and hydrocarbon expulsion, whereas the reactions, opal A → opal CT, and opal CT → quartz, provide the fluid drive for the hydrocarbon migration.

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Late Mesozoic to Early Cenozoic Foreland Sedimentation in Southwest Montana

Stratigraphic variations in the petrology of Upper Jurassic through lower Tertiary sandstones from southwest Montana, and inferred dispersal patterns and depositional environments, reflect the tectonic evolution of a foreland basin in response to gradually increasing orogenesis. Upper Jurassic to Lower Cretaceous (Aptian) chert-litharenites were largely derived from an older folded and faulted miogeoclinal prism of terrigenous and carbonate rocks farther west in Idaho. Volcanic and plutonic sources were negligible. Deposition was on a broad coastal plain extending east toward the craton. Subordinate admixtures of sediment containing low-rank metamorphic rock fragments derived from an intrabasinal reactivated Precambrian structure (Belt arch) and regionally extensive intercalated fresh to brackish-water limestones are unique characteristics of this retroarc sequence.

Marked upward increase in the quantity of locally derived plutonic and volcanic rock fragments in Blackleaf (Albian) and younger sandstones indicates the progressively more important role of nearby comagmatic sources. A transition in time from paralic sedimentation to dominantly alluvial sedimentation, was associated with the increase in igneous detritus. Dispersal patterns were complex because of local topographic barriers.

Early Tertiary sedimentation occurred in extensional fault-bounded basins in an intra-arc setting. Highly immature lithic sandstones and arkoses with a complex plutonic-volcanic-gneissoid provenance accumulated in a variety of high- and low-energy alluvial environments.

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Comparison of Gulf Coast Late Jurassic Ostracoda with Those of Western Europe

More than 30 genera of Ostracoda are represented in the Upper Jurassic rocks of the central Gulf region, United States. Most of these occur in the Schuler Formation, Dorcheat Member (Portlandian-Tithonian). About 12 of the genera are of European origin and, of these, several (e.g., *Nophrecythere, Galliaecytheridea*) began in earlier Late Jurassic or in Middle Jurassic of the European province. Emigration to the Gulf of Mexico region probably occurred around the northern margin of the opening Atlantic Ocean.

About 10 of the other Jurassic ostracode genera were endemic to the northern Gulf of Mexico or the western Atlantic. Most of these remained in those areas, some extending into the Cretaceous. Only a few Gulf forms, particularly *Hutsonia* and *Paraschuleridea* dispersed sparsely eastward to Europe. *Schuleridea,* which became abundant on both sides of the Atlantic, may have migrated eastward from the Gulf region in the Oxfordian or Kimmeridgian, as indicated from occurrences in offshore wells in the western Atlantic where it is associated with index foraminifera.

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State of the Art in Conodont Taxonomy

Two taxonomic schemes have been available to students of conodonts for more than 120 years. Until about 1970, most taxonomists opted for a "nuts-and-bolts" approach, or form-taxonomy, which emphasized similarities and differences in the morphology of discrete skeletal elements. Since the mid-1930s, however, it has been known that skeletal apparatuses of many conodonts included mineralized elements of more than one morphologic type. Beginning about 1964, clues to assembly of at least parts of multi-element apparatuses from collections of morphologically diverse discrete specimens came to be more systematically explored. In recent years with empirical reconstruction of a rather small number of skeletal-apparatus plans, and repeated confirmation of the general applicability of these in samples through much of the known range of conodonts, emphasis has shifted away from form-taxonomy to multi-element taxonomy. Major problems that remain include (1) standardization of descriptive and locational terminology for components of multi-element apparatuses, (2) resolution of nomenclatural problems that arise because multi-element affinities of numerous type specimens cannot be (or have not been) established, and (3) correction of errors introduced by application of multi-element models to collections in which they cannot be objectively justified. The advantage of 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

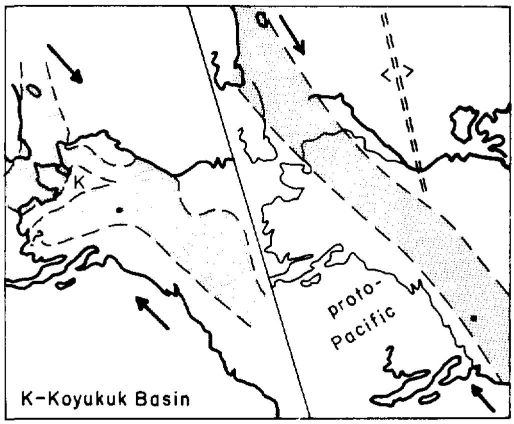
Rocks of northern Alaska may have had tectonic continuity with rocks of central Alaska. The present syntaxis would have formed along with those at the ends of the Brooks Range in response to right-lateral drift between the Arctic and outboard plates. The Cretaceous Koyukuk basin is interpreted to have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