sets of avalanche cross-stratification, cuspate cut-and-fill structures, and antidune cross-stratification also characterize the lower Sespe conglomerate facies. These features all indicate a braided stream model for lower Sespe deposits.

Steep gradients during lower Sespe deposition are suggested by: (1) clast size data (average maximum clast size = 41 cm), (2) a predominance of upper flow regime structures (85% of all structures measured), and (3) high consistency ratios (mean consistency ratio = 0.78) of paleocurrent data.

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Eustatic Sea-Level Control of Silurian (Niagaran) Reefs, Michigan Basin

Eustatic sea-level changes controlled Niagaran reef and off-reef facies and eogenesis both in the Michigan basin and on the adjacent platform, as shown by surface (Thornton, northeast Illinois; Pipe Creek Jr., central Indiana) and subsurface reef studies (Onandaga, south Michigan). We recognize four stages of development defined by alternating highstands and lowstands of sea level. (1) During Llandoverian-Wenlockian time, a highstand resulted in growth of reefs with 10s to 100 m depositional relief with a basal stromatactis mudstone facies capped by volumetrically dominant crinoidal wackestone to grainstone-coral boundstone facies. Reef growth was below wave base and was characterized by extensive submarine cementation. (2) A relative fall of sea level in the late Wenlockian caused a saline brine to develop in the restricted Michigan basin, halting pinnacle reef growth and resulting in A-1 Evaporite deposition and anhydrite replacement of reef fossils and sediment. This fall of sea level did not expose the shelf or bring reef tops above wave base. It may be expressed in the surface reefs as distal megabreccias containing normal marine stromatoporoid-coral-*Renalcis* fauna and in the subsurface reefs (basin) by a hiatal break. (3) A Ludlovian-Pridolian highstand resulted in basinal reef rejuvenation (stromatoporoid-algal boundstone facies and followed by the stromatolite facies) and dissolution of replacement anhydrite. The deep-water basinal A-1 Carbonate was deposited at this time. (4) A subsequent lowstand (Pridolian?) resulted in basinal hypersalinity, cessation of pinnacle reef growth, and A-2 Evaporite deposition.

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Canadian "Deep-Water" Carbonate Deposits: Distinction from "Analogous" Siliciclastic Deposits and Their Hydrocarbon Potential

"Deep-water" carbonates accumulate by gravitational processes which have many similarities to, but important differences from, those responsible for "analogous" siliciclastic deposits. For example, recently there has been much emphasis on the accumulation of "deep-water" siliciclastics in submarine channel-fan complexes. In contrast to this type of point source origin, carbonate basin slopes are mainly the result of processes from shelf and slope-centered linear sources, and processes from basin water-mass-centered area sources. The resulting carbonate slope accumulation is most commonly a debris apron which has a geometry and petroleum potential that is distinct from a fan.

Much of the worldwide petroleum interest in deep-water carbonates is in chalks which in the last 100 million years have become the major type of deep-water carbonate accumulation. However, in Canada almost all of our major deep-water carbonates are Paleozoic or older and, therefore, we are confronted with mainly hemipelagic slope deposits and peri-platform talus. There will be no new advances in understanding the process of accumulation of these latter types of basinal carbonate deposits until the premise that the processes and their resultant deposits are identical to those responsible for similar siliciclastic deposits is examined critically. An understanding of the obvious differences, combined with recognition of interactions between carbonate processes and process sets and of the factors that modulate carbonate process systems, leads to a more realistic understanding of the resulting "deep-water" facies and the physical and chemical controls on diagenesis.

The spectrum of Canadian deep-water carbonate basinal slope deposits which will be discussed cannot be integrated into one single model. Four major depositional facies models will be presented which are dependent on the nature of the adjacent margins (by-pass versus depositional) and type of margin sediment (reef versus lime sands). These models can be distinguished as separate seismic facies. Still other models are possible, underlining both the complexity of this type of carbonate accumulation and the challenge involved in its exploration, especially in the frontier areas.

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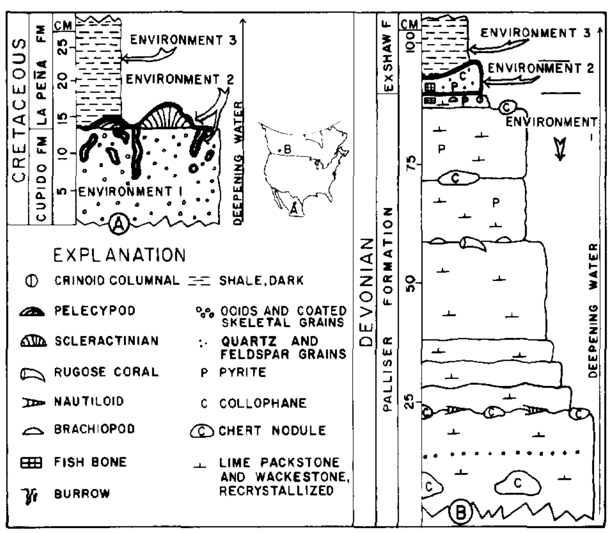
Comparison of Two Enigmatic Contacts: Palliser-Exshaw, Devonian, Southwestern Canada, and Cupido-La Pena (Cretaceous), Northeastern Mexico

In both the Palliser-Exshaw and Cupido-La Pena sequences, uncommonly sharp contacts separate carbonate bank deposits from overlying dark shales. Three environments discernible in each sequence may be attributed to gradual deepening of water during detrital influx.



At Potrero de la Mula, Coahuila, the uppermost Cupido consists of poorly sorted, oolith lime grainstones (environment 1). Abundant filled scolecoid burrows 1 to 2 mm in diameter extend 8 cm down into the Cupido from the iron-stained upper surface on which occur gastropods, pelecypods, and unabraded, hemispherical scleractinian colonies (environment 2). Dark shales of the La Pena Formation (environment 3) rest on this surface. Environment 1 was an active shoal with a shifting substratum which may have been stabilized as a result of deepening water (environment 2) permitting occupancy by corals and small burrowers. Bypassing prevented sedimentary accumulation except for shells and burrow fillings. Shales of the La Pena Formation accumulated as still deeper water (environment 3) caused bypassing to cease.

At the type section of the Exshaw Formation on Jura Creek, Alberta, beds of the uppermost Palliser Formation accumulated on a shallow-marine carbonate bank (environment 1). These are overlain abruptly by a 2 to 7 cm sandy bed bearing collophane, bone fragments, and abundant pyrite. This bed may have accumulated in turbid, deeper water (environment 2) during bypassing of finer grained sediment. Further deepening of water resulted in decreased currents, and the black shale of the Exshaw Formation accumulated (environment 3).

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Geology on the Continental Scale: The Decade of North American Geology

No abstract.

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Early Cretaceous Edmonton Channel in Alberta

The Edmonton channel forms part of an extensive Early Cretaceous drainage system on the Alberta plains. Local topographic relief in excess of 160 m was infilled by the Lower Cretaceous Mannville Group. The pre-Mannville unconformity juxtaposes Lower Cretaceous strata on Devonian, Mississippian, Jurassic, and possibly earlier Cretaceous sediments. Erosion was prevalent over sedimentation between the Pennsylvanian and Early Cretaceous Periods, a time of about 150 m.y. This ultimately produced a broad, low-relief alluvial plain with a southwestern dip, blanketed by easterly derived quartzose sandstones.

A prominent lowering of sea level, possibly associated with a worldwide eustatic sea-level fall at about 130 m.y., caused widespread erosion and dissection of the alluvial plain. The north-south oriented Edmonton channel was cut at this time, incorporating elements of an earlier drainage pattern. Flow was to the south and then west to join the Spirit River system which flowed northwest subparallel to the Columbian orogenic belt.

Southward transgression of the sea in Aptian(?)-Albian time led to lowering of stream gradients, deposition of coarser bed load where available, and inundation of the previously established drainage system. The Edmonton channel became a small adjacent sea with somewhat restricted circulation to the main seaway during its early infilling. Numerous estuaries formed in tributaries to the main channel. Sedimentology and paleontology of the Lower Mannville Group sediments in the Edmonton channel indicate deposition is a standing body of brackish water directly upon, or only slightly above, the unconformity. Sedimentation associated with continuing transgression and a subsequent regression accounted for most of the infilling of the Edmonton channel. Local lithostratigraphic nomenclature does not adequately reflect the nature and complexities observed in this sedimentary sequence.

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Application of Computer Graphics to Coal Geology and Coal-Resource-Assessment Studies, Canyon Coal Bed, Birney 1° Sheet, Montana

The National Coal Resources Data System (NCRDS) of the U.S. Geological Survey has the capability through spatial data bases and computer software to depict coal geology and calculate coal resources by computer. The Birney 1:100,000 map in southeastern Montana and the Canyon coal bed were selected to demonstrate this capability. The Birney quadrangle includes parts of Big Horn, Rosebud, and Powder River Counties. Other political entities are the Northern Cheyenne Indian Reservation and the Custer National Forest. The Canyon coal bed locally splits into an upper and lower unit, whose thicknesses range from 1/3 to 33 ft (0.1 to 10 m).

The desired data subset retrieved from the stratigraphic (USTRAT) data base consists of more than 300 drill-hole and 100 outcrop locations and their respective Canyon coal stratigraphic sections. Required digitized information included: X-Y locations (lat. and long.) for each point, township-range intersections, county, and national forest boundaries from the base map, the Indian reservation boundary, the Canyon bed outcrop, and the 200, 400, and 1,000 ft (61, 122, and 305 m) overburden isolines as drafted by the geologist.

GARNET, a NCRDS interactive graphics program, produces isopachs and structure maps, does trend analysis, and allows the user to edit data points, expand areas of interest, and calculate coal-resource areas and tonnages for any defined area. The USGS methodology for calculating and reporting coal resources requires that computations be delimited by criteria of coal thickness, overburden thickness, rank, and distance from points of observation as related to land classification and political subdivisions. GARNET allows interactive graphic combination of digitized and computer-derived lines to produce boundaries of these categories.

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Coralline and Associated Carbonates from Florida Bank (Pliocene), Lee and Collier Counties, Florida

Forty-five rock cores have defined a north-south-trending coralline limestone on the middle of the Florida platform. This is the only known Pliocene bank reef in the Caribbean and differs from Pliocene and Holocene shelf-edge reefs. This bank reef differs from shelf-edge reefs in that (1) its dimensions are smaller, having a maximum thickness of 6 m; (2) pycnodont oyster and molluscan packstones dominate the interreef beds; (3) marine muds are not as abundant; (4) the number of subaerial discontinuities and associated calcitic muds are greater; and (5) dolomitization is not as extensive and appears to be restricted to the oyster facies.

Coralline limestones have been interpreted as boundstones, bioclastic packstones, and monospecific bafflestones. Coralline boundstones usually are divided into two growth episodes separated by calcitic mudstones or subaerial laminated crusts. Oysters and molluscan-rich limestones commonly display current sorting and packing and fining-upward sequences that may be analogous to Holocene sequences associated with sea grasses and/or storm deposits. Environmental information derived from fossils and texture indicates shallow to moderate water depths and moderate energy conditions with sporadic storm events.

Detailed petrographic analysis has identified products of marine, mixing, and freshwater phreatic and vadose diagenetic environments associated with transgressive-regressive cycles related to glaciation. Studied limestones range from 6 m above to 14 m below present sea level in elevation and therefore have been subjected to repeated changing conditions. A complete record of the diagenetic history is lacking in any single rock because of dissolution processes or early tight cementation.

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