sparse in the nonmarine sediments of the upper Morrison, are common in the marginal-marine deposits of the lower Dakota and are extremely abundant and taxonomically diverse in the nearshore-marine lithofacies of the upper Dakota and lower Mancos. The distribution of most trace fossils reflects strong control by substrate and environmental facies; however, several taxonomic and ethological variants of a few ichnogenera demonstrate a lack of such control.

The "Jackpile Sandstone" of the upper part of the Morrison Formation contains only a few trace-fossil structures; many of these can be ascribed to the ichnogenus *Planolites*, the only trace-fossil type present in all stratigraphic units investigated in this study. The paludal and strand-line deposits of the lower Dakota contain abundant *Skolithos* and *Planolites*, and *Ophiomorpha*, which displays transition in form to a small variety of *Thalassinoides*, "Reed(?) molds" also are common in the lower Dakota sandstones.

Shallow-water marine sandstones of the upper Dakota are intertongued with the lower Mancos shales and are characterized by an abundance of trace fossils. Well-developed *Ophiomorpha* and *Teichichnus* structures show transition in form to a small variety of *Thalassinoides* and are probably ecovariant forms made by the same organism. Additional ichnogenera studied include large polygonal *Thalassinoides*, *Asterosoma*, *Arenicolites*, *Zoophycos*, *Chondrites*, *Crossopodia*, *Gyrochorte*, *Pelecypodichnus*, *Planolites*, and *Skolithos*. The presence of *Zoophycos* is of particular interest because of its usual association with deep-water deposits. The large *Thalassinoides* and *Asterosoma* structures appear to be restricted to the deeper water sandstone deposits of the upper Dakota.

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TECTONIC FRAMEWORK OF MACKENZIE DELTA DETERMINED FROM GRAVITY DATA

The MacKenzie delta is the most exciting petroleum exploration area in North America. It is situated at the confluence of three orogenic belts: the north-trending Richardson Mountains; the northwest-trending British and Barnes Mountains; and the northeast-trending Aklavik arch-Campbell uplift. Within the delta are local and regional structures which correspond in strike to all 3 of these tectonic trends. A recently completed, extensive gravity survey clearly reveals these structures.

The main tectonic elements of the delta from the gravity data are: a large northeast-trending basement high and parallel system of growth faults that bound the delta on the east; the adjoining northeast-trending Kugmallit trough; the Campbell uplift on the southeast margin of the delta; the Aklavik-Tunnunuk arch; a regional basement high in the Beaufort Sea parallel with the coast; large, northwest-trending, anticlinal folds; faults bounding the major positive structures; and probable diapirs.

The present delta was a Cretaceous depocenter. Cretaceous sandstones, shales, and conglomerates thicken abruptly across faults into the Kugmallit trough. Oil and gas discoveries to date in the delta are from Cretaceous and Cretaceous-Tertiary sandstones on structures indicated by pronounced gravity maxima. However, Paleozoic rocks may be at drillable depths on some of the structures and are possible objectives. Numerous, very large structures prospective for hydrocarbons delineated by gravity data are of 4 types: (1) regional arch (regional gravity maximum); (2) large, linear fold, with a dense core (large linear gravity maximum); (3) large linear fold, with a low-density core (relatively small gravity maximum); and (4) probable diapirs (round to oval gravity minima).

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RELATIONS OF CRATONIC AND CONTINENTAL-MARGIN TECTONIC EPISODES

The Phanerozoic history of continental cratons is marked by repeated global episodes of 3 types: (1) oscillatory—generally elevated or oscillating with respect to sea level; marginal and submarginal areas subject to highly differentiated uplift and subsidence; periodicity of oscillations and uplifts 10^5-10^6 years; wave lengths of intracratonic tectonic elements 10^1-10^2 km; duration of episodes 10^7-10^8 years; (2) emergent—progressively elevated in time; without significant topographic relief; tectonically undifferentiated below wave lengths of 10^3; duration 10^6-10^7 years; and (3) submergent—progressively depressed below sea level to form widespread epicontinental seas; subepisodes (10^6-10^7 years) of differential subsidence to form basins and arches ($\delta = 10^2$-10^3 km); duration 10^7-10^8 years.

Time relations of cratonic episodes are (1) oscillatory—much of Cenozoic, including present and period from Pennsylvanian to Early Jurassic (time spans of Appalachian-Hercynian, Laramide and Alpine orogenies); (2) emergent—latest Precambrian, early Middle Ordovician, Early Devonian, *etc.* (lacunal intervals between accumulations of cratonic sedimentary sequences); and (3) submergent—time spans of Caledonian, Antler-Acadian, and Nevadian orogenies.

In plate-tectonic terms, the present is characterized by high spreading rates and by convergent boundaries of oceanic and continental plates relatively remote from cratonic margins. These probably were the prevailing conditions during times of oscillatory cratonic behavior. Emergent cratons, by historical analysis, appear to be related to quiescent episodes at continental margins, possibly reflecting spreading-rate minima. Submergent cratons would seem to coincide with times of active plate convergence involving oceanic margins of cratons expressed by obduction and subduction at such margins.

Differences in cratonal tectonic habit may represent responses to either or both time-variable factors in continent-margin tectonics: variation in lateral stress transmitted to cratons from their margins, and variation in thickness, and thus in flexural rigidity of the continental lithosphere.

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HALITE CRYSTALLIZATION IN SUPRATIDAL SALINA, OMETEPEC LAGOON, BAJA CALIFORNIA, MEXICO

Supratidal flats of the Colorado River delta are sites of active evaporite formation. Major evaporite minerals are gypsum and halite. Flooding of the flats by Gulf waters several times per year causes the Ometepec Lagoon to be covered by a standing body of water not deeper than 2 ft. After the initial stage of gypsum crystallization, halite forms until evaporation reduces the standing brine to a ground-water brine. The dominant growth mechanism of halite is a competitive upward growth of cubes which nucleate on the brine-pan floors. The upward advancing edges of the cubes produce chevron grains, an internal inverted V-structure caused by rapid alternations of fluid inclusion-rich and inclusion-free zones. Entrapment of brine inclusions represents a rapid growth stage, whereas the inclusion-free zones represent slow-growth periods. Very rapid fluctuations in growth rates seem necessary during crystallization of chevron halite. The very shallow depths of Salina Ometepec brines are extremely susceptible to rapid changes in growth-rate-control factors such as brine temperature, concentration, and rate of evaporation. These factors in turn are dependent on air temperature, humidity, wind, *etc.* If the assumptions are made that (1) inclusions are dependent on growth rate, and (2) growth rate is controlled by various combinations of the above factors, it is logical to conclude that chevron halite is a characteristic feature of halites produced in environments of rapidly fluctuating growth rates. Brine depths of these environments would be expected to be very shallow, as it is difficult to envision the necessary rapid fluctuations in a deep body of brine.

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