the sediments during the Pertnjara orogeny in Devonian time.

The marine sequence consists of clastics, carbonates, and evaporites. They were deposited in shallow water, shelf environments as is shown by algal growths, biohermal and biostromal carbonates, abundant ripple marks and abundant cross laminations in sandstones, and by widespread coquinoid facies in Ordovician shales. Silled or barred basins with restricted circulation of marine waters existed from time to time during the marine cycle as is shown by salt deposits in the upper Proterozoic and Cambrian sections and by thick accumulations of dark shales with abundant pyrite in late Proterozoic and Ordovician sediments.

The marine cycle of deposition was terminated by the Pertnjara orogeny. This orogenic episode created a welt north of the Amadeus basin and a bordering foredeep whose depoaxis follows the present northern margin of the basin. Marine sediments were stripped from the rising welt, transported southward, and dumped into the subsiding foredeep where they now form a thick apron of poorly sorted, coarse clastic deposits.

Salt tectonics has played an important role in the growth of structures in the northern Amadeus basin. Thick salt deposits in the Bitter Springs formation of late Proterozoic age constituted a semi-plastic layer near the base of the Proterozoic sequence. Sedimentary loading on this layer produced flowage and initiated salt anticlines and salt domes. These structures grew during late Proterozoic and early Paleozoic deposition as is shown by crestal stratigraphic convergence and local unconformities confined to one structure. The evaporite layer also provided a "lubricated zone" along which slippage was localized during the Pertnjara orogeny, and it may be responsible in part for the large nappes and overthrusts along the northern margin of the basin.

The anticlines and salt domes initiated by salt flowage were formed early in the history of deposition and thus constituted potential traps for hydrocarbons long before the Pertnjara orogeny. However, folding during the Pertnjara orogeny greatly increased structural relief on the anticlines and thereby created traps having large volumetric capacities.

Two of these large structures have been tested with encouraging results. The Exoil-Magellan-United Canso groups have discovered a large wet-gas accumulation, possibly with an appreciable oil leg, in Ordovician reservoirs on the Mereenie anticline in the western part of the Amadeus basin. They also discovered a non-commercial gas accumulation in Proterozoic sediments on the Ooraminna anticline in the eastern part of the Amadeus basin. A third test of a small structure near the Ooraminna anticline encountered non-commercial oil shows in Cambrian sediments. In addition, the Australian Bureau of Mineral Resources discovered oil-saturated sands in Ordovician sediments penetrated by a well being drilled as a test for phosphates. With the exception of shallow water bores, no other wells have been drilled to date in this basin.

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Gross Sedimentary Facies in Uppermost Cretaceous and Lower Tertiary Sediments, West-Central Alberta

Uppermost Cretaceous and lower Tertiary rocks in central Alberta include a sequence of largely non-marine sediments which crop out between the eastern provincial boundary and the Foothills belt. On the basis of subtle to obvious differences in lithology, stratigraphic relations, inferred environments of origin, economically important mineral deposits, and the order in which areas were mapped, the rocks were long ago subdivided into several formations, but relationships among units and between areas never were determined satisfactorily. Problems associated with the sequence are of stratigraphic, historical, structural, tectonic, and economic importance.

The marine Bearpaw Formation separates the Belly River Formation (below) from the Edmonton Formation (above) along and east of the Red Deer River and on the North Saskatchewan River. Westward, the Bearpaw thins, tonguing out in the subsurface a short distance west of Red Deer and Leduc. Where the Bearpaw is absent, the Edmonton lies directly upon the Belly River; the entire section, Belly River, Edmonton, and Paskapoo, is non-marine.

Following the lead of Ower (1958) and Elliott (1958), the authors have attempted to trace the Belly River-Edmonton and Edmonton-Paskapoo contacts into the subsurface by means of electric and sample logs. No usefully persistent stratigraphic units that might mark the contacts have been identified. Gross electrical characteristics that have been used for this purpose are not atisfactory.

Portions of the sequence (Brazeau and Paskapoo) that crop out in the Foothills belt include much more sandstone than units that crop out along and east of the Red Deer River. The sandier character of the western sequence is also evident in well logs. The change from more sandy in the west to less so in the east occurs through reduction in number of sandstone bodies, reduction in thickness of sandstone units, and reduction in sandiness of the total section. However, in the eastern part of the subsurface section, distinctly more sandy intervals alternate with distinctly more shaly intervals; the change in character of the sequence is not uniform throughout.

At this stage, it is not possible to establish satisfactory criteria which would enable precise correlation of the subsurface units with the eastern outcrop belt; but it is probable that sandier units crop out and shalier units occupy covered intervals along major river systems.

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Cuban Evaporite Diapirs[1]

At least five rock sequences occur in central Cuba: (1) an igneous-metamorphic basement of unknown age; (2) a Jurassic evaporite-redbed sequence; (3) a Portlandian-Turonian orthogeosynclinal suite; (4) a Turonian-Eocene series; and (5) a post-orogenic Eocene-Recent sedimentary cover.

The Portlandian-Turonian orthogeosynclinal suite includes, from south to north, four facies belts: a eugeosynclinal suite, a transitional suite associated with the median welt, miogeosynclinal carbonates, and platform carbonates. During mid-Cretaceous and Eocene orogenies, the eugeosyncline was thrust northward, overriding the median welt and, locally, the miogeosyncline. The latter is deformed much more severely than the other belts.

Only four evaporite diapirs are known in north Cuba. These lie north of the median welt in Matanzas and Camagüey Provinces, and are localized by deep faults. Two diapirs penetrate the eugeosynclinal rocks at or close to the surface. Exotic blocks in these two diapirs include fragments of eugeosynclinal, median welt, and miogeosynclinal facies.

[1] Published with the permission of The California Company.

The following hypothesis is proposed to explain these facts: during orogenesis, the miogeosynclinal carbonates were detached from the underlying evaporites, crushed between the median welt and platform, and overridden locally by the eugeosyncline. After middle Eocene time, the diapirs intruded along deep faults and reached the surface with fragments from the overridden facies belts. The latest diapiric movements are post-Miocene. The small number of diapirs probably is related to the great competence of the thick, overlying post-evaporite carbonate section.

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DENSITY CURRENTS EXPERIMENTS

An extensive series of experiments on density currents of salt water, or muddy water flowing under fresh water, have been performed by engineers. The author has verified some of the results reported by earlier workers. Some new results have been obtained, using the small flume described by Bell (1942). A "specific law of saline fronts" was described by Keulegan (1958) who found that the movement of the head of a density current "surge" across a flat bottom could be described (for high Reynolds Numbers) by the equation

$$v = C\sqrt{\frac{\Delta_p d g}{\rho}}$$

where v is the velocity of advance of the head, C is a constant, Δ_p is the density difference between the two fluids, ρ is the mean density of the two fluids, d is the thickness of the current behind the head of the current, and g is the acceleration due to gravity. The author's experiments reveal a similar law for density currents flowing down a slope, with the exception that C depends on the slope. It is found that the ratio v/u, where u is the average velocity of uniform flow down the same slope (after the passage of the head), also depends on the slope, and is close to unity only for very low slopes. These results may have considerable significance for interpreting the behavior of turbidity currents.

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DEPOSITION ACCOMPANYING LARAMIDE TECTONICS, RED DESERT (GREAT DIVIDE) BASIN, WYOMING

The last major invasion of the sea in the northern Rocky Mountains is known from the distribution of the Upper Cretaceous Lewis Shale. Electric log correlation of key marine beds within the Lewis Shale provides reference horizons that facilitate the measurement of the subsequent structural deformation and accompanying terrestrial deposition during the Laramide orogeny.

Structural subsidence of the basin was contemporaneous with the accumulation of paludal, lacustrine, and fluvial deposits observed in 4,000 feet of the Upper Cretaceous Lance Formation. Post-Cretaceous erosion leveled the margins of the basin. Isopachous maps of the Lance interval, from the unconformity to the key beds, reveal areas of local uplift that are coincident in several places with hydrocarbon accumulations in the underlying Mesaverde Formation along the east flank of the Rock Springs uplift.

Periodic subsidence continued during the Paleocene and was accompanied by large scale normal and reverse faulting along the northern margin. Fort Union arkosic conglomerate, sandstone, and silty mudstone, derived from adjacent source areas, accumulated in and around the embryonic basin. Three lithologic facies that define the detritus related to each period of structural change are recognized. Lateral expansion of the basin is revealed by the onlapping relationship of the "basal" conglomerate and the distribution of the associated basin facies. The stratigraphy of the "basal" conglomerate is poorly understood from fossil evidence.

More than 6,000 feet of Paleocene Fort Union, and Eocene Battle Springs, Wasatch, and Green River strata in the subsurface have been correlated with the surface section recently described by George Pipiringos of the United States Geological Survey.

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CRUSTAL SHEAR PATTERNS AND OROGENESIS

Major crustal shears of North America, Europe, and Africa are shown and analyzed, and it is concluded that two orthogonal primary compressional shear sets, which are essentially wrench fault zones, exist world-wide. These sets are thought to have been generated by meridional and equatorial compressive stresses; the meridional and equatorial shear systems for the world are shown.

Major fault zones of the earth's regmatic shear pattern are considered to exercise fundamental control on orogenesis. These major fault zones probably extend downward to a discontinuity which may be the Mohorovicic discontinuity at the base of the crust, or may be deeper. It is thought that "continental drift" occurs by translation (with very little, if any, rotation) of the polygonal crustal blocks, which derive from the regmatic shear pattern, moving above this discontinuity. Ultimate driving forces are to be sought in relation to the earth's translation and rotation in space, and in sub-crustal (sub-Moho) convection currents; the result of these forces is omnipresent lateral compression in the crust.

Orogenesis results from the interaction of the crustal blocks as they move and yield in response to the lateral-compression stress field and the earth's gravitational field. On this basis, tectonic mountains are classified into: (a) linear uplifts with longitudinal wrench fault zones and related thrusting, (b) autochthonous fold belts, (c) vertically uplifted or tilted fault blocks, (d) domal uplifts, and (e) volcanic chains. Secondary effects of orogenesis include metamorphism and magmatic activity related to frictional heat from movement in major shear zones; and erosion, glaciation, and gravity sliding resulting from vertical components of movement along major faults.

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CONTINUOUS REFLECTION STUDIES OF MARGINAL BASIN SEDIMENTATION

Marginal basins include those within the body of the continental terrace (shelf and slope basins) and those flanking the terrace where it is separated from the deep sea by intervening topographic highs. Geographically widespread investigations with continuous reflection profilers suggest that continental slope basins are more common than previously suspected, particularly in tectonically active regions. Because of well-known topography and surface-sediment distributions, selected California continental borderland basins can be used as natural laboratories to study details of internal structures of basin deposits. These are compared with records