Briefly analyzed examples call attention to physical and biological aspects of obscure and even problematical breaks in selected areas at or near boundaries of (1) the Permian and Triassic, (2) the Cretaceous and Paleocene, (3) the Silurian and Devonian, (4) the Devonian and Mississippian, and (5) the Pennsylvanian and Permian; and of minor stratigraphic divisions on (6) the flanks of the Nashville dome and (7) on the northern Mid-Continent stable platform. It is concluded that the obscurity of hiatuses is unrelated to their importance and that pulsatory, more or less localized, differential crustal subsidence furnishes the main control for sedimentary accumulations and the "breaks" within them.

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EAGLE PLAIN BASIN OF YUKON TERRITORY

The Eagle Plain basin is an intermontane structural depression, 120 by 60 miles, which straddles the Arctic Circle in the Yukon Territory, Canada. Geologic history was influenced by a mildly positive central core which was flanked by local depositional basins through most of post-Cambrian time. Paleozoic basins include the Richardson basin, the area of the present southern Richardson Mountains, a Late Devonian basin west of the Richardson Mountains in the northeast, and a prominent Permo-Pennsylvanian area of depression in the southeast. Depositional topographic profiles identified in Permo-Pennsylvanian seismic record sections suggest shoreline conditions north of the present erosional limit of the Pennsylvanian, indicating increasingly positive behavior of the central core during the late Paleozoic.

Regional uplift during the Triassic hiatus culminated in the development and erosion of the Eagle arch, which plunged gently northeast through the stable core. Late Jurassic and Early Cretaceous sands onlapped the area from the north. Not until Albian time, when a depositional trough along the present Dave Lord ridge linked the northern Richardson Mountains to the Kandik basin of the Alaska border region, did Mesozoic seas inundate the Eagle arch and the southern Eagle Plain. Laramide deformation of the mountain belts and the concurrent development of simple folds in the enclosed Eagle Plain basin were the final acts in a Mesozoic diastrophic cycle, during which pressure from the Yukon stable block in the northwest at first fostered and later crushed the Kandik-Richardson trough against the stable Eagle Plain.

Exploratory drilling has been directed mainly toward the testing of the folded subcrop of Permo-Pennsylvanian sandstone, and the lower Paleozoic carbonate reservoirs on major anticlines. Fourteen wells have been drilled, with the resultant discovery of one oil and two gas accumulations, all in Permo-Pennsylvanian rocks.

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LATE DEVONIAN CONODONTS FROM ALBERTA SUBSURFACE

Cores from four wells in mid-southern Alberta have yielded diverse and abundant conodont faunas. Large numbers of specimens were recovered from Upper Devonian strata assigned to the Wabamun Group (Famennian) and the stratigraphically lower Winterburn Group, Woodbend Group, and Beaverhill Lake Formation (Frasnian). Included in the Wabamun Group are the Big Valley Limestone and the lower evaporitic and dolomitic Stettler Formation. Named units of the Winterburn Group include, in descending order, the Graminia, Calmar, and Nisku. The upper two units of the Winterburn Group did not yield conodonts; the Nisku contained a sparse fauna. In descending order, the Woodbend Group includes shale of the Ireton, limestone of the Duvernay, and limestone and dolomite of the Cooking Lake units. These last units are in juxtaposition with the reefs of the Leduc Formation. All Woodbend strata contain well-preserved and diagnostic conodont faunas which are markedly different from the forms of the Famennian Wabamun rocks above. Below the Woodbend Group lies the Beaverhill Lake Formation, which is predominantly limestone and contains a moderately abundant conodont fauna.

Comparison of faunas recognized in the Alberta subsurface with other described faunas reveals correspondence with forms known in North America and western Europe. Alberta subsurface strata contain significant forms representing widely distributed species of *Apatognathus, Ancyrodella, Ancyrognathus, Enantiognathus, Falcodus, Hibbardella, Icriodus, Nothognathella, Palmatodella, Palmatolepis, Pelekysgnathus* and *Polygnathus.* These species, among other characteristically Devonian conodonts, are present in sufficient quantities to demonstrate a typically Late Devonian faunal sequence.

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UNCONFORMITIES IN PHANEROZOIC SUCCESSION OF NORTHERN JASPER NATIONAL PARK, ALBERTA

Several unconformities occur in the Paleozoic and Mesozoic shelf sequences of the Alberta Rocky Mountains. The stratigraphic succession is repeated several times because of thrust faulting. This repetition, combined with excellent exposures, permits a study of the lateral variations in the stratigraphic units and of the contacts of these units. Most of the stratigraphic breaks are disconformities in local outcrops, but regionally some are important angular unconformities.

The stratigraphic, sedimentologic, and paleontologic evidence is reviewed for the following unconformities: (1) Precambrian-Cambrian and Lipalian interval, (2) Cambrian-Ordovician, (3) sub-Devonian, (4) Late Devonian Frasnian-Famennian, (5) Devonian-Mississippian, (6) Carboniferous-Triassic, and (7) Triassic-Jurassic boundary and gaps in the Jurassic sequence.

The important criteria for recognition of these breaks in the stratigraphic succession are, in order of importance: (1) regional stratigraphy, (2) paleontology, and (3) sedimentary phenomena. Of the sedimentary phenomena, eroded surfaces or truncations and residual concentrations of quartz and chert are very useful. Fossils also are useful for locating stratigraphic breaks. Other features, including phosphates and abrupt changes of lithology, also are associated with some unconformities. In several cases it is impossible without paleontologic evidence to determine the position of a particular stratigraphic break even with complete exposure and closely spaced stratigraphic sections.

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COMPACTION PHENOMENA IN GYPSUM AND ANHYDRITE

Anhydrite can be precipitated from natural brine in the presence of gypsum in the temperature range of 60°–70°C. Below this temperature range and within the anhydrite stability field, the rate of growth is extremely slow. Growth of gypsum in brine in the presence of anhydrite within the gypsum stability field is rapid. Recent anhydrite in the Persian Gulf in general occurs above the free-water level in supratidal sediments. It is postulated that this anhydrite is formed in the dark sediments during the hottest summer days and is preserved throughout the year in the partly dry sediments because of lack of water. However, at temperatures below approximately 23°C. in the presence of sea water which has been evaporated to precipitate halite, or at higher temperatures in less concentrated brine, the anhydrite will be dissolved and gypsum will precipitate. Thus, with burial of a few feet below the free-water level, any surface anhydrite should be dissolved easily and gypsum precipitated, at least during winter, at any known mean annual temperature. Only gypsum would be carried into the subsurface, despite the fact that anhydrite may have formed at or near the surface. This gypsum, and all original gypsum, will be replaced by anhydrite with burial to a depth of 500–2,000 feet, depending on the salinity of the subsurface water and on the geothermal gradient. During this stage, there will be at least a 38-per cent volume reduction of the solid. It is unlikely that this volume will be compensated by addition of anhydrite from an outside source because of the generation of abnormal fluid pressure and, thus, outward water flow during the gypsum-anhydrite replacement. Anhydrite in the subsurface commonly is devoid of pore space, indicating additional compaction. Therefore, ancient anhydrite sections must represent approximately one-third of their original depositional thickness. Because much of the volume reduction is delayed, the compaction and any dissolution of evaporites provide a mechanism for increasing and perpetuating the subsidence of an established evaporite basin in addition to and after its tectonic history.

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DIAGENESIS IN ESTUARINE SEDIMENTS

Diagenesis in estuarine sediments is affected by broad physical and chemical environmental patterns, the nature of which is becoming clear. The bottom environment is influenced most fundamentally by physical conditions, such as the pattern of water movements and the stability of the water column from place to place. Physical parameters are distinctly different in three major regimes of estuaries, the distributary reaches, the mixing zone, and the saline basin. Location and extent of each of these regimes are determined in any system by the interaction among fresh-water discharge, tidal range, channel geometry, and wind effects. The Rappahannock River estuary and the Po River delta illustrate contrasts in such physical differentiation.

In estuaries the environment for diagenesis is imposed by a determining physical background and the supplemental operation of chemical and biological processes. Variations in pH, Eh, and in dissolved silica and attainment of sulfide equilibrium illustrate the interaction between physical milieu and bottom chemistry. There is a class of chemical interactions (pH adjustment, ion exchange) which proceed instantaneously when fresh-water sediment enters the marine zone. There is another class that requires physical stability in the bottom sediments before equilibrium is approached (dissolution of silica, sulfide equilibrium). This latter class of reactions is the starting point for diagenesis. The initial stages of diagenesis begin just below the sediment-water interface in estuaries.

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PARACONFORMITIES

The stratigraphic succession is the net result of sedimentary deposition, non-deposition, and erosion within constantly changing environments. Consequently, rock strata are heterogeneous and interrupted by countless discontinuities, many of which are not readily apparent. The radiometric scale of geologic time firmly supports Joseph Barrell's theoretical conclusion that sedimentary rocks of any locality represent a small fraction of the time spanned by the formation of those rocks. Parallel evidence is supplied by the fossil record. In other words, the aggregate stratigraphic hiatus, recognized or concealed, greatly exceeds the preserved rock and fossil record.

The term *unconformity* (and its variants, disconformity and discordance) is employed generally for physically conspicuous stratigraphic discontinuities with inferred hiatuses. Existing confusion may be avoided if the antonym *conformity* is applied only to probably rare examples of strictly continuous deposits free from diastems, paraconformities, and disconformities. A preferred structural designation for indicating parallel bedding planes is *concordance,* whereas angularity of sedimentary contacts may be referred to as *discordance.*

The writer's observations of paraconformities in craton areas of the Colorado Plateau, Rocky Mountains, Mid-Continent, Mississippi Valley, Ohio Valley, Sweden, Andes of Peru, Salt Range of India, and elsewhere have led to the conclusion that present-day configurations of erosion and sedimentation do not yet provide an obvious explanation of ancient paraconformities. There is a surprising lack of evidence of protracted subaerial erosion such as soil profiles, sinks, and channels along paraconformities. This suggests extensive planar erosion or non-deposition near, or below, sea-level for long spans of time. Evidently, relative sea-level for long intervals rarely fell far below the land surface of the cratonal areas.

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CONODONT ZONES IN SALAMONIE DOLOMITE AND RELATED SILURIAN STRATA OF SOUTHEASTERN INDIANA[1]

Conodont zones recognized in the Brassfield Limestone and the Salamonie Dolomite (includes the Osgood and Laurel as members) in southeastern Indiana and adjacent Kentucky generally are comparable with Zone-I, the *celloni-* and *amorphognathoides*-Zones, and probably the *patula*-Zone established by Otto Walliser in the Carnic Alps. Differences in generic composition of the European and Midwestern faunas and apparent range extensions suggest a more complex zonation than that established by Walliser.

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