carbon accumulations giving rise to a seepage. Data are available for typical hydrocarbon backgrounds, abnormal hydrocarbon backgrounds, suspected gas seeps, and suspected petroleum seeps.

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### Applications of Digitized Logs in Exploration

Present-day technology is supplying digitized wireline log records, either at the well site or at computing centers. Most of these records are used to calculate reservoir parameters of subsurface formations. Although porosity estimates have been vastly improved by these procedures, the techniques developed have dubious application in lithologic evaluation. Digitized logs do provide an excellent base for improved display of log information. Variable area, variable density, mixed mode, and filtered-curve displays accentuate similarities in deposition patterns between wells. Logs in wells with hole-deviation problems or steeply dipping beds may be normalized to match nearby wells. The human eye can be encouraged to act as an analogue computer by such changes in mode of presentation. Techniques developed to estimate formation fluid pressures from well-log data have been used to control drilling practices and may have a significant contribution in detecting patterns of fluid migration within deposition basins.

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### Kinzers Formation—Appalachian Analogue of Burgess Shale?

The Kinzers Formation of southeastern Pennsylvania contains a definite Middle Cambrian fauna near the top of what has been designated as Lower Cambrian rocks. Locally fossiliferous limestone, dolomite, and shale are highly deformed by folding and faulting, making physical tracing of individual units difficult or impossible. Ten faunules can be recognized within the Kinzers Formation, and range in age from Early Cambrian to middle Middle Cambrian. One unexplained time gap occurs in this interval.

The Middle Cambrian fauna, found in black organic shale, compares favorably with part of the Middle Cambrian Burgess Shale fauna. A lower assemblage, designated the "*Ogygopsis klotzi* fauna" contains *Ogygopsis klotzi* (Rominger), *Acrothele decipiens* (?), *Elrathina* sp., *Olenoides* sp., and *Peronopsis* sp., as well as unidentified agnostid trilobites, silicic sponge spicules, and segmented worms. The upper part of the black shale, less than 10 ft above the *Ogygopsis klotzi* faunule bed, contains an assemblage herein designated the "*Peronopsis* sp. faunule." This faunule includes *Peronopsis* sp., *Bathyuriscus* sp., *Elrathina* sp., and *Oryctocephalus* sp.

These beds may represent offbank ("outer detrital") deeper water deposits correlative in part with the Parker Formation of northwestern Vermont and the West Castleton Formation of the New York Taconics.

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### Tectonic Control of Devonian Reef Sedimentation, Alberta

Kaybob reef is one of a group of geologic reefs which underlie west-central Alberta and which comprise the Upper Devonian Swan Hills Formation of the Beaverhill Lake Group. Kaybob reef is a flat north-south elongate lens, 250 ft thick, 11 mi long, and 3 mi wide, built on the Slave Point Formation, a widespread platform carbonate.

Detailed core study of sedimentary structure, texture, and constituents reveals that the carbonate sediments composing the reef can be grouped into 3 environmentally controlled facies groups: reef-slope, reef-margin, and shelf-lagoon facies. The reef-slope facies is a stromatoporoid-crinoid-brachiopod grainstone. The reef marginal deposits consist of a groundmass of massive stromatoporoid grainstone containing varied concentrations of different stromatoporoid growth forms (ranging from slender branching to large massive heads).

The interior facies includes several rock types arranged in repeated vertical sequences. A basal unit of massive wackestone is overlain by combinations of massive, thin-bedded, and laminated mudstones, mudclast grainstones, and amphiporid carbonate conglomerate. Submarine and subaerial scoured surfaces are present within the upper units. The outer slope sediments intertongue with contemporaneous open-marine deposits seaward and with the reef-marginal facies on the inner side of the reef. This pattern changes laterally in vertical section, as the thickness of the reef changes from place to place. The upper half of the reef shows a marked westward displacement.

Position of the various facies within the geologic reef mass, and comparison with Holocene carbonate sediments from several Caribbean localities, together provide a paleoenvironmental interpretation. The interior facies includes most of the sediment types which have been described from recent shallow shelf-lagoon environments. Sequential arrangements are the same and result from similar processes. The marginal realm includes many facies comparable with those observed in Holocene "reef tracts," ranging from scattered coral growth on a sand bottom to coral constructed buttresses of ecologic reefs. Circumferential variations in geologic reef development, the westward displacement of the upper part, and a thick pile of open-marine deposits on the southwest are attributed to prevailing north winds during the Devonian.

Tectonic control is exhibited at 4 levels. 1. The interior shelf-lagoon sequences are initiated by small-scale pulses of subsidence, perhaps complicated by eustatic sea-level changes. 2. Larger scale subsidence variations account for the thickening and thinning of the geologic reef body as a whole. 3. An orthogonal pattern of sharp elongate folds trending NE-SW and NW-SE is expressed clearly at the base of the reef. The folds are confined to the area of reefing, where they controlled reef initiation by forming mud mounds during upper Slave Point deposition. The pattern may reflect Slave Point block faulting. 4. This reef and others in the region, together with their associated carbonate-shelf deposits, fit into a well-expressed orthogonal tectonic pattern controlled by larger scale basement features. The basement features include a "family" of NE-SW-trending, relatively stable arches revolving about a NW-SE-trending major arch, the West Alberta ridge. They form part of the system of stable arches that provides the tectonic framework of the continent.

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### Computer-Based Information Bank for Cretaceous Foraminifers from Western Interior Region, United States and Canada

Micropaleontologists and stratigraphers are overwhelmed by the vast accumulation of literature dealing with taxonomy and occurrence of fossil foraminifers. About 30,000 species of foraminifers have been recognized and described in the literature, and the present rate of publication is approximately 1,000 papers/year. Not only is the volume of publication overwhelming, but also the entire field of foraminiferal study is changing dynamically as new data modify old conclusions and change taxonomic concepts.

The Western Interior Foraminiferal Project was established at Colorado School of Mines to compile selected data concerning Cretaceous foraminifers of the western interior region of the United States and Canada in order to provide an accessible information base on which future research may be built. Information relating to species described, synonyms, geographic occurrence, and stratigraphic occurrence has been abstracted from all papers published through 1968. A printed bibliography with annotations on species occurrence is planned. The abstracted data also have been compiled into an information bank which will be available for computer research workers. The compilation of such a data bank will not eliminate all of the problems of voluminous literature and changing concepts, but will aid research by providing rapid and complete automated search of the literature.

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### Worldwide Development in Exploration Field

Current trends of exploration and development activity in the world's sedimentary basins reveal a major success in Alaska, important discoveries in South America and the Middle East, and increasing activity in the Canadian Arctic. A large proportion of the newer exploration activity is offshore; operations off the North American coasts are at an early stage; exploration continues at a slower tempo than previously on the shelves of northwestern Europe; and activity around Africa, in the Indonesian region, and around the Australian coast is steady. A major discovery in New Zealand is being followed up, and interest is spreading into the Pacific islands.

Exploration in these widespread areas will continue for many years, but sufficient work already has been completed to indicate that (1) offshore basins are as variable in their potential as those onshore, and (2) offshore exploration provides no automatic guarantee of discovering major reserves.

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### Borden Delta (Lower Mississippian) in North-Central Kentucky

The Borden Formation in north-central Kentucky consists of 4 widespread units—a basal clay shale, a middle siltstone and silty shale, a glauconite-rich marker bed, and an upper siliceous silty carbonate. The lower 2 units are a clastic deltaic wedge, the upper limit of which is defined by the marker bed. The wedge thins gradually westward at a few feet per mile to the vicinity of Elizabethtown, where it was found by areal geologic mapping to pinch abruptly from 260 to 50 ft southwestward across a zone about 2 mi wide. This more steeply sloping surface represents the clinoform or foreset front of the Borden delta.

Recognition of this part of the fossil delta is an important adjunct to reconstructing the Late Devonian and Early Mississippian geography of the Illinois basin. Within this framework, several extrapolations are possible: (1) time planes within the delta parallel the delta front; (2) the water into which the delta prograded was at least 200 ft deep in this area; (3) the basal clay shale represents prodelta fondoform sediments; (4) the middle siltstone and silty shale represent the clinoform sediments of the delta proper; and (5) the upper silty carbonate represents resumption of sedimentation under somewhat different conditions following a period characterized by thin glauconite-rich sediment of possible nondeltaic origin.

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### Importance of Continental Drift to Petroleum Exploration

Continental drift is no longer academic, but is important to the oil business as exploration moves increasingly to offshore areas and to remote parts of the world. This field of study meets 2 requirements of petroleum geology: it explains certain known situations, and predicts others that are yet unknown.

Certain features of the Atlantic continental margin are clarified when the evolution of that ocean is understood. Predictions then can be made about the ages of rock and kinds of structures to be expected beneath other parts of the North Atlantic continental shelves.

Integration of submarine and terrestrial geology helps to clarify the relations between geologic features of the marine and continental realms. Examples of areas where integration of submarine and terrestrial geology is possible, are in Arctic Canada, where continental drift is in an arrested stage of development.

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### Geochemistry, Mineralogy, and Occurrence of Calcium Sulfate Minerals

The subsurface distribution of gypsum and anhydrite, the lack of subsurface bassanite, and variations in trace-element ratios between mineral phases confirm experimentally determined stability relations and indicate that the replacement of one mineral phase by another proceeds by a dissolution-reprecipitation process. The earth surface occurrence of calcium sulfate minerals indicates that long-lived metastability is almost the rule and that in many situations kinetic factors dominate over equilibrium controls. In a standing body of brine, gypsum apparently is the only phase precipitated, either at the brine-air interface with elongate growth forms indicative of rapid rate of crystal growth, or at the brine-sediment interface, commonly as cemented layers of discs with their *c* crystallographic axes almost horizontal. Significant anhydrite deposits are known today only from the warmer salt-flat or sabkha environments of the Persian Gulf and Baja California, precipitated interstitially within host sediments as an early diagenetic mineral. The anhydrite is present as contorted layers and nodules, commonly with a felted lath texture. These structures, textures, and other associations are characteristic of anhydrite occurrences.

Experimental studies and Holocene gypsum and anhydrite occurrences provide the information needed to determine which mineral was formed first in a particular situation. Where gypsum is the mineral buried, when and at what depth did it dehydrate, in which direction did the large volumes of dehydration water move, and what diagenetic effects did this dehydration water have on adjacent rocks and pore fluids? Where