Gulf of Mexico basin (located between the Campeche Escarpment and the Florida Escarpment and north of Cuba) provides the basis for an interpretation of the geologic history of the area.

A prominent unconformity of middle Cretaceous age (middle Cenomanian, 97 m.y.) separates the sedimentary section into two major depositional sequences. The pre-middle Cretaceous sequence consists of about 2 to 3 km of Middle Jurassic through middle Cretaceous sedimentary rocks unconformably overlying rifted, attenuated continental crust containing inferred Triassic-Lower Jurassic rift basins. This major sequence is further subdivided into several depositional sequences defined by unconformities tentatively age-dated by correlation with the global sea-level chart. Seismic facies analysis suggests that this major sequence represents a gradation upward from nonmarine to shallow marine and then to deeper marine rocks, the offbank equivalent of the Lower Cretaceous carbonate sections forming the adjacent Florida and Campeche Banks. Overlying the middle Cretaceous unconformity is a relatively thin sequence consisting mainly of pelagic and hemipelagic sediments mixed with carbonate debris eroded from adjacent banks (drilled in Deep Sea Drilling Project 97).

Two DSDP core holes will be drilled in this area in early 1981. Together, these two holes will sample a continuous section into the Jurassic, providing a valuable reference for extrapolating seismic data and unraveling the evolution of the southeastern gulf. In addition, these holes will test the principles of seismic stratigraphy as a tool for predicting depositional setting and age of sedimentary sequences ahead of the drill and will provide data for dating and understanding the origin of deep-sea unconformities.

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Assessment of Potential for Fluid Hydrocarbons in Iowa

Iowa has traditionally been regarded with only passing interest by the petroleum exploration industry operating in the Mid-Continent. This has been primarily due to the lack of structural and stratigraphic information in the area of greatest oil potential, the southwest quarter of the state. Thick deposits of glacial drift and a thick, poorly understood Pennsylvanian section have obscured the character of underlying Paleozoic rock units and restricted exploration incentive and subsurface control in the area. Working with recently acquired geophysical and well-control data, the Iowa Geological Survey has constructed a series of structural and stratigraphic maps that suggest that the oil potential of the Forest City basin in southwestern Iowa should be reevaluated.

Gravity and stratigraphic work along the northeast-trending Thurman-Redfield fault zone suggests vertical displacements of lower Paleozoic rocks of up to 1,000 ft (305 m). The abrupt termination of the large vertical component of the north-trending Humbolt fault against the Thurman-Redfield zone, and the recent recognition of left-lateral movement of the Humbolt fault in Nebraska and Kansas has led to speculation that transcurrent movement and associated structures could provide traps for oil migrating out of the basin. Stratigraphic mapping has also delineated a series of basins and uplifted areas throughout the Paleozoic column in Iowa, possibly associated with isostatic equilibration of the massive Keweenawan flood basalts of the Portage Lake Series, which forms the pronounced geophysical feature known as the Mid-Continent geophysical anomaly. Details of these basins are not clear at this time, but the potential for stratigraphic traps associated with such features in this area should not be ignored.

A series of maps and cross sections of the southwest quarter of Iowa has been prepared illustrating the results of recent and current studies.

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Foreland Fold and Thrust Belt of Carpathians and Its Relation to Pannonian and Related Basins

The foreland fold and thrust belt of the Carpathians extends from Austria through the Carpathians to the south Carpathian bend in Romania where most structural units plunge beneath younger Pliocene-Pleistocene cover. Folds continue westward until all surface expression disappears before reaching Danube River. The belt is flanked by elements of the European, Russian, and Moesian cratonal areas which are overlain by foredeep deposits that are themselves involved within the external fold and thrust belt and overridden by it. Within the fold and thrust belt are older parts of the Carpathian orogene formed on continental crust with evolutionary differences between the western and eastern Carpathians.

The foreland fold and thrust belt consists of an inner flysch and an outer molasse cut into thrust sheets verging cratonward. Oldest flysch units are Middle Jurassic in the U.S.S.R., Upper Jurassic in Romania, and Upper Cretaceous in C.S.S.R. Oceanic crust may have underlain the flysch, and continental crust the molasse. Timing of thrusting is constrained locally, but suggests deformation in the western Carpathians developed during Oligocene to Miocene time progressively outward. Deformation in the eastern Carpathians began in the Albian or early Cenomanian internally and proceeded to late Miocene deformation externally.

The convex east loop of the Carpathian foreland fold and thrust belt resulted from subduction beneath inner Carpathian continental elements fragmented during collision within the European alpine system and driven or pulled eastward, molding the rocks of the fold and thrust belt against a recess in the craton. A Miocene volcanic arc lies internal to the fold and thrust belt, suggesting subduction of a few hundred kilometers of lithosphere.

Basins developed contemporaneous with thrusting within the Carpathian loop. Two types of basins occur: (1) peripheral (Vienna, Transcarpathian, and Transylvanian), showing fast initial subsidence followed by slower linear subsidence, and (2) central intra-Carpathian (Pannonian), showing only fast linear subsidence. Structural and thermal models indicate the peripheral basins formed by twofold stretching and some dike intrusion, whereas the Pannonian basin formed by either twofold stretching accompanied by subcrustal attenuation or by attenuation and erosion of the subcrustal lithosphere.

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Foreland Fold and Thrust Belts—Review

Most foreland fold and thrust belts are linear or arcuate belts of folds and thrust faults that form a marginal part of an orogenic belt between an undeformed craton and a more intensely deformed inner zone. They are characterized by an assemblage of structures that include low-angle thrust faults, folds, tear faults, and ramped and folded thrust faults that deform a wedge-shaped sedimentary sequence. In some belts it can be proved, and in others it is suspected, that these structures have been detached along one or more decollement zones, producing a shortened structural cover and an unshortened structural basement. Vergence of thrusts and folds is predominantly toward the craton, and in many belts it can be shown that there is a general decreasing age of structural development toward the craton. An external foredeep filled with molassic sediments is an integral part of these belts, and the history of thrust movements can often be read from these rocks. Foreland fold and thrust belts are known in orogenic belts of early Proterozoic to recent age.

There is, however, great variation in the general geometry, composition, and evolution of these belts, as well as numerous exceptions to the characteristics outlined above. The sedimentary wedge may consist of rocks that range from continental margin to deep sea fan environments. Variation in rock sequence, particularly the variation in thickness of ductile units such as evaporites, greatly controls the geometry of structures. Some foreland belts involve crystalline basement rocks both locally or extensively, and in one belt (High Atlas, Morocco) basement shortening occurs directly beneath the belt.

Kinematic and dynamic evolution of foreland belts are diverse, but they are an integral part of orogenes and are related to convergent boundary dynamic systems coupled with varying amounts of transform motions. Foreland belts can be shown to have evolved from the following convergent settings: both synthetic and antithetic to B- and A-type subduction, continent and arc collisions, and convergence within transform systems or combinations of such systems. The dynamics of foreland belts has been related to crustal convergence, lateral spreading of plutonic and metamorphic rocks in orogene cores, and a variety of gravity-induced instabilities. Palinspastic reconstructions of foreland belts suggest that while all of these mechanisms may contribute in different degrees to the formation of foreland belts, crustal convergence is the dominant process.

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Coal Resource Data Processing, Old and New Techniques

The use of data-processing techniques in coal resource evaluation is characterized by a gradual adaptation of computer techniques rather than by any revolutionary breakthrough. The main thrust of the data-processing effort is the use of computers to store and retrieve the large volumes of data associated with core-hole analyses. The data are of two types: (1) assay data from coal seams; and (2) codified lithologic descriptions of the stratigraphic sequence of interest. The automatic contouring of assay isopleths is now a routinely accepted procedure; the limitations of the contouring algorithms have been offset by the ability to generate quickly large quantities of maps. The trend now is toward increasingly sophisticated use of available options such as trend analysis and the different geostatistical algorithms for interpretation, estimation, and classification.

In regard to stratigraphic data, the main emphasis is a graphic display of information to aid the geologist in interpreting the stratigraphic sequence. Some attempts have been made to automate the interpretation. In the near future, we expect to see the routine use of interactive graphic devices to aid the geologist in his work. The type of tool envisaged is analogous to the stratigraphic interpretation of seismic records by petroleum explorationists.

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Unconformities—Key to Major Oil Accumulations, North Slope, Alaska

The entrapment of oil and gas at an unconformity at Prudhoe Bay, North America's largest oil field, is well known. It now appears that other large oil and gas accumulations such as those in the Kuparuk River sandstones west of Prudhoe Bay are trapped at an unconformity.

Prudhoe Bay field is on a large anticline on which the reservoir rocks have been truncated by an unconformity. The unconformity places organically rich Cretaceous shales in juxtaposition with Sadlerochit reservoir rocks. Cretaceous shales above the unconformity also provide the updip seal for the oil accumulation.

Oil in the Jurassic Kuparuk River sandstones is trapped on a large structural nose by truncation of the reservoir rocks. The Cretaceous shales above the unconformity provide the seal and possibly the source for the oil.

Uplift of the Barrow arch in Late Jurassic and Early Cretaceous time resulted in a regional unconformity. The truncation of older rocks by this unconformity, and the seal provided by the overlying shales are key factors to exploration of this arch which extends for more than 300 mi (483 km) along the Beaufort Sea coast. The delicate relations of source, reservoir, and trap, which are commonly controlled by one or more unconformities, are important to exploring this rich petroleum province.

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Future Exploration for Geothermal Resources

Exploration for geothermal resources has been concentrated in those areas where hot springs and hydrothermal alteration and deposition at the surface directly indicate geothermal potential.