another supply/demand cycle. The opportunities for advanced-degree graduates probably will continue during this decade and the energy crisis should guarantee a long and exciting professional career.

The intense search for non-Arab, non-OPEC oil-producing areas in the world will continue. The present 28/1 reserves/production ratio of world oil probably will not decline rapidly as long as OPEC nations restrict production to levels significantly below capacity. Other nations with recently expanded oil-production capacity may choose also to maintain moderate export levels. High import prices, supply insecurity, and balance-of-payments problems will keep extreme pressure on production of domestic oil and gas, coal, atomic energy, hydroelectric power, synthetic fuels, and other energy alternatives. In addition, strong compulsory conservation measures probably will be imposed. Rapidly rising leasing, exploration, and production costs and their relation to wellhead prices (minus tax) may result in a deterrent to U.S. oil and gas production.

The outcome of environmental, political, and economic constraints on domestic energy production is more problematic than are the scientific and technologic questions. Three-fourths of our oil and gas reserves and production are in giant fields. Most future discoveries of large fields will be in the frontier areas, largely offshore and in Alaska. National energy policy should encourage exploration in frontier areas, in addition to conservation and development of other energy sources.

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Paleogeography of Eustatic Model for Deposition of Mid-Continent Upper Pennsylvanian Cyclothems

The hypothesis that eustatic sea level changes formed Upper Pennsylvanian cyclothems in Mid-Continent North America has been supported by recent documentation of many episodes of Mississippian through Permian glaciation in Gondwanaland. Changes in Mid-Continent paleogeography and sedimentation during a single eustatic advance and retreat are described in 6 phases. (1) At maximum transgression, deep water promoted development of a thermocline, quasi-estuarine circulation, and upwelling, all leading to widespread deposition across the Mid-Continent of phosphatic black shale, which graded in shallower peripheral areas to gray marine shale and carbonates. (2) Progressive shallowing during early regression destroyed the thermocline, restored bottom oxygenation, and caused deposition of gray shale, and then algal-skeletal calcilutite. Deltas began prograding from Oklahoma and the Appalachians, and shoreline carbonates began prograding southward from the Dakotas. (3) During late regression extensive shoal-water calcarenites developed over most of Kansas, carbonate shoreline facies prograded into southern Nebraska and Iowa, and deltas of Appalachian origin prograded across Illinois. (4) At maximum regression, the sea was confined to the deep basins of west Texas and Oklahoma. Karst, caliche, and residuum developed on the exposed carbonate terrane to the north. The extensive deltaic deposits to the east underwent channeling, alluviation, and soil formation. (5) Expansion of the sea during early transgression restored shoal-water calcarenite deposition across western Kansas, caused gray shale deposition in embayments and lagoons along the inundated deltaic terrane to the east, and impounded Appalachian-derived streams flowing westward across the immense alluvial plain to form widespread coal swamps in Illinois. (6) During late transgression deeper seas restored skeletal calcilutite deposition across the Mid-Continent, caused marine shell accumulations over coals in Illinois, and shifted coal swamp formation eastward into the Appalachian region.

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Stratigraphy and Depositional History of Powell Formation (Uppermost Canadian) in Northern Arkansas

Subsurface geologic data reveal that uppermost Canadian carbonate rock units previously designated as the Smithville and Black Rock Formations in northeastern Arkansas are intertonguing lithofacies of the Powell formation, which trends east-west across northern Arkansas, and do not overlie the Powell as tabular formations. Therefore, these units are considered members of the Powell.

The Powell of northeastern Arkansas was deposited in and marginal to a transgressing epeiric sea along the hinge line of the Reelfoot basin, which lay to the east. Transgression, coupled with subsidence, resulted in Black Rock wedging to the northwest, onlapping the Smithville. Numerous minor regressions superimposed interfingering upon the overall transgressive pattern. Influx of quartz sand terminated Powell deposition, initiating deposition of the Everton Formation without interrupting sedimentation.

Constantly shifting environments resulted in complex intertonguing of carbonate lithofacies, with nonmarine lithofacies in the west progressively giving way to marine lithofacies toward the east. The Powell of northwestern and north-central Arkansas is characterized by nonfossiliferous, unburrowed cryptalgalaminate dolostone deposited above the strand on occasionally inundated algal mudflats. The Smithville Formation of northeastern Arkansas is characterized by fenestral carbonates and an abundant gastropod fauna, deposited above the strand on frequently inundated algal mudflats. The Black Formation is characterized by two distinct marine lithofacies: burrow-mottled cryptalgalaminates, deposited below the strand but above wave-base in a low-energy, schizohaline environment; and abundantly fossiliferous sponge-bearing biomicrudite, deposited below the strand but above wave-base in a moderately agitated, normally saline marine environment.

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Scientific Ocean Drilling near United States

Deep sea drilling by the *Glomar Challenger* is scheduled to phase out in October 1981. Plans are being made to phase in the *Glomar Explorer* or a drill ship with more capabilities after that time. These additional capabilities include longer drill string, a riser, a blow-out

preventer, and better station-keeping abilities. Plans also include an extensive science program for regional and site specific surveys and sample analysis. Primarily the drilling will be used on passive margins, especially those of the continental United States. Where feasible, the drill holes and their site surveys will be used to extend seaward land sea transects that might include continental drilling, CORCORP profiles, and continental drilling by U.S. Geological Survey or petroleum companies.

HELWIG, JAMES, ARCO Oil and Gas Co., Dallas, TX

Stratigraphy and Structure of Early Tertiary Orca Group, Prince William Sound, Alaska

The late Paleocene-early Eocene Orca Group records much of the depositional and deformational history of the Tertiary accretionary prism found in the subduction zone of the Pacific plate in south Alaska. The thick (?5,000+ m) quartzo-feldspathic sandstones and interbedded shales were deposited as a submarine fan complex. Paleocurrents show derivation of detritus from a northeastern source. Three facies belts are distinguished. A northwestern belt characterized by massive sandstones and strong deformation is thrust southeasterly over a central melange belt containing originally interbedded basalt and turbidites deposited on an ophiolite basement. To the southeast, the third belt comprises a classic turbidite sequence which may have been deposited upon imbricated offscrapings of pelagic Upper Cretaceous sedimentary rocks now exposed only in one faulted outcrop on southeast Montague Island.

The predominant structures of the Orca Group are steeply northwest-dipping thrusts and folds overturned to the southeast in harmony with northwesterly subduction of the Pacific plate. However, on Montague Island the neotectonic southeasterly overturned structures overprint early major northwesterly overturned folds. Along strike to the northeast, northwest-trending cross structures overprint the early folds. Structural analysis indicates that the structure of the late Tertiary offshore basin is complex.

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Oxidation-Reduction in Oakville Sandstone of South Texas—Implications for Uranium Mineralization

Three distinct oxidation-reduction zones have been identified within the uranium-bearing Oakville aquifer. An oxidizing zone with Eh values greater than 300 mv and with measurable dissolved oxygen occurs in areas of recharge and extends to depths as great as 800 ft (244 m). An intermediate zone with Eh values between 110 and 10 mv occurs downdip from the oxidizing zone. Eh in these waters may be controlled by ferrous-ferric mineral reactions. About half of the intermediate Eh waters contain low but detectable concentrations of hydrogen sulfide. In east Texas the deepest wells sampled (1,600 ft; 488 m) penetrate this intermediate zone. A reducing zone with Eh less than −40 mv and dissolved H_2S occurs in deepest parts of the Oakville in south Texas and also at shallow depths (300 ft; 91 m) associated with faults, which apparently provided conduits for the discharge of reducing, sulfide-rich waters from deeper formations. Present-day Eh is controlled by either the continued discharge of reducing water or the presence of pyrite formed by previous reduction.

Thermodynamic calculations show that uranium and selenium phases may precipitate within the intermediate zone, but that molybdenum and arsenic require more reducing conditions for precipitation. All four elements should occur together only where the oxidizing and reducing zones are adjacent without an intervening intermediate zone. Such areas can occur (1) where fault discharge has superimposed reducing, sulfidic conditions on an otherwise normal Eh gradient or (2) where a sharp Eh gradient separates highly permeable oxidized sediment from less permeable reduced sediment. Where oxidizing and reducing zones are not adjacent, uranium and selenium only should accumulate within the intermediate zone, and mineralization may be diffuse.

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Marine Petroleum Prospecting with Airborne Fraunhofer Line Discriminator

Natural oil slicks from the Santa Barbara Channel, California, have been imaged using an airborne Fraunhofer Line Discriminator (FLD). The imaged distribution correlates well with aerial photographs, visual observations, and simultaneous television monitoring. However, the areal extent of the surface film mapped by the FLD is larger than that determined by the other methods, suggesting that the FLD is more sensitive to exceptionally thin films. Digital image-enhancement techniques applied to multispectral FLD data may provide general compositional information. The FLD may be useful to explorationists looking for evidence of hydrocarbons in frontier marine areas.

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Possible Geometries of Sandstone Bodies as Reflected by Geomorphic Features on Modern Submarine Fans

Understanding the growth processes and geomorphic features of modern submarine fans will aid in the exploitation of potential hydrocarbon resources in deep-water turbidites. Surveys on four fans in the northeast Pacific using the deep-tow instrument package show a wide variety and size range of relief features. At least three types of channels can be recognized; (1) leveed valleys, common on the upper fan; (2) distributary channels that branch from the active valley; and (3) "headless" channels found at the basin slope and fan margin or along the edges of depositional lobes. All the channel types are associated with areas of active sand deposition. An abandoned distributary channel would likely become the site of deposition of pelagic and hemipelagic muds and occasional thin-bedded turbidites. A connection to the main channel may be maintained by