At least 3 factors appear critical for marine dolomitization: (1) waters undersaturated with respect to calcite, but supersaturated with respect to dolomite; (2) permeable limestones; and (3) hydrologic position of those limestones where numerous pore volumes of undersaturated water will be flowing through. In the past, different oceanographic conditions may have caused some ancient seas to have relatively shallow calcite saturation depths. Many ancient dolomites found in atoll and reef-wall settings may have also precipitated in normal marine water.

SAMS, RICHARD H., Sams Exploration, Inc., San Antonio, TX

Explorationist's Model of a Patch-Reef Trap

A geologic model of a carbonate patch-reef complex is proposed. When applied to subsurface control where wells have been cored, the model is designed to actually position a well location with respect to a stratigraphic trap formed by the patch reef. The model is lithofacies governed and is based upon those facies relationships observed among several Gulf Cost patch-reef examples. The relationship between variations in effective porosity and permeability and the variations in lithofacies appears to be direct, judging from the examples studies. This direct relationship points to the formation of a permeability barrier stratigraphic trap where certain updip and lateral facies changes occur.

Only primary porosity and permeability are considered by the model. The effects of secondary porosity, fracturing, dolomitization, and/or secondary cementation can be considered by a second model applied as an overprint to the first.

Application of the model as an additional exploratory tool in carbonates where reservoir quality is a function of lithofacies distribution can lead to the drilling and discovery of numerous subtle stratigraphic traps.

SANDERS, DAVID E., Superior Oil Co., Midland, TX, and NEIL PETERSEN, Superior Oil Co., Houston, TX

Structural Evolution of Val Verde Basin, West Texas

The Val Verde basin is a northwest-southeast trending foreland basin contained within the southern portion of the Permian basin. The Val Verde basin has several large fields, e.g., Brown Bassett and JM, which have a combined ultimate recovery of over 1 tcf of gas. Structurally, the major fields are complexly faulted features related to differential uplift of basement blocks. Vertical and horizontal displacement resulted from a wrench system dominated by northwest and northerly trending faults. Reverse faults associated with the wrench system appear to exhibit characteristics of both high-angle and low-angle faults, as is typical of foreland structures. Tectonism was initiated during the late Mississippian, consequent to Ouachita plate convergence, and continued into the Permian.

Middle and Upper Permian strata are not present in the central and southern Val Verde basin. Appreciable amounts of Permian sediment were eroded prior to deposition of Cretaceous strata, thus, Cretaceous rocks unconformably overlie Wolfcamp sediments. Restored estimates for vitrinite reflectance data indicate a minimum of 8,000-10,000 ft (2,400-3,000 m) of Permian rocks have been eroded. Therefore, in the central and southern portions of the basin, Paleozoic rocks are inferred to have occupied depths several miles deeper than present. Vitrinite reflectance values for Ellenburger (Ordovician) rocks at Brown Bassett are approximately 1.8 to 2.0% R_0. Ellenburger reflectance values increase to the south and southeast to values greater than 4.5% R_0. The most southerly wells also have reflectance depth trends which show a break in gradient within Wolfcamp sediments (9,000-10,000 ft, 2,700-3,000 m). The change in gradient suggests a thermal event contemporaneous with the basin's rapid downwarping and Wolfcamp deposition.

Any exploration in the basin, therefore, must recognize the unique relationships between structural timing, structural position, depth of burial, thermal pulses, and hydrocarbon mobility for a large portion of the Val Verde basin.

SAWYER, DALE S., Univ. Texas at Austin, Austin, TX

Gulf of Mexico Plate Reconstruction by Palinspastic Restoration of Extended Continental Crust

A number of recently published Gulf of Mexico plate reconstructions are strikingly dissimilar. There are no sea floor magnetic lineations, and the sizes and shapes of the continental blocks are not well-defined. Perhaps the only common feature of the several reconstructions is that they ignore the role of continental crust extension during rifting.

In this study, total tectonic subsidence analysis was used to estimate the mount of crust extension in the Gulf of Mexico to determine its effects on the proposed plate reconstructions. This involves the calculation and mapping of the sediment-unloaded basement depth from observations of the basement depth, water depth, and sediment compaction properties. The well-known depth-age relation for oceanic crust and a model for the subsidence of extended continental crust allowed within the limits of available data the identification and mapping of crust type and the amount of extension of transitional crust.

The zone of extended continental crust under the northern margin of the Gulf is extraordinarily wide, more than 800 km (500 mi) in a cross section through east Texas. The zone of extended crust to the south is much narrower, about 150 km (90 mi) on the margin of the Yucatan Block. Palinspastic restoration shows that the total 950 km (590 mi) of extended and thinned continental crust corresponds to 490 km (300 mi) of continental crust of original thickness. Therefore 460 km (280 mi) of crustal extension occurred during rifting and prior to ocean crust formation. The 460 km (280 mi) of extension along this cross section, and the results of similar calculations on other cross sections, must be accounted for properly when reconstructing the prerift configuration of the Gulf of Mexico.

SCHLOSSER, A. C., Gulf Exploration & Production Co., Houston, TX, and D. G. JOVANOVICH*, R. C. JONES, and J. H. CALDWELL, Gulf Research & Development Co., Houston, TX

3-D Seismic Interactive Interpretation of Complex Stratigraphic Environments: An Example From Grayson County, Texas

Interactive interpretation of 3-D seismic data is now an effective tool for mapping complex stratigraphic targets on land. Slicing a 3-D seismic cube through a single reflector provides an insight into complex stratigraphic environments.

A case study from Grayson County, Texas, is used as an example. Production from the lower Davis sands of the Atokan series was established in the Southmaud area in 1978. Further development of the field led to a success ratio of only 50%. Stratigraphic complexity of the fluvial to deltaic environment made reservoir prediction and placement of offset wells difficult. A 6-mi^2 3-D survey was shot for the purpose of mapping the sand distribution. Acquisition and processing costs were less than the cost of one dry hole. The producing sands were a difficult seismic target. Resolution of these sand bodies was in question due to their vertical and horizontal extent as well as their small reflection coefficients.

The interpretation was completed in eighteen hours using Gulf's Interactive Seismic Interpretation System (ISIS). Only one well was used initially to identify seismic horizons. Structural mapping was completed using dual polarity, random vertical lines, and isotime slices. Stratigraphic interpretation was done with discrete amplitude coloring to take advantage of seismic tuning effects. Stratigraphic slices revealed the distribution and thickness of the reservoir sand. Geological features interpreted include a meandering channel with point-bar buildups, a distributary complex, and erosional or nondepositional areas.

SCHROEDER, E. ROBERT, DeGolyer and MacNaughton, Dallas, TX

Hydrocarbon Resources of United States Arctic

In April 1980, the National Petroleum Council, an advisory committee to the Secretary of Energy, was requested to estimate, among other directly relevant matters, the oil and gas resources of the United States Arctic regions. The evaluation was based on a review of publicly available information and a survey of the study participants. The results are a composite of anonymous estimates of 20 industry representatives.

As of August 1980, 16.5 billion bbl of recoverable oil and oil-equivalent gas had been discovered on the North Slope. An additional 44 billion bbl of undiscovered, recoverable oil and oil-equivalent gas are estimated for the United States Arctic. Of these, 24 billion bbl may be oil and the remainder will consist of 109 tcf of gas and natural gas liquids. These undiscovered resources constitute as much as 40% of the total undiscovered recoverable oil and gas remaining within United States jurisdiction.

A 1% chance exists that the undiscovered recoverable oil and oil-equivalent gas could exceed 99 billion bbl. Of 10 highly prospective areas, the largest resources occur offshore in the Beaufort shelf and the Navarin basin shelf. Basins appearing to have a relatively low potential should not be ignored. Future geologic information could cause significant revisions. Cost and technical considerations detract significantly from the apparent exploration merit of some resource-bearing basins, particularly in the arctic marine areas.

Industry investment commitments since the study correspond with the study results.

SCHULL, THOMAS J., Chevron U.S.A. Inc., Concord, CA

Oil Exploration in Nonmarine Rift Basins of Interior Sudan

In early 1975 Chevron Overseas Petroleum Inc. commenced a major petroleum exploration effort in previously unexplored interior Sudan. With the complete cooperation of the Sudanese Government, Chevron has acquired a vast amount of geologic and and geophysical data during the past 9 years. These data include extensive aeromagnetic and gravity surveys, 25,000 mi (40,200 km) of seismic data, and the results of 66 wells. This information has defined several large rift basins which are now recognized as a major part of the Central African rift system.

The sedimentary basins of interior Sudan are characterized by thick Cretaceous and Tertiary nonmarine clastic sequences. Over 35,000 ft (10,600 m) of sediment have been deposited in the deepest trough, and extensive basinal areas are underlain by more than 20,000 ft (6,100 m) of sediment. The depositional sequence includes thick lacustrine shales and claystones, flood plain claystones, and lacustrine, fluvial, and alluvial sandstones and conglomerates. Those lacustrine claystones which were deposited in an anoxic environment provide oil-prone source rocks. Reservoir sandstones have been found in a wide variety of nonmarine sandstone facies.

The extensional tectonism which formed these basins began in the Early Cretaceous. Movement along major fault trends continued intermittently into the Miocene. This deformation resulted in a complex structural history which led to the formation of several deep fault-bounded troughs, major interbasin high trends, and complex basin flanks. This tectonism has created a wide variety of structures, many of which have become effective hydrocarbon traps.

SCHWAB, KARL W., Geo-Strat, Inc., Houston, TX, and DOUGLAS PERRY, 4130 Osby, Houston, TX

Effect of Radiation on Particulate Organic Matter Associated with Roll-Front Deposits

When multiple maturation populations are observed in organic materials derived from core and/or outcrop samples, the common assumption is that the more mature organic constituents have been reworked from older sediments. Uranium roll-front deposits are exceptions to this rule. In core samples that pass through roll-front deposits, the extractable organic matter frequently exhibits various aspects of radiation damage (selective oxidation and/or thermal alteration). Core samples taken above the roll-front contain spores, pollen, and associated plant debris which have a uniform level of alteration (thermal maturity). However, once the roll-front deposit is penetrated, a dual mode of thermal maturity is observed. Lower levels of maturation gradually give way to much higher alteration values as one approaches the zone where the uranium ore is most concentrated. This process reverses itself once the core hole passes through the roll-front into nonmineralized rocks.

Because the alteration of the spores, pollen, plant tissue, and associated vitrinite particles is irreversible, the organic petrographer can use this data to assist the explorationist in regional mapping of uranium roll-front deposits, even when radioactivity in a given location has decreased below measurable levels.

SEELAND, DAVID, U.S. Geol. Survey, Denver, CO

Paleodrainage-Unconformity Model as Guide to Uranium Deposits

This paper considers a uranium occurrence model that shows how early Eocene and Oligocene depositional patterns and paleogeography can be used to identify favorable host rocks and to suggest where uraniferous ground water passed through these rocks. The uranium in the ground water was derived mostly from volcanic ash of the Oligocene White River Group. This model accounts for most known uranium deposits and occurrences in eastern Wyoming, western South Dakota, and western Nebraska.

All major deposits in Eocene sandstones are in rocks of the fan-channel facies that were identified by sand grain size and shape studies, and most deposits are basinward of present-day major mountain valleys. Deposits occur only where rocks of this facies are less than 300 m (980 ft) below the reconstructed basal Oligocene surface—a distance calculated from roll-front migration and erosion rates.

Uranium deposits in other than Eocene rocks also are related to the configuration of the pre-Oligocene surface. White River channel sandstones have deposits and occurrences along a 200-km (125-mi) section of a major Oligocene river in eastern Wyoming and Nebraska. Oligocene trans-mountain drainages localized uranium occurrences in Precambrian granitic rocks in the Laramie Mountains. Deposits in Cretaceous rocks in northern Colorado and along the flanks of the Black Hills lie beneath the axes of Oligocene channels. The channels were the major conduits that localized the movement of the uranium-bearing solutions. Rocks underlying the divides between the channels are unfavorable for uranium deposits where the channels are parallel to the regional dip, because the divides have a thick impervious lateritic soil cover.

SENGÖR, A. M. C., and NACI GÖRÜR, Istanbul Technical Univ., Istanbul, Turkey

Strike-Slip Tectonics, Related Basin Formation, and Sedimentology in Zones of Continental Escape: Turkey as a Case Study

Strike-slip movement on various scales and in diverse orientations is one of the most prominent modes of deformation in zones of continental convergence. Extreme heterogeneity and low shear strength of continental rocks are responsible for creating "escape routes" of bewildering complexity into free faces from nodes of constriction along irregular collision fronts. Since the Tortonian (11 Ma), the tectonics of Turkey has been dominated by its escape westward from the east Anatolian collision zone onto the oceanic lithosphere of the eastern Mediterranean, mainly along the north and east Anatolian transform faults (NAT & EAT), and at least two other southeast-concave strike-slip faults that branch off the NAT near Erzincan and Resadiye. The Aegean graben system is a broad shear zone between the latter of these and the Grecian shear zone. At "triple junctions" involving the NAT/EAT and EAT/Dead Sea transform fault, space problems arise, giving rise to the Karliova and Adana/Cilicia basins, respectively. In Thrace, where the NAT takes a southwesterly bend, part of the resulting constraint is released by rifting in a northwest orientation that formed the Ergene basin. In addition, various pull-apart structures and "leaky" strike-slip faults contribute to the richness of strike-slip-related negative structures in Turkey. Some of these are of lithospheric dimensions and contain thousands of meters of sediment, whereas others formed within thinner crustal flakes above decollement horizons. Because escape tectonics necessarily involves subduction, arc-related strike-slip deformation may interfere with that indigenous to collision tectonics, as in south Turkey. Continental convergence eventually eliminates all subductable areas along the collision front and the structures generated by escape regimes may fall prey to compressional obliteration. In zones of complex and multiple continental collision such as Turkey, several episodes of escape tectonics may alternate with intracontinental compressional deformation, whereby the products of the older escape regimes would be very difficult to recognize. The present tectonics of Turkey constitutes an excellent guide to earlier episodes of escape tectonics in and around Turkey.

SEYLER, BEVERLY, Illinois State Geol. Survey, Champaign, IL

Role of Diagenesis in Formation of Stratigraphic Traps in Aux Vases of Illinois Basin

The Aux Vases Sandstone, a prime exploration target in the Illinois basin, is a prolific but enigmatic reservoir that has produced nearly a billion bbl of oil. Detailed outcrop and subsurface study shows that much of this production is from diagenetically influenced stratigraphic traps in a complex tidal-sandbar system. The complexity of this system makes iden-