part of the geosyncline are thick, probably Triassic redbeds. Superjacent strata consist of widespread evaporites, notably halite, and redbeds which may be Triassic, Jurassic, or both, in age. Younger Jurassic, Coahuilan, Comanchean, and early Gulfian rocks vary lithically from coarse, marginal, or continental clastics to basin and platform or shelf carbonates. Thick evaporites, predominantly anhydrite, are present in the Late Jurassic, Coahuilan, and Comanchean of the Gulf region. Extensive, calcareous-argillaceous, marine Cretaceous beds constitute evidence of the maximum spread of oceanic waters upon North America during the Mesozoic. Subsequently, in the Tertiary, waves of clastic sediments progressed into the geosynclinal province. Paleogene sedimentation centered in the Rio Grande region of southern coastal Texas whereas Neogene deposition was concentrated in southern Louisiana and adjacent offshore area. Tertiary thicknesses in each area exceed 25,000 feet. In the Florida and Yucatan platforms, on the other hand, deposition of carbonates predominated during the entire Mesozoic and Cenozoic.

Major sedimentary units of the geosynclinal mass are arranged in belts roughly concordant with the general trend of the modern shore. In gross form, they resemble flattened link sausages, the thick portions corresponding with centers or loci of deposition (depocenters) of particular sedimentational epochs. Several depocenters of the same age constitute a regional axis of deposition (depoaxis), the locations of which have gradually shifted gulfward since the Jurassic. Major reversals of this gulfward migration occurred in the Cretaceous and Tertiary and resulted in widespread cyclic sedimentary sequences (cyclothems).

Filling of the Gulf basin occurred by seaward building (prograding) of sedimentary masses. With progradation, depression of the continental edges continued; the sedimentary masses increased generally in thickness, possibly because of concentration in belts of less width; and tilting and uplift of the landward margins of the older rocks of the geosyncline occurred. Sags, swells, faults, salt structures, and so on, measurably deformed and affected the sedimentary materials. These processes of accretion and deformation continue today, gradually adding girth and natural resources to the continental area.

2. JOHN G. WINGER, Chase Manhattan Bank, New York, N. Y.

United States Energy Outlook to 1975

Presentation will deal with outlook for domestic petroleum industry to 1975. Outlook will demonstrate impact of U. S. economy and energy markets of a significant change in the composition of the population by age brackets. A regional division of U. S. energy market will show relative opportunities for market growth of oil and gas in each area. Pointed up will be the effect on oil of likely gas expansion in Atlantic Coast market.

3. JOHN D. HAUN and HARRY C. KENT, Department of Geology, Colorado School of Mines, Golden, Colorado

Geologic History of Rocky Mountain Region

In late Precambrian time, sedimentary rocks were deposited in a developing geosyncline in the Cordilleran region. Eastward extensions of this geosynclinal sea occupied parts of the Rocky Mountain Region. Following gentle deformation and erosion the sea spread eastward during the Cambrian and Ordovician Periods.

Discontinuous Ordovician, Silurian, and Early Devonian rocks indicate short intervals of marine invasion interrupted by periods of erosion. A major invasion of the sea over the craton is recorded by the onlap of Devonian and Mississippian carbonates and Devonian evaporites which rest on rocks ranging in age from Precambrian to Early Devonian.

The pattern of widespread shallow seas of the Mississippian Period was interrupted in the Pennsylvanian and Permian Periods by significant tectonic activity (Ancestral Rockies). Portions of the uplifts remained positive until Triassic or Jurassic Periods and supplied coarse clastics to adjacent areas within late Paleozoic basins. At greater distances from land areas, sandstones, redbeds, evaporites, and carbonates accumulated.

Marine Triassic sediments were deposited in southeastern Idaho and adjacent areas. Triassic and Early Jurassic continental deposits accumulated throughout much of the region.

A series of Jurassic marine invasions from the Arctic initiated another major sequence of events. The boreal sea moved southward into the northwestern and western parts of the region in Middle Jurassic and successive transgressions reached as far southeast as northern Colorado by Late Jurassic. After withdrawal of the Jurassic sea, the pattern of overlap was continued by deposition of nonmarine Jurassic and Cretaceous sediments.

In the Early Cretaceous a sea again invaded from the north and in late Early Cretaceous joined a southern sea forming a seaway which persisted during the remainder of the Period. During Early Cretaceous, clastic sediments were derived from the craton to the east and from the Cordilleran region to the west. In Late Cretaceous, the western source area predominated.

The present tectonic framework was initiated during the Late Cretaceous and early Tertiary with the development of uplifts and intermontane basins (Laramide Orogeny) accompanied by the emplacement of the Idaho batholith and associated intrusions. Extensive thrust faulting occurred in the western part of the region. Lacustrine and fluviatile sediments, derived from surrounding uplifts, were deposited within the intermontane basins.

Volcanic activity was moderately important to the west during the Cretaceous Period, but igneous intrusion and volcanic activity became widespread throughout the Rockies in the Tertiary.

The present drainage system was largely developed as the intermontane basins filled. Subsequent stream erosion, accompanied by Pleistocene glaciation and regional uplift, resulted in the shaping of the present topography.

4. L. DAVID GRAYSTON, Monsanto Oils Ltd., Calgary, Alberta, Canada

Paleozoic Tectonic Framework of Western Canada Basin

The Paleozoic sedimentary record in the Plains and Rocky Mountains (Eastern Cordillera) regions of western Canada is fairly complete, but it is characterized by five major unconformities and at least four lesser discontinuities. The five interregional breaks form the boundaries of four distinct depositional sequences which are, in general, equivalent to the Sauk, Tippecanoe, Kaskaskia, and Absaroka (lower part) of Sloss (1963). With minor exceptions, these sediments are all of miogeosynclinal and shallow shelf types. In the Western Cordillera west of the Rocky Mountain trench, Devonian and Mississippian rocks are almost totally lacking except in northwestern British Columbia where thick eugeosynclinal deposition occurred. It is probable that Pennsylvanian eugeosynclinal conditions prevailed in southern and central British Columbia, and the Permian is represented by widely distributed thick eugeosynclinal deposits in this region. There is some evidence of pre-Middle Devonian orogeny in the Western Cordillera, correlative with the Caledonian interval of Europe and the Arctic Islands, and, in a restricted sense, equivalent to the Cariboo orogeny of White (1959). In the interior cratonic region and the Rocky Mountains, the evidence indicates that the emergences of Late Proterozoic (Precambrian), Early Ordovician, Early Devonian, Late Pennsylvanian, and Late Permian were epeirogenic in character. Intracratonic features such as the Williston basin, Sweetgrass arch, Western Alberta arch, Peace River arch, and Keewatin-Wisconsin arch in part had early development in Ordovician-Silurian time, but were emphasized during the post-Silurian to pre-Middle Devonian interval of uplift and deep erosion. The Paleozoic ended with the widespread post-Permian emergence and erosion, herein regarded as a discontinuity of interregional type.

5. L. L. SLOSS, Northwestern University, Evanston, Illinois

BASEMENT INFLUENCES OF TECTONIC CYCLES IN BASINS

Although direct information from deep boreholes and indirect data from geophysics add significantly to interpretations, the geometry and composition of the basin fill remain the most fruitful fields from which to draw inferences on the behavior of major sedimentary basins. Geometric and compositional data are capable of analysis to yield interpretations through geologic time of the rate of subsidence in basins, their degree of differentiation from surrounding neutral and positive elements, the positions and stability of the hingelines along which such differentiation is accomplished, and the position and character of source areas contributing to the basin fill.

Evaluation of the sedimentary record of basins in the interior of the North American craton indicates that, for the period since late Precambrian, such basins, in harmony with the rest of the craton, have been involved in six major sedimentary cycles. Four of these, corresponding with the times of accumulation of the Sauk, Tippecanoe, Kaskaskia, and Zuni Sequences, exhibit records of five distinct stages that appear to have simultaneous effects on all cratonic basins. None of the cratonic cycles shows any systematic correlation in space and time with orogenic events in extracratonic mobile belts.

These essentially stratigraphic deductions raise questions that require consideration in the development of geologically meaningful basin models. Such models must include simultaneous consideration of the composition, structure, and dynamics of the continental crust and upper mantle.

6. ROSS H. LESSENTINE, Pan American Petroleum Corporation, Farmington, New Mexico

KAIPAROWITS AND BLACK MESA BASINS—STRATIGRAPHIC SYNTHESIS

The Black Mesa and Kaiparowits Basin area is located in the southwest portion of the Colorado Plateau Structural Province. The Black Mesa basin, encompassing approximately 6400 square miles, extends from the Kaibab upwarp on the west to the Defiance uplift on the east; from the Mogollon Rim on the south to the Utah-Arizona line on the north. The Kaiparowits basin covers approximately 8500 square miles and is bounded by the Sevier and Paunsaugunt faults which delineate the east edge of Basin and Range structures and by the Circle Cliffs upward on the east. To the north the Kaiparowits basin passes under the extensive Tertiary flows of the Aquarius Plateau.

Throughout most of Paleozoic time, the Black Mesa and Kaiparowits basin area occupied an extensive shelf area between the Ancestral Sierra Grande on the east and the Cordilleran geosyncline on the west.

Cambrian, Devonian, Mississippian, Pennsylvanian and Permian sedimentary units are present in the subsurface. No rocks of Ordovician or Silurian age are recognized. Rocks of Permian age and younger are commonly exposed. Paleozoic strata are products of marine sedimentation on the shelf which bordered the Cordilleran geosyncline. Stratigraphic or depositional strike was apparently controlled by adjacent low-lying land masses and embayments into the shelf area from the Cordilleran geosyncline.

Orogenic activity, beginning in Late Pennsylvanian and continuing through the Tertiary affected sedimentation during this portion of geologic time as the seas periodically withdrew and encroached upon the shelf area.

Large anticlinal features are present in both basins which appear to have had an early history and offer many favorable possibilities for oil and gas production in areas of favorable stratigraphy.

7. RICHARD A. ULLRICH, El Paso Natural Gas Company, Farmington, New Mexico

SEDIMENTARY HISTORY OF SAN JUAN BASIN OF NEW MEXICO AND COLORADO

The San Juan basin is an ovoid-shaped intermontane basin located in northwestern New Mexico and southwestern Colorado. It is the southeastern part of the Colorado Plateau and as defined in this paper it encompasses about 7,600 square miles within the Point Lookout (Cretaceous) outcrop.

Except for the Ordovician and Silurian and possibly Lower Cretaceous which are not present, all rocks of the geological time scale can be penetrated in 15,000 feet or less.

Marine conditions prevailed during early Paleozoic time. At the end of Pennsylvanian time, sedimentation of clastics increased from neighboring highlands and a period of transition from marine to continental deposition extended into Permian time. Primarily, continental conditions continued through Triassic and Jurassic time. After a hiatus at the end of Jurassic time, the Cretaceous was deposited in a varied but mainly marine environment. Local movement due to the Laramide Orogeny, caused subsidence of the basin and rising of the surrounding mountains. Large quantities of detrital material filled the basin with Paleocene and Eocene sediments.

Most of the basin has not been drilled below the Dakota Formation. Only 19 wells have penetrated the Paleozoics within the Point Lookout outcrop. The density of Paleozoic tests is one well per 400 square miles and most of these tests are near the periphery of the basin. Because of this exiguous well control, most of the deeper sediments of the basin are relatively unknown. None of the deeper tests have been commercial producers.

Economic importance of the rocks in the basin is very diverse with oil, natural gas and coal being the main economic resources.