Many geological concepts of widespread application to petroleum exploration were either first, or early, observed and studied in the Mid-Continent region. Five are selected for discussion. These are: (1) pools reservoired in sandstone patches, lenses, channels and bars; (2) unconformities, truncations, and layers of geology—their influence on exploration; (3) tilted oil-water contacts, fluid pressure gradients; (4) changing structure with depth, converging strata, "bald-headed" structures, closed structures below terraces, and the hingeline concept; and (5) one discovery leads to another—and another. These are typical of some of the simple geological phenomena that abound in this region, that seem to control much petroleum occurrence, and that are continually being used in the world-wide search for oil and gas.

3. J. G. WINGER, Chase Manhattan Bank, New York, New York

OUTLOOK FOR DOMESTIC PETROLEUM INDUSTRY TO 1975

The changing composition of population by age brackets is providing an impact upon U. S. energy markets. A similar impact is noticeably affecting the general economy. Each regional division of the U. S. energy market possesses a relative growth opportunity for oil and natural gas. The expanding Atlantic Coast gas market is providing a noticeable effect on the oil market.

Considerable new oil and gas reserve additions will be necessary to maintain production levels required to satisfy the increasing demand by major markets.

4. R. C. CLINTON, Clinton Oil Company, Wichita, Kansas

GEOLOGIST'S ROLE IN ECONOMICS OF FINDING OIL IN MID-CONTINENT AREA

The Mid-Continent geologist must become involved with the economics of oil-finding. Because the fields being found today are smaller, the development risk is greater. We must compensate by improving our technique of selecting exploratory drill-sites.

The costs of overhead, equipment, travel, promotion, geophysical work, *etc.* are increasing at a fairly steady rate. Drilling costs, however, are about the same because they have increased in certain areas and decreased in others. The price of oil remains the same, but the net price paid to the oil-finder is reduced by an increase in taxes and service fees for oil-gathering. The over-all cost of selecting and preparing an exploratory prospect for drilling has nearly doubled in the last 5 years.

The tax burden has now become so great that it seems necessary to incorporate tax savings in drilling and development programs to realize a profit comparable with other businesses. A larger number of geologists may be required to represent oil "deals" for sale to the general public, particularly to those in high tax brackets. Therefore, the geologist must be completely familiar with the Securities Act of 1933.

5. L. L. WYNN, Apache Corporation, Tulsa, Oklahoma

GAS FIELDS FROM HARTSHORNE SAND OF ARKOMA BASIN

The Arkoma basin of southeastern Oklahoma is characterized by long, steeply folded anticlines, dry gas production, and no oil. One of the most prolific gas reservoirs in the area is the Hartshorne Sand, of early Desmoinesian age, productive at 1,000–4,000 ft. This sandstone produces gas in the Poteau-Gilmore field on the Gilmore anticline, at Cameron field on the Midland anticline, at Red Oak-Norris on the Brazil anticline, and at Quinton-Carney-Featherston and Kinta fields on the Kinta anticline.

The first commercial gas well in the Quinton field was completed in September, 1915, with an open-flow potential of 25 million cu. ft. of gas daily from the Hartshorne Sand. Subsequent drilling along the structural axis of the anticline found the Blocker-Featherston, Carney, and Kinta fields. The significance of the "structural" accumulation of gas on the Kinta anticline was not fully understood until Pine Hollow gas field was discovered and developed nearly 50 years after the completion of the discovery well at Quinton. It now appears that the Hartshorne Sand is producing from stratigraphic traps in a series of off-shore bar deposits that extend from Pine Hollow to Kinta.

6. W. E. RICHARDSON, Consultant, Oklahoma City, Oklahoma

OSWEGO LIMESTONE FACIES CHANGE IN MID-CONTINENT REGION

The Oswego is the oldest and most widespread limestone unit of the Marmaton Group. The Marmaton is the oldest succession of Pennsylvanian carbonates that are indigenous to the shelf area of the western Mid-Continent.

The Oswego Limestone occurs over most of northern Oklahoma and southeastern Kansas, where it sometimes attains a thickness in excess of 100 ft. The Oswego is developed as a shelf limestone unit. Southward, it grades into a basin shale. The gradation from shelf limestone to basin shale occurs in a zone that is usually from 2–4 mi. wide. Within this transitional band, "reef-like" limestone banks occur. Some of the limestone banks have become reservoirs for large oil and gas accumulations.

A regional facies change of the Oswego can be traced from its outcrop east of Tulsa into the subsurface west to the Oklahoma panhandle. This facies change in eastern Oklahoma parallels the Arkoma basin. It intersects the Nemaha ridge south of Oklahoma City and, west of Oklahoma City, it parallels the Anadarko basin. In Ellis County, it swings abruptly northward.

A regional study of the transitional zone explains the location of such fields as Putnam and Kendrick, and may point the way to future oil and gas production.

7. J. E. BREWER, Consultant, Wichita, Kansas

SEDGWICK BASIN

The Sedgwick basin is a moderate-size basinal structure, approximately 10–12,000 sq. mi. located in south-central Kansas. The basin is bounded on the east by the Nemaha anticline and on the west by the Pratt anticline. It is actually an embayment connected to a major Oklahoma structural basin. The northern boundary is poorly defined. It is separated from the Salina basin by lithologic changes within the rock section. These changes are the primary causes of a large number of producing zones.

This paper deals with past and future prospects of the area with respect to these changes in lithologic types.

8. ORVIE HOWELL, Hinkle Oil Company, Wichita, Kansas

O.S.A. AND GILLIAN POOLS, SEDGWICK COUNTY, KANSAS

Regionally the O.S.A. and Gillian pools, producing from the upper Simpson Sand, lie on a prominent northeast-southwest-trending anticline that plunges toward the southwest. This 25-mi.-long structural trend is an asymmetric fold bordered on the western flank by a normal, down-to-the-west fault possessing an average throw of 180 ft. at a Simpson datum. Discontinuous normal faulting, downthrown toward the east, exists on the more gentle eastern flank of the trend.

The Gillian pool accumulation is attributed entirely to structural closure, whereas that of the O.S.A. pool is primarily stratigraphic, because of the presence of the updip beveled edge of the upper Simpson Sand which regionally circumvents the northwestern portion of the buried pre-Mississippian Chautauqua arch. Locally in the O.S.A. sector, this sandstone edge strikes nearly north-south and parallels the crest of the anticline, thus providing a preserved sandstone section on the western flank.

The combined structural-stratigraphic relationship of these pools is significant. It is estimated that a reserve in excess of 3,500,000 barrels of recoverable oil has been proved to date.

9. C. R. KING, Consultant, Wichita, Kansas

Alameda Field—Sedgwick Embayment "Sleeper"

The discovery of the Alameda field in Kingman County, Kansas, has bolstered the spirits of all seekers of Ordovician oil in Kansas. Knowing that a field of this magnitude remained undiscovered in an area where core-drill and seismic crews have come and gone during past years, its discovery has provided hope for Mid-Continent explorationists.

Most production in Alameda field comes from the Middle Ordovician Viola-Simpson. This zone produces at 36 locations. Many wells are dually completed within the Kansas City Limestone. Some wells are also completed in the Mississippian. Forty-acre spacing permits daily allowables of 44 barrels. Kansas City Limestone daily allowables average 37 barrels.

The Alameda structure is located on a northwest-southeast-striking anticlinal trend in an area of Mississippian thinning. The western side of the structure is bounded by a down-to-the-west normal fault having about 75 ft. of throw.

Alameda owes the major portion of its 35 ft. of closure in the Viola to pre-Pennsylvanian folding. Early pre-Mississippian structure was probably present at the time of folding. Some structural growth occurred during Pennsylvanian and Permian time.

The Viola-Simpson pool discovery was drilled by Stelbar Oil Corporation, with Texaco Inc. support, as a result of subsurface and seismic work.

Recovery, to date, is in excess of 1,780,000 barrels. Ultimate recovery is expected to approach 7,500,000 barrels of oil.

10. B. J. WRIGHT, Champlin Petroleum Company, Wichita, Kansas

Lyons West Field, Rice County, Kansas

The Lyons West field was discovered in March, 1963, 34 years after the first of four "dry holes" was drilled within the present productive area. Nomenclature inconsistencies and lack of the electric logs contributed to the delay in recognizing the widespread continuity of the pre-Pennsylvanian sandstones which were called "Conglomerate," "Kinderhook," or "Misener," depending on their position in the basal Kansas City-Maquoketa section.

The limits of the field are essentially defined; it covers 5,000 acres, and has 104 wells producing from one or more of four contiguous sandstone bodies which comprise the Kinderhook bar. This bar, approximately 10 mi. long and 2 mi. wide, is composed of Simpson-derived sediments deposited in an embayment between the Chase-Silica section of the Central Kansas uplift and the Geneseo-Edwards peninsula.

The reservoir has a gas-solution and water drive with a series of successively higher gas caps and water levels from south to north formed by small noses across the bar.

This field inspired exploration which resulted in the later discovery of several smaller fields. The relationship between Lyons West and adjacent comparable production is speculative at this time.

11. C. S. BARTLETT, JR., J. M. Huber Corporation, Oklahoma City, Oklahoma

New Approaches to Arkoma Basin Gas Exploration

The Arkoma basin is becoming a giant among gas-producing areas. Few gaps remain in the 150-mi. chain of gas pools from near Hartshorne, Oklahoma, to Russellville, Arkansas. Rapid development since 1949 has resulted in 90 new gas fields.

Well-exposed surface structures, anticlines, and fault traps have been mapped by field geologists and by seismic crews. Drilling these structures has been a principal exploration method.

At least 35 separate units from the Upper Pennsylvanian to the Upper Ordovician have proved productive. With the hundreds of new deeper wells, it is now evident that the principal trap is stratigraphic, with structure often secondary.

Much of the gas production today is from sandstones that have previously been identified as lower Atokan. Evidence is now available to reassign these beds to the reinstated Winslow Formation of the Morrow Group. The Winslow Formation is apparently of deltaic origin, the sediments having come from a predominantly northern source. Channels, with a generally north-south orientation were established outward into the basin. These channels are evident on sandstone porosity maps of individual Winslow sandstones. Sandstone mapping is now possible in much of the Arkoma basin and will greatly aid in selecting both development and wildcat locations.

12. L. O. WARD, Ward & Gungoll, Enid, Oklahoma

Mississippian Osage, Northwest Oklahoma Platform

The Sooner trend portion of the Northwest Oklahoma platform comprises a fractured limestone belt subparalleling the Anadarko basin hinge-line from West Edmond field through Enid townsite to Ringwood field. It ranges in width from 15–30 mi. and it is approximately 90 mi. long.

Fracturing forces have been supplied by orogenies affecting the Nemaha ridge and Anadarko basin. Open fractures within the brittle cherty members of the thick Mississippian carbonate possess permeability ranging from sub-commercial to astronomically high. The reservoirs exist because of this widespread, effective permeability system. High initial potentials and fairly wide regional drainage support the common-source concept.

Fracture density often determines reservoir value. It is difficult to predict fracture density in advance of drilling. Consequently, attractive areas are defined by