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 local drilling and by close observation of individual well productivity.

Primary porosity is generally absent. Whole-core analysis reveals a fracture porosity average of 2% or less and an average net effective productive interval thickness range of 50–400 ft.

Reserves are limited and estimates differ in direct proportion to the fracture density, gas/oil ratios, initial potentials, and total number of producing wells in an area. Commercial production can be obtained if the available facts are evaluated properly.

13. L. E. GATEWOOD, Consultant, Oklahoma City, Oklahoma

CRINER-PAYNE AREA, STUDY IN STRUCTURAL GROWTH

Criner-Payne field, located in T. 5 and 6 N., R. 3 W., is the largest oil field in McClain County in terms of reservoir oil in place and areal extent. It is near the southern end of the Nemaha ridge. This highly faulted structure owes its present position to local crustal downbreaking along the flanks of the regional Hunton uplift. Continuous structural growth occurred from Ordovician through Pennsylvanian time as a result of a subsiding Anadarko basin; gentle progressive compressional folding culminated in the sharper folds and faults near the rim of the syncline.

Post-Hunton tilting and truncation, and post-Morrowan—pre-Desmoinesian uplift, can be matched closely with the stages of evolution of the Anadarko basin and the Nemaha ridge. The growth and tilting have resulted in the shifting of the younger fold axis progressively eastward from the Simpson axis.

The field is characterized by two distinctly different producing zones. The Bromide Sand, with structural relief of about 1,700 feet, produces only on up-thrown closures against north-south-trending faults. The Bois d'Arc Member of the Hunton Limestone has structural relief of about 1,650 feet, but the oil occurs generally wherever there is porosity and (or) fracturing, without regard to the structural position. Most Hunton porosity occurs west of the fold axis on the more steeply dipping western flank which was more exposed during intermittent stages of growth and tilting. Approximately 80% of the total acre-feet of Hunton porosity is localized west of the fold axis, but this comprises only about 35% of the total Hunton productive area.

14. L. R. RILEY, Humble Oil & Refining Company, Ardmore, Oklahoma

CHALLENGE OF DEEP EXPLORATION—CHITWOOD POOL, GRADY COUNTY, OKLAHOMA

In February, 1965, the South Alex and Chitwood producing areas were consolidated and designated Chitwood. These two Bromide producing areas are closely related geographically and geologically, and both are included in this discussion. Emphasis of this discussion is placed on the deeper producing Simpson rocks.

Even though there is this close relationship, geological and reservoir data indicate that the two areas are separate. Based on structural data from subsurface and seismograph, the two producing areas are located on separate anticlines. This interpretation is supported by differing condensate ratios in the wells of the two sectors.

Production ranges in depth from 15,908 to 17,202 ft.; Oklahoma's deepest productive well is located in the South Alex part of the field.

Production capabilities of the wells appear to be related directly to porosities and permeabilities which change significantly from well to well. The changes are sufficiently great that wells range from very good producers to dry holes.

Data from petrographic analysis indicate a small amount of pressure solution and a large amount of secondary silica growth. Both factors decrease original porosity of the reservoir.

Predicting the presence or absence of porosity is a most difficult problem. Extremely high drilling costs make it necessary to drill a minimum number of dry holes. Subsurface control from 640-acre spacing leads to unreliable development predictions.

15. R. C. LARSON, Larson Exploration Company, Tulsa, Oklahoma

HEALDTON ARBUCKLE FIELD AND ITS RELATIONSHIP TO OTHER POTENTIAL ARBUCKLE STRUCTURE

The Healdton Arbuckle oil field of Carter County, Oklahoma, is an example of a large reservoir for which ample subsurface information was available to the exploration geologist prior to discovery. In the application of refined and sophisticated exploration techniques elsewhere, the industry ignored basic and fundamental subsurface facts in this area. This pool is located in the middle of a productive zone that pre-dates World War I. Oil in the Arbuckle actually was produced from this reservoir for many years before the Sinclair No. 1 Ratcliff was drilled to find what is now recognized as the Healdton Arbuckle field. This paper deals with the facts leading to the Sinclair discovery and it attempts to reveal how they may be used to find additional pools. It is felt that a basic understanding of the producing pool is requisite to intelligent exploration for additional traps of a similar type.

16. K. H. HOLMES, Mobil Oil Company, Oklahoma City, Oklahoma

STRATIGRAPHIC TRAPS IN NORTHWEST QUINLAN AND CEDARDALE FIELDS, NORTHWESTERN OKLAHOMA

Northwest Quinlan and Cedardale fields in eastern Woodward and western Major Counties, Oklahoma, are located on the northern shelf of the Anadarko basin. Both fields produce gas from stratigraphic traps in the Mississippian Chester Limestone. Production at Cedardale is primarily from the Pennsylvanian Cottage Grove Sandstone.

Traps in the Chester were formed by lateral changes in the original limestone deposition and cementation. Original porosity and permeability were later altered by subaerial leaching which preceded the deposition of the overlying Pennsylvanian sediments.

The trap in the Cottage Grove Sandstone was formed by an updip facies change from sandstone to shale on the gently sloping shelf.

Cedardale was discovered in 1957 and Northwest Quinlan in 1958. Production has been established in 55 sections and development drilling is continuing with the limits of these fields still not defined.

17. J. F. JOHNSON, Sinclair Oil & Gas Company, Tulsa, Oklahoma

RECENT ADVANCES IN GEOLOGY AND GEOPHYSICS

No wholly new exploration techniques have evolved during the past 10 years. However, geologists and geophysicists have learned that there is more to discovering oil fields than the detection of closed structures and the selection of sites where rocks have sufficient porosity to hold oil. They have realized that oil fields are located only in favorable geological settings characterized by certain large-scale geological features. They also have realized that it is possible, using geology and geophysics,