Instead, these wells, under the normal thickness and facies of Mesozoic formations, found Paleozoic beds that showed no evidence of metamorphism, and that exhibited flat dips in cores.

It is proposed to describe these occurrences in some detail and to assess the effect they have on presently held theories concerning Llanoria and the Ouachita Folded Belt.

BEVERLY MCMAHON, Shell Oil Company, Wichita Falls, Texas. Atoka Series in North Central Texas.

During the Mississippian and Pennsylvanian periods in North Texas, the area of thickest accumulation shifted westward and the tectonic activity, as shown by the character of the sediments and their rate of thickening, decreased. In the sequence of gradually changing depositional environments from linear geosynclinal type to continental basin type, the Atoka and Des Moines epochs are transitional. The depositional pattern of Atoka sedimentation suggests a modified geosynclinal environment.

Sediments of early Atoka time indicate that the Atoka basin formed under conditions of considerable crustal mobility. Thousands of feet of interspersed shale and "dirty" sandstones attest the rapid burial of the geosynclinal sediments. The Atoka series thins rapidly across a hinge area, where the sediments are predominantly shales with some interbedded sandstones, to the shelf area, where limestones and dark shale were deposited. The different sedimentary types, controlled by environment, were deposited contemporaneously. The marked divergence of time and lithologic units makes it advisable to apply terminology only to facies types.

The Marble Falls formation in North Central Texas, as generally considered, includes the Pennsylvanian-Mississippian unconformity.

Although the Muenster Arch was not uplifted until post-Atoka-pre-Des Moines time, conditions existed in the general area which inhibited the rate of downwarping relative to the surrounding area. The thinner Atoka sediments, which were deposited over the Arch, were later removed by erosion.

HERBERT D. HADLEY, Billings Geological Service, Billings, Montana. Development in the Williston Basin.

Modern exploration for oil and gas possibilities in the Williston Basin began with the drilling of the California Kamp No. 1 well during 1937–38. Some attempt to further evaluate this huge area was made in 1940, '41 and '42.

The present activity was initiated by discovery of oil in the C. Iverson well on Nesson anticline by the Amerada Petroleum Corporation in 1951. This was followed by the Shell-Richey discovery in Dawson County, Montana. At least seven new fields have been discovered to date, and it is becoming increasingly apparent that the Cedar Creek and Nesson anticlines may be the location for very large oil reserves.

Commercial oil has been found in rock of at least four different ages with several potential horizons believed present in the Mississippian, Devonian and Ordovician. While the Paleozoic rocks, to date, have proved the most fruitful, there is much yet to be learned concerning the age of portions of the thick Paleozoic section.

Cost of wildcat drilling varies from $50,000.00 to as much as $750,000.00 per well.

Estimates of the number of wildcat tests to be drilled during 1952 run as high as 250.

The discoveries to date have been located where structural closure is thought to exist, but as additional information is secured many tests will be drilled to evaluate stratigraphic variations.

HARRY L. THOMSEN, Shell Oil Company, Tulsa, Oklahoma. Oil and Gas Development in the Denver-Julesburg Basin.

Close to 50 new producing areas have been discovered on the east flank of the Denver-Julesburg Basin since the discovery of oil in Cheyenne County, Nebraska, by the Ohio Oil Company in June, 1949. All of these fields produce from Dakota group sandstones of Cretaceous age, at depths ranging from 3,300 feet to 7,350 feet. Deeper objectives appear to be present but as yet are relatively untested in the central part of the basin.

Most of the new fields have been found by use of the seismic method. They appear to be located on structural anomalies of minor relief, but it is apparent from subsurface information that stratigraphic changes within the Dakota group often aid in controlling accumulation.

More than half of the undeveloped acreage in the basin is now under lease. Exploration and development work is proceeding at a high level particularly in the area outlined by recent discoveries, which covers over one-tenth of the total basin area.

P. R. SCHULTZ, Stanolind Oil and Gas Company, Tulsa, Oklahoma. Oil Discovery—Past, Present, and Future.

Current alarm concerning the ability of the petroleum industry to satisfy the liquid fuel requirements of the United States is unwarranted. Unfortunately, information released by the industry in the past has been misinterpreted so as to indicate that the potentiality of the nation is reaching a criti-

cal point. Correct interpretation of industry statistics reveals that large quantities of oil still remain to be discovered and that improved technologies will permit the finding and development of this oil at costs only moderately above current experience.

Decreasing discovery rates indicate that a rapidly increasing exploratory effort will be necessary to bring forth the new reserves, but with available data it is impossible at this time to forecast any exhaustion in petroleum supplies. If geologists do not maintain a satisfactory discovery rate, the petroleum engineers are ready to expand secondary recovery projects at only moderate price increases.

G. H. WESTBY and H. M. THRALLS, Seismograph Service Corporation, Tulsa, Oklahoma, presented by H. M. Thralls. Geophysics in the Mid-Continent Area—Present and Future.

The area covered by this paper includes the State of Kansas, the State of Oklahoma, and adjacent areas of Texas.

At the end of March, 1952, there were 35 seismic crews and one gravity meter crew operating in Oklahoma, 16 seismic crews and one gravity crew in Kansas, and 17 seismic crews in north Texas within thirty miles of the Oklahoma border.

In Oklahoma it is evident from their locations that almost two-thirds of the crews are attempting, by more detail or better interpretation, to glean new possibilities from worked-over areas. Others, in both the Anadarko Basin area of poor records and in southeastern Oklahoma, are, by usage of new techniques, attempting to obtain new satisfactory data. In Kansas, except for the concentration of four crews in Barton County, the crews are well scattered over the western part of the state. Careful work on the central Kansas uplift is still yielding results in small but profitable oil fields. Some discussion of present techniques used in Kansas and in the poor record area of the Anadarko Basin is given.

Some coverage of both states has been made by aerial magnetic work but facts on such coverage are difficult to obtain due to the speed of the surveys and lack of ground indication of such activity.

The Anadarko Basin, despite large areas of poor seismic record quality, holds great promise for exploration with improved seismic techniques. Further development of seismic methods of locating stratigraphic-trap type fields will yield results. New and improved devices for obtaining velocity data from wells will aid in the advancement of seismic stratigraphic techniques and improve the accuracy of structural determination.

The gravity meter shows promise of ability to locate porous trends in limestone reservoirs and will be used to advantage in western Oklahoma and southwestern Kansas.

Both Oklahoma and Kansas, as well as adjacent areas of Texas, offer great opportunities for the further discovery of oil by utilization of geophysical methods, some new, some still in the experimental stage.

N. F. WILLIAMS, State Geologist, Little Rock, Arkansas. Present Activity and Petroleum Possibilities in the Arkansas Valley.

During the past year the Arkansas Valley of west-central Arkansas, which has produced dry gas from the Atoka formation (Pennsylvanian) for the past fifty years, has had its most intense period of activity. An estimated one million acres of leases have been taken and at least six oil companies now have surface parties working in the area. This new activity is the result of a combination of factors: (1) new and better markets for gas, (2) new discoveries with initial potentials of as much as seventy million cubic feet per day from the Atoka formation, and (3) recognition of the possibilities for production from pre-Atoka beds following discoveries of gas in the Hale formation of the Morrow group (Pennsylvanian).

This last factor was extremely important as it had previously been considered by many that the pre-Atoka sands had been silicified in the first stage of regional metamorphism, and therefore they could not be considered as potential reservoir rocks. There are now at least two gas fields, Cecil and Clarksville, producing from the Morrow group.

The Atoka gas possibilities are great in the area, which contains roughly fifty untested anticlines. Tests on at least three of these structures are either staked or drilling at the present time. The oil possibilities are still a question mark. In the Morrow and pre-Boone Mississippian outcrops to the north, there are three well-developed sandstone sections (Hale, Wedington, and Batesville), all potential reservoir rocks in the Valley. An oölitic member of the Boone limestone (Osage, Mississippian) is also present on the outcrop and may have porosity in parts of the region, as may the basal Mississippian sand, where present. In the less than a dozen scattered wells in the region that cut the older rocks, the Hale sandstone is the only formation in which appreciable porosity was found. This information is too fragmentary to properly evaluate the productive possibilities of the section involved.

Eight wells have tested the Wilcox-St. Peter (Ordovician) section in the region, but in each case the porosity present at the outcrop was absent in the subsurface. These wells also tested the Silurian-Devonian section, which is cut out at many places on the outcrop by unconformities, but again, porosity was missing.