Springs sandstone is on the west side of the Black Mesa basin, where the formation consists of greenish gray well sorted cross-stratified firmly cemented quartzitic sandstone. This formation extends from northwestern New Mexico to south-central Utah and attains a maximum thickness of nearly 500 feet in the southern part of the area.

The Upper Jurassic strata that comprise the northern phase of deposition include the Entrada sandstone, Summerville formation, and Bluff-sandstone member and the other members of the Morrison formation. A better understanding of lateral gradation and intertonguing of these rocks with the southern eolian sandstone phase is dependent upon the recognition of contemporaneous eolian and subaqueous environments.

14. JOHN PAUL GRIES, South Dakota School of Mines, Rapid City, South Dakota

History of Exploration in Williston Basin, North Dakota, South Dakota, Montana, and Canada

The presence of a structural basin in the western Dakotas, was noted by exploration parties along the Missouri River about 100 years ago. Discovery of gold in the Black Hills in 1874, and of artesian water in the Dakota sandstone early in the 1880's, led to rapid delineation of the eastern and southwestern sides of the basin. The Cedar Creek anticline and the Nesson anticline were discovered in 1910 and 1917, respectively, incidental to the inventory of our coal resources.

About 25 oil tests were started within the basin proper between 1920 and 1925. Six or eight of these went deep enough to supply useful pre-Cretaceous stratigraphic information, but most of the early interpretations were incorrect.

Appreciation of the oil possibilities of the area as a structural basin awaited the development of the Michigan and Illinois basins in the early 1930's. Modern exploration began with the drilling of the Gypsy No. 1 Hunter in South Dakota and the California No. 1 Kamp in North Dakota in 1937–38. The first concerted efforts to locate stratigraphic traps were made in the 1940's.

15. HERBERT HADLEY, Billings Geological Service, Billings, Montana

Résumé of Recent Drilling Activity in Williston Basin, Montana, North Dakota, South Dakota, and Canada

More test holes for oil and gas were drilled in the Williston basin last year than in any previous year. As a result of this activity several new fields were discovered and oil in commercial quantity found in rock of at least three different ages. Problems of drilling are being overcome and it appears that activity in 1952 will only be limited by the number of available rigs.

16. DONALD TOWSE, North Dakota Geological Survey, Grand Forks, North Dakota

Preliminary Report on Sedimentational History of North Dakota

Subsurface data presently available are inadequate for a detailed sedimentational analysis of the stratigraphy of North Dakota, but some preliminary interpretations are possible. This paper is a progress report on a continuing study, the results of which will be presented in detail when the current drilling program has provided the necessary data.

Thickness maps and facies analysis are used to interpret and to illustrate the stratigraphy. The Williston basin in North Dakota was a gently subsiding intracratonic basin during most of post-Cambrian time. Differentiation of the pre-Cambrian basement suggests pre-Huronian folding in the area later occupied by the basin.

Middle Ordovician marine shales and quartzose sandstones cover most of the state. Western North Dakota was the center of Ordovician deposition, and the sands were apparently derived from erosion of the shield area to the southeast. Continued gentle downwarp was accompanied by deposition of Upper Ordovician and Silurian carbonates. The center of Silurian deposition was to the northwest in Canada, and some Silurian sandstones were derived from erosion in the southeast. Reef structures are possible in the Silurian, and the top of the system is marked by a disconformity.

Middle Devonian through Middle Mississippian rocks are largely carbonates and evaporites. A northwesterly plunging uplift, herein named the Burleigh uplift, is apparent in thickness maps of the Silurian and Devonian systems in the south-central part of the state. The uplift was the site of nondeposition and clastic deposition. The Upper Devonian series is restricted to the northwestern part of the state. The Upper Devonian evaporite and carbonate basin extended into Montana, and the Middle Devonian extends into Manitoba and Saskatchewan.

Lower and Middle Mississippian rocks cover the western three-quarters of the state and thicken toward the west and northwest. The present eastern edge is near the original shoreline, and the Charles evaporite facies is restricted to the western half of the state.

The Upper Mississippian Big Snowy group and Amsden formation are largely marine clastics deposited during a westward regression of the seas. Local concentrations of shoreline sands may provide stratigraphic traps.

No Pennsylvanian or Permian rocks have been recognized in the state, and the Amsden and Big Snowy sediments are overlapped by Triassic redbeds and evaporites. Evaporites and a thick section characterize the Triassic in the west, whereas the system is thin and sandy in the east.

Overlapping marine Jurassic rocks cover most of the state, with clastics and sandstones in the west and relatively more limestone and evaporites in the east.

Marine Cretaceous rocks cover most of the state, and more than 4,000 feet were deposited in western North Dakota. Shallow Lower Cretaceous sandstones tentatively correlated with the Newcastle of the Black Hills offer interesting possibilities where they pinch out to the east and north in the central and southeastern part of the state.

Non-marine Tertiary sediments cover most of western North Dakota.

The stratigraphy of North Dakota is inadequately known. No great tectonism or facies variations are expected to be found, but further knowledge of the details of the offlap and onlap relations of the sediments and the gentle folding during the Paleozoic may lead to further oil exploration based on stratigraphic information.

17. JOHN PAUL GRIES, South Dakota School of Mines, Rapid City, South Dakota
Stratigraphic Traps on the South Edge of the Williston Basin

The entire Ordovician, Silurian, Devonian, and upper Mississippian sections pinch out around the southern margin of the Williston basin. On the southeastern edge, the Pennsylvanian, Permian and Triassic also pinch out beneath the pre-Sundance unconformity.

Upper Cretaceous sands, whose source is to the east, pinch out on the west flank of the basin.

Variations in quality, quantity and artesian pressure within the Pahasapa, Minnelusa, and Sundance formations also suggest effective barriers to circulation of fluids within these formations.

18. WILLARD PYE, North Dakota Agricultural College, Fargo, North Dakota
Relationship of Oil Accumulation to Paleogeology and Structure in Manitoba, Eastern North and South Dakota

The eastern side of the Williston basin is bounded by the pre-Cambrian rocks of the Canadian shield. These pre-Cambrian rocks gradually slope westward toward the center of the basin. Paleogeological maps show the successive eastward overlapping of the seas upon this shelf in Cambrian and Ordovician times and the successive off-lapping during each period from Silurian throughout the remainder of the Paleozoic era. The Mesozoic era again saw a general increasing eastward overlap of sediments in each new period. A study of the lithology and isopach relationships indicates that the center of the basin has not always been located along its present axis and that the seas had a variety of generally westward connections.

Structures in the pre-Cambrian in Manitoba, North and South Dakota can be traced into the sedimentary basin and can be followed in the sediments both through structural and lithological studies. Where these structures, as well as structures originating in the sedimentary basin, cross lithological changes as shown on isopach and paleogeological maps, there is considerable promise of oil accumulation. That such accumulation may be present in certain areas is indicated in some cases by surface evidence.

19. E. H. STEVENS, South Dakota School of Mines, Rapid City, South Dakota
Surficial Faults Along the Missouri River

A fault system is described that is located in Armstrong County in central South Dakota. Superficially it is similar to the system described by Hollinger in the Ironstone district in England. The fault spacing is fairly close, the displacement usually small and the individual faults are commonly upthrown toward the Missouri River. The Ironstone faults were ascribed to the tilting of vertically jointed blocks toward the valleys under the influence of gravity. As some of the faults in the South Dakota area are fifteen miles from the major stream valley the force developed by gravity would not seem adequate. If these faults are surficial the writer suggests that a tangential stress may have been stored in the rocks since the folding of the Lemmon syncline and that the cutting of the rivers relieved these stresses permitting the adjacent rocks to move toward the valleys. Because relief would be easier near the surface there would be a tilting of joint blocks toward the river with a small fault displacement at each joint. A weak point in this mechanism is that there is some evidence suggesting that the faults extend below the bed of the Missouri River.

20. W. L. HERSHELMAN, Ohio Oil Company, Sidney, Nebraska
Developments in the Julesburg Basin During 1951

The year 1951 represented the current peak of activity in the structural basin, located in western Nebraska, northeastern Colorado, southeastern Wyoming, northwestern Kansas, and known as the Julesburg basin. Three of the four phases of finding and development reached all-time peaks during 1951. The leasing phase reached its peak in 1950 but extended into 1951 at a high level. Exploration drilling, exploitation drilling, and geophysical programming resulted in the drilling of 453 wells. 187 wells were drilled in the Nebraska part of the basin, 260 wells were drilled in the Colorado part, and Wyoming and Kansas were represented with four and two wells, respectively.

111 wildcats were drilled in the Nebraska part of the basin and resulted in the discovery of 15 new