flush production at 2,100 feet was developed in the Lodgepole (Mississippian) in the Roselea field, 56 miles north of the North Dakota line in Manitoba. Subsequent wells in the Roselea field have reported initials as high as 2,500 barrels of oil per day. The lack of sufficient well information makes it impractical to calculate the reserves represented by the fields thus far discovered; however, the most conservative estimate places this figure between 500 million and 1 billion barrels of recoverable oil.

The year 1953 witnessed the completion of the 300,000 barrels per day Interprovincial Pipe Line from Edmonton, Alberta, to Sarnia, Ontario, and marked the beginning of construction of three new refineries in North Dakota, which on completion will process 33,500 barrels of basin crude daily. 1953 also saw the completion of the 100,000-barrel-per-day common carrier Service Pipe Line from the Beaver Lodge-Tioga area to Mandan, North Dakota, the beginning of construction of a natural-gasoline plant at Tioga, North Dakota, and the completion of Stanolind's products line from Mandan to Fargo, North Dakota. There remains, however, an urgent need for additional marketing facilities before the full economic potential of the basin can be realized. Judged from recent official and unofficial announcements, plans to create new facilities are under way and the next five years should show marked progress in this direction.

With geophysical activity maintaining its record-breaking pace, and millions of acres of leases approaching one year closer to the expiration date of their primary terms, it is expected that 1954 will witness an unprecedented wildcat and field development program in the Williston basin. Excellent shallow production in Manitoba, the discovery of the first commercial oil in South Dakota, plus continued success in Montana, North Dakota, and Saskatchewan will serve as an incentive to substantiate this 1954 prediction.

9. MISSISSIPPIAN OIL ACCUMULATIONS IN NORTHERN MONTANA.
JACK W. NORDQUIST, Phillips Petroleum Company, Billings, Montana.

Mississippian reservoirs in northern Montana have produced oil in an amount almost equal to the combined total from all other producing zones. Six important fields, four in the Sweetgrass arch area and two in the Williston Basin, currently yield a total of over 350,000 barrels of oil monthly. Without exception, the producing zones are carbonate reservoirs which contain either intergranular, vuggy or fracture porosity. A discussion of each field is presented to illustrate that stratigraphic variations are equally, if not more important, than structural closure in governing accumulation. The stratigraphy of the Mississippian is treated briefly to show regional correlation of the producing zones.

10. WILLISTON BASIN PALEOZOIC UNCONFORMITIES.
W. S. MCCABE, Stanolind Oil and Gas Company, Casper, Wyoming.

The Williston basin is primarily a Paleozoic basin. Regional Paleozoic unconformities are present in the basin at the base of the following: Cambrian, Ordovician, Middle Devonian, Lower Mississippian, Middle Pennsylvanian, and Middle Permian. The unconformity at the base of the Mississippian is the most pronounced of the regional unconformities. Regional stratigraphic sections and ispach maps are used as illustrations.

11. EXPLORATION FRONTIERS IN NORTH DAKOTA.
CHARLES TALLARD, Continental Oil Company, Bismarck, North Dakota.

Most of the fields in North Dakota were located by a combination of surface mapping and the reflection seismograph. Detailed surface mapping in southwestern North Dakota will be very valuable in locating other structural anomalies; however, the essentially flat Tertiary and Upper Cretaceous beds and the glacial débris north and east of the Missouri River hamper this method of exploration.

Other fields have been located by a combination of seismograph and subsurface studies, and in the future this combination will become a much more valuable method of exploration.

12. WILLISTON BASIN IN SOUTH DAKOTA, AN OIL FRONTIER.
FRANK W. FOSTER, Ohio Company, Bismarck, North Dakota.

No oil in commercial quantities has been found in South Dakota. The geology, however, is replete with the promise that oil will be found in this state. The north-plunging Lemmon syncline, that is, the south end of the Williston basin, occupies the west half of South Dakota. Paleozoic sediments, the source of oil in North Dakota and in adjacent areas in Montana, are known in the subsurface of South Dakota and comprise 37,000 square miles. Cretaceous sediments, which produce oil in Nebraska, occur throughout the state, over an area of about 77,000 square miles. Mesozoic and Paleozoic sediments may range up to 10,000 feet in thickness.

Cross sections indicate the wedging-out of formations of Ordovician, Silurian, Devonian(?), Mississippian, and Pennsylvanian age. These wedge-ends should form porosity traps and be prolific sources of oil. A pre-Jurassic unconformity overlies the truncated edges of most, if not all, of the older formations. Oil reservoirs may be found here. Isopach maps indicate a wide areal distribution of several potential oil-bearing formations.

Surface structures are known, especially in the western part of the state, and also around the Black Hills and along the Missouri River. Some structures have been drilled.

In comparison with the great potential area for oil finding in South Dakota, only scattered drilling has so far been accomplished, and few wells have tested the deeper possible oil and gas zones.

At present more wells are being drilled, seismic information is being accumulated, and surface parties are evaluating the areas of exposed Cretaceous and Tertiary rocks. Interest is high and this frontier may soon become another oil state.

13. SWEETGRASS ARCH, GEOLOGIC FRONTIER.

VIRGIL R. CHAMBERLAIN, Consultant, Great Falls, Montana.

The Kevin-Sunburst, Pondera, Cut Bank, and Bannatyne oil fields are located along or across some part of the Sweetgrass arch. Oil has been produced from these fields since the 1920's. Relatively little is known and clearly understood of the importance stratigraphy and subsurface geology play in the accumulations of oil and gas in this province. Numerous wells have been drilled and are still being drilled in the continued search for oil and gas in this area. However, few electric or radioactive logs are run and few if any samples of the cuttings are taken for geologic study. Consequently, much valuable geologic information is going to waste.

East-west stratigraphic cross sections show a pre-Middle Jurassic positive area east of the present Sweetgrass arch in the Chinook-Bearpaw mountain area. Between Middle and Upper Jurassic time

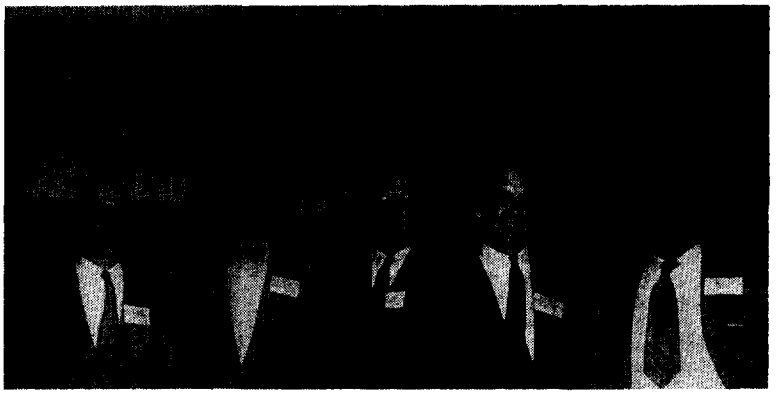

FIG. 2.—Radio-panel members: E. W. ELLSWORTH, business manager, A.A.P.G., Tulsa; FRANK D. GORHAM, JR., Pubco Development, Inc., Albuquerque; A. I. LEVORSEN, Tulsa; MAURY GOODIN, Petroleum Information, Denver; SHERMAN A. WENGERD, University of New Mexico, Albuquerque.

this positive area was depressed and the Belt Island positive area came into being. The present northwestward plunge of the Sweetgrass arch was probably established at this time.

Periods of erosion and truncation of sediments followed by redeposition have caused numerous wedge belts of porosity in sediments from Lower Mississippian to Lower Cretaceous. Changes in facies from the predominantly clastic sediments of the Big Snowy group (Upper Mississippian) into the limestone and dolomites of the miogeosyncline west to the present Sweetgrass arch offer multiple stratigraphic trap possibilities for the accumulation of oil and gas. Relatively little has been done to explore these stratigraphic traps or wedge belts. The wedge edge of the Middle Jurassic Sawtooth sandstone and limestone remains unexplored. Changes in tilt and hydraulic gradient may have caused oil accumulation off the top of structurally high areas forcing a re-evaluation of formerly condemned structures. The area is further complicated by thrust faulting along its western margins.

The Sweetgrass arch area offers a challenge to the petroleum geologist to solve its stratigraphic and structural complexities. Rewards will be high—the oil is here, find it!

14. CEDAR CREEK ANTICLINE, EASTERN MONTANA.

JOHN W. STRICKLAND, Continental Oil Company, Denver, Colorado.

The Cedar Creek anticline is an elongate northwest trending flexure approximately 100 miles long and 10 miles wide located in eastern Montana on the northwest flank of the Williston basin.

As expressed in surface beds of Upper Cretaceous age, the structure is an asymmetric fold with