It may be shown that every major oil accumulation in the area is related to a combination of structural and stratigraphic conditions with increasing evidence to indicate that stratigraphic controls are dominant. Many of the stratigraphic factors can be analyzed through study of the rocks themselves and by interpretation of their geophysical responses. With the abundant outcrops of the Rocky Mountain area, the increasing availability of subsurface data, and the developing know-how whereby these data may be related to oil occurrence, there remains a broad and encouraging field for an expanding exploration program.

2. BEAVER LODGE AND TIOGA FIELDS, MOUNTRAIL AND WILLIAMS COUNTIES, NORTH DAKOTA.
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This report reviews the history of exploration on the Nesson anticline leading to the discoveries of the Beaver Lodge and Tioga fields. The point is made that the discoveries were the result of good geological and geophysical work combined with economics, geology, and good fortune.

The structure of these fields is thought to be due to faulting in the basement which has been intermittently active since Ordovician time. Indirect evidence also suggests cross faulting to the main Nesson anticline trend.

The producing reservoirs are now entirely in porous zones in the upper part of the Mission Canyon formation of the Madison group of Mississippian age. Productive reservoirs are known in the formations of Devonian and Silurian age although they are not producing at present. The Mission Canyon formation is light gray to brownish gray limestone with oölitic and fragmental to finely crystalline texture. The porosity is most marked in the upper 200 feet of the formation.

The reservoirs of the Beaver Lodge and Tioga Madison pools appear to be water-drive and possible gas-expansion types. The reservoirs are still above bubble point and no secondary gas cap is believed to be forming. Gas-oil ratio for both fields averages about 1,100:1, and reservoir pressures at present are 3,270 for Beaver Lodge and 3,188 pounds for Tioga. Reserves in the Mission Canyon pay for Beaver Lodge are estimated to be 155 million barrels; for Tioga 57 million barrels. API gravity of the oil in Beaver Lodge is 43.1°; in Tioga 42.5°. The MER of the fields is not known positively, but it has been suggested that the MER for Beaver Lodge is 15,000 barrels daily and a MER of 10,000 barrels per day for Tioga.

Conservation laws were in effect when these fields were discovered and the fields are being developed along sound lines of conservation. Production is limited to an amount which does not exceed the reasonable market demand.

3. NORTHWEST SUMATRA FIELD, ROSEBUD COUNTY, MONTANA.
J. THOMAS LLEWELLYN, Honolulu Oil Corporation, Billings, Montana.

The Northwest Sumatra oil field, located on the Central Montana uplift, was discovered in July, 1952. The discovery well, The Texas Company's Grebe No. 1, was located on the basis of seismic investigations by The Texas Company. This geophysical work indicated slight seismic closure on one of the *en echelon* folds characterizing the Central Montana uplift between Ragged Point Dome on the west and Ingomar Dome on the east.

The surface formation in the field is Upper Cretaceous in age. The stratigraphic section drilled in the area consists of Cretaceous, Jurassic, Pennsylvanian, and Mississippian rocks. Oil is obtained from lenticular sands developed in two zones in the Upper Heath transition zone of Upper Mississippian age. The origin of these lenticular sands is attributable to sand-bar and dune development associated with estuarine and lagoonal conditions of deposition.

The maximum thickness of effective sand penetrated in any well is 148 feet, and the average effective sand thickness throughout the field is 46 feet. The production of oil is stratigraphically controlled by sand development, rather than structural position.

On December 1, 1954, 58 wells had been drilled in and adjacent to the field, of which 42 were producing, 15 were abandoned, and 1 was drilling. The 42 productive wells were producing about 3,900 barrels of oil a day. Production was restricted due to market outlet. There were, at that time, 1,680 acres, with an estimated recoverable reserve in excess of 30,000,000 barrels of oil with the field limits still undefined.

4. MANDERSON FIELD, BIG HORN COUNTY, WYOMING.
LOY E. HARRIS, Consultant, Basin, Wyoming.

The Manderson field on the Manderson anticline, which is a plunging structural nose about 12 miles long, is located on the eastern flank of the Big Horn basin in Big Horn County, Wyoming.

Seismic and subsurface information indicates no effective structural closure along the axis of this anticline to form a trap for the accumulation of oil and gas.

The facies change in the Phosphoria formation, from carbonates to redbeds takes place in an easterly direction across the southern end of the Big Horn basin.

By establishing a chert horizon as the dividing line between the productive and non-productive zones of the Phosphoria formation, the problem of locating stratigraphic traps is simplified. Isopach

maps of the productive part of the Phosphoria formation show the relation of the Manderson field to this stratigraphic trap.

The reservoir in the Manderson field is a stratigraphic trap formed by the facies change in the Phosphoria formation.

5. ADENA FIELD, MORGAN COUNTY, COLORADO.

LOUIS M. PERRY and HENRY D. OVERSTAKE, Pure Oil Company, Denver, Colorado.

With the discovery of stratigraphically trapped oil in Washington County, Colorado, in 1952, interest in the south-central part of the Denver basin greatly increased, resulting in the discovery of the Adena field in 1953, the largest reserve developed to date.

The Dakota "J" reservoir embraces approximately 12,000 acres and contains substantially more than 40 million barrels and 32 billion cubic feet of recoverable oil and gas. During the first year of production, more than 3 million barrels of oil were produced, resulting in a pressure decline of 92 pounds.

Oil is produced predominantly from the Dakota "J" sandstone and secondarily from the Muddy "D" sandstone of Cretaceous age. Structurally the field is characterized by relatively uniform northwest dip of approximately 50 feet per mile, though local terracing and nosing exist. Accumulation is controlled by stratigraphic variation within and below the producing zones. Locally, a permeability barrier is present on the eastern side of the field, while a basal seal below the pay zone prevents migration into the main sand body.

Most of the oil now produced in the Muddy "D" sandstone is found in the northwestern extremity of the field and is associated with those areas where the formation has its best development of porosity, permeability, and thickness.

6. GEOLOGY OF RAILROAD VALLEY AND VICINITY, NEVADA.

R. C. SPIVEY, Shell Oil Company, Los Angeles, California.

Railroad Valley is situated in the western part of a miogeosyncline where sediments representing all of the Paleozoic systems accumulated to a thickness of about 22,000 feet. The region was uplifted in late Permian or early Mesozoic time and no marine invasion is known to have occurred since. Great thicknesses of fresh-water sediments and volcanic rocks were deposited, possibly partly during Cretaceous and early Tertiary, but mostly in Miocene and later time. The faulting which has formed the present-day basin-and-range structure of the region also took place in late Tertiary and Quaternary time.

Wells drilled in Railroad Valley have penetrated several thousand feet of presumed Tertiary beds which can be compared in a general way with rocks exposed on the east side of the valley. Oil-saturated welded tuff in this Tertiary (?) section was encountered at a depth of 6,445–6,880 feet in Shell's Eagle Springs Unit 1 and the well was completed with an initial production of 373 barrels of oil per day from this zone. Shell's Eagle Springs Unit 2, about 9 miles southwest of Unit 1, encountered more than 2,000 feet of similar volcanic material but found only minor oil shows in it. The zone of welded tuff was not encountered in Unit 3, about 5 miles south of Unit 1. All three of these wells penetrated Paleozoic rocks below the Tertiary (?) but found only minor oil shows.

7. CASE HISTORY OF EAST POPLAR FIELD, ROOSEVELT COUNTY, MONTANA.

J. B. POWELL, JR., Murphy Corporation, Billings, Montana.

The discovery well for the East Poplar field was completed in March, 1952. On December 1, 1954, there were 53 producing oil wells in the field which had proved approximately 15,000 acres to be productive.

The field is located on a large, northwest-southeast anticline. Oil is obtained from limestone beds in the Charles formation of Mississippian age. The accumulation is partly controlled by porosity variations. During the first 11 months of 1954, more than one out of every 5 barrels of oil produced in Montana came from the East Poplar field.

8. SEDIMENTATION AND STRATIGRAPHY OF DAKOTA FORMATION IN SAN JUAN BASIN.

GUY C. BURTON, JR., El Paso Natural Gas Company, Farmington, New Mexico.

Exploration for gas in the Dakota formation of the San Juan basin can be designated as structural and stratigraphic. Petrographic analyses and subsurface studies of sand bodies below the top of the Graneros formation were used in attempting to designate the areas best suited for stratigraphic exploration.

High degrees of regeneration of the quartz grains composing the Dakota have hindered the drilling and exploration of the formation, and is believed responsible for the varying degrees of porosity and permeability of the Dakota in wells in adjoining sections.

The deletion of permeability by an increase in clay-mineral content of the sandstone members of the Dakota formation is believed responsible for the accumulation of gas southwest of the axis of the low part of the basin.