(Duperow, Nisku, Three Forks). Deposition was continuous or nearly continuous into the Mississippian, but the center of the Madison depositional basin was nearly coincident with the present Williston basin. It began with predominantly carbonate deposition with increasing evaporites in the upper part. The evaporites are mostly halite in the central basin area with anhydrite toward the flanks of the basin. Predominantly clastic deposition (Big Snowy Group) followed the evaporites and this was followed by another unconformity.

The Pennsylvanian and Permian periods are represented by clastics with minor carbonates (Minnekahta Formation) and some evaporites. This was a time of slight subsidence with the Williston basin area being part of a larger depositional area extending to the south and west. Similar conditions continued through the Triassic with fine grained clastics and some evaporites being deposited, followed by some non-marine redbeds and another unconformity.

The Williston structural basin had little effect on Jurassic or Cretaceous sedimentation so these periods are represented by eastward extensions of the predominantly fine grained clastics from the Rocky Mountain area seas. The Tertiary Period is represented by a wedge of predominantly non-marine beds which thickens westward toward the Rocky Mountain area.

EXPLORATION AND REVIEW PAPERS 1963–1964, ROCKY MOUNTAIN REGION

IRVIN KRANZLER, Independent Geologist, Billings, Montana

HIGHLIGHTS OF EXPLORATION IN MONTANA, APRIL, 1963–JULY, 1964

Exploration activity in Montana produced significant results in five widely separated areas:

(1) Northwestern Montana (Sweetgrass Hills area)—Oil was discovered in the Cretaceous Sunburst Sandstone in the old Fred and George Creek—Arch Apex gas field area. Also significant was the possible linking of Jurassic Swift Sandstone oil production of Whitlash and Flat Coulee fields.

(2) Northeastern Montana (Williston basin)—Nine new oil discoveries were made in Mississippian Mission Canyon, Devonian Nisku and Duperow, Silurian Interlake, and Ordovician Red River formations.

(3) Central Montana (Big Snowy uplift)—Pennsylvanian Amsden oil was discovered on Pole Creek anticline. Extensions to Keg Coulee field provided new emphasis for Pennsylvanian Tyler Sandstone prospects.

(4) South-central Montana (Big Horn basin)—Pennsylvanian Tensleep oil was discovered below a known gas cap in Northwest Elk basin field.

(5) South-central Montana (Powder River basin)—The first discoveries of Tensleep oil in many years breathed new life into a long dormant part of the basin.

These events, along with recent renewed interest in previously ignored areas such as the intermontane basins of southwestern Montana, should ensure a high level of exploration activity throughout Montana in the months ahead.

DAN E. HANSEN and JOHN N. KLEMER, North Dakota Geological Survey, Grand Forks, North Dakota and Consulting Geologist, Bismarck, North Dakota

REVIEW OF EXPLORATION AND DEVELOPMENT IN NORTH AND SOUTH DAKOTA; 1963 AND FIRST HALF OF 1964

Development and exploration in North Dakota during 1963 was down from 1962. Exploration activity increased during late 1963. The area which received the most attention was the north-central portion of the state where the pools are chiefly found in stratigraphic traps.

There were 183 wells completed in North Dakota during 1963 and of these, 73 were wildcats. There were 9 discoveries for a wildcat success of 12.3%. Field and outpost wells numbered 110 with 76 producers. Perhaps the most significant discovery of 1963 was the Ordovician Red River production found in the Fryburg-Scoria field of Billings County. The other wildcat discoveries were found in the north-central part of the state.

There were 12 wildcats drilled in western South Dakota during 1963 with no discoveries. A total of five new producers were drilled in the known fields of Custer and Harding Counties. The highlight of activity in the state during 1963 was a widespread lease play.

A considerable increase in exploration activity has taken place in North Dakota during the first six months of 1964. The leading county in number of discoveries is Renville where four wildcats have been found productive. The most significant discovery has been the Mouse River Park field.

Drilling in South Dakota during the early part of 1964 has been confined to the western part of the state with most of the activity centered in Custer and Harding Counties.

RICHARD O. DONLEY, Cities Service Oil Company, Casper, Wyoming

GEOLOGICAL EXPLORATION AND DEVELOPMENT IN WYOMING, 1963–1964

Oil and gas activity in Wyoming in 1963 and so far in 1964 was highlighted by interesting discoveries and developments which could have a far-reaching effect on future exploration in the state. In the way of what might be termed new and startling were: a Cretaceous Lewis Sandstone oil discovery at a rank wildcat in the Hanna basin; stratigraphic Tensleep accumulation discovered on the north side of the Big Horn basin; two widely separated Cretaceous Lakota Sandstone discoveries in the Powder River basin; a flurry of shallow Cretaceous Turner Sandstone drilling, also in the Powder River basin; experimental fire flooding and steam flooding at several places in the state; and two deep wells, Shell's 20,000-foot Madison test at Pavillion in the northwest portion of the Wind River basin and Texaco's 15,000-foot Jurassic Nugget gas well at Table Rock field in the Washakie basin.

The old standbys continued to furnish new reserves—the Minnelusa, Muddy, and Fall River (Dakota) reservoirs in the Powder River basin, and the Tertiary and Late Cretaceous oil and gas sandstones on the Big Piney La Barge platform in the Green River basin. At the Timber Creek field in the Powder River basin, discovered late in 1962, 1.5 million barrels of oil was produced during 1963. At Birch Creek, also discovered in 1962, on the La Barge platform, over 1.1 million barrels of oil was produced in 1963.

ROBERT P. KUNKEL, Consulting Geologist, Salt Lake City, Utah

EXPLORATION ACTIVITY AND OIL AND GAS DEVELOPMENT IN UTAH, NEVADA AND IDAHO SINCE JANUARY 1, 1963

Two significant developments which took place in Utah during the past 20 months are expected to strongly

influence oil and gas exploration in the state during the months ahead. One was the discovery of oil in the Permian Kaibab Limestone in the relatively undrilled Kaiparowits region in the south-central part of the state. Several large anticlines there, which are either untested or inadequately tested, are underlain by the Kaibab Limestone. Beneath the Kaibab several good reservoir sandstones of Permian age are also present.

The other important development is the continued westward extension of oil production from sandstones near the base of the Tertiary Green River Formation at the Red Wash field. Exploratory drilling westward from Red Wash, along the depositional strike of the Green River Formation for a distance of 30 miles, and stimulated largely by successful development at Red Wash, has resulted in two new Green River oil discoveries from sandstone. Two other Green River oil discoveries were completed along this trend in 1962. A large area with relatively few dry holes, an excellent success ratio and additional factors favorable for successful exploration is indicated.

Other exploration and development trends in Utah include a decline in exploratory drilling and an increase in both oil and gas production in Utah in 1963 over 1962. So far in 1964, oil production has dropped slightly and gas production has remained about the same.

Two dry wildcat wells have been drilled in Nevada and two in Idaho since 1962.

Two good development wells were completed in the Eagle Springs oil field in Nevada during the same period.

STUART C. TAPP, Consulting Geologist, Denver, Colorado

REVIEW OF EXPLORATION ACTIVITY, EASTERN COLORADO AND WESTERN NEBRASKA IN 1963

During 1963, 426 wells were drilled in eastern Colorado versus 606 for 1962, registering a 30 per cent decline in drilling activity. The 234 exploratory wells resulted in 21 discoveries, yielding a success ratio of 9 per cent. Important developments in 1963 included continued exploration and development in Washington County, and a revitalized emphasis on Pennsylvanian production in southeastern Colorado. Oil production declined from 21,898,579 barrels in 1962 to 16,809,109 barrels in 1963, while gas production remained about constant—28,289 MMCF in 1962 and 29,020 MMCF in 1963.

During 1963, 537 wells were drilled in western Nebraska versus 645 for 1962, representing a 16.7 per cent decrease in drilling activity. The 288 exploratory tests resulted in 24 discoveries, for a success ratio of 8.05 per cent. Important developments in 1963 included a northwestern extension of the Sleepy Hollow field in Red Willow County, establishment of northernmost production in the Nebraska portion of the Denver basin at Scottsbluff County, and Lansing-Kansas City discoveries in Red Willow County between Ackman and the Silver Creek fields. Oil and gas production declined from 30,703,000 barrels and 24,200 MMCF in 1962 to 26,912,000 barrels and 15,470 MMCF in 1963.

There was a 27 per cent decrease in geophysical activity in eastern Colorado but the decline was stronger, 77 per cent in Nebraska.

Early statistics listing the drilling activity for the first half of 1964 indicate a reversal of the 1962, 1963 trend.

H. W. PRAETORIUS and D. L. WALKER, Humble Oil and Refining Company, Durango, Colorado

EXPLORATION AND DEVELOPMENT ACTIVITY, FOUR CORNERS AREA

Exploratory drilling in the Paradox basin in 1963 and early 1964 was concentrated in the Aneth area in southeastern Utah where it was prompted by expiring Navajo Indian leases. The principal objectives were Pennsylvanian carbonates which produce oil at the Aneth and Ismay fields. Reserves discovered by this effort were negligible. Elsewhere in the basin a new depth record, 16,237 feet, was set for the State of Utah in the Salt Anticline area, and in southwestern Colorado an active leasing and drilling play developed on a Pennsylvanian carbonate trend marginal to the Paradox evaporite basin.

In the San Juan basin of Colorado and New Mexico, development of gas reserves from the Cretaceous Dakota Sandstone in the Basin Dakota field continued at the rate of approximately 200 completions per year. Exploration drilling for oil in the Cretaceous Gallup Sandstone slowed somewhat but development drilling continued at the Many Rocks field where 53 producing wells have now been completed. A small Gallup oil field was discovered at South Waterflow and it presently consists of seven producing wells.

The most significant development influencing industry activity in the Four Corners was the offering for lease by the Navajo Indians of approximately two million acres of tribal land in Arizona, New Mexico, and Utah. Industry interest was particularly high in the Black Mesa basin of northeastern Arizona where much of the acreage was made available for the first time. The high bid of $935 per acre for rank wildcat acreage reflects the intensity of this interest. A few wildcats have been drilled around the margins of the Black Mesa basin; however, the central portion of the basin which is entirely Indian land, is virtually undrilled. Geological information is meager but Pennsylvanian, Mississippian and Devonian beds appear to have the most potential for the development of significant hydrocarbon reserves.