beds. The Interlake is variably eroded, but everywhere affected by the great pre-Devonian unconformity.

L. M. Fuzesy, Saskatchewan Department of Mineral Resources, Regina, Saskatchewan
Problems in Correlation of Mississippian Strata in Southeastern Saskatchewan

The area examined is located in the northern part of the Williston Basin in southeastern Saskatchewan. The lithology and stratigraphy of the Mississippian strata of this area (excluding the Bakken formation) are discussed. Emphasis is given to the clarification of correlation problems which exist in certain parts of the succession. For the purpose of illustration, subcrop maps, cross-sections and isopach maps of the various Mississippian units are presented.

The Mississippian strata consist mainly of limestone and dolomites with several interbedded evaporite beds in the upper part of the succession. At the present time these Mississippian rocks are the most important oil-producing strata in Saskatchewan. The oil reservoirs occur in porous limestones or dolomites. Reservoir caprocks may be divided into 3 distinct categories—(1) those crested by primary evaporites in the normal Mississippian succession; (2) those caused by secondary infilling of normally porous and permeable rocks by anhydrite and dolomite, giving rise to dense non-porous layers at the erosion surface; (3) those formed by the argillaceous beds of the overlying Watrous formation of Jura-Triassic age. Combinations of these types of caprocks occur in certain locations.

A. J. Gosar, Belco Petroleum Corporation, Big Piney, Wyoming
Stratigraphic and Structural Traps in Big Piney-La Barge Area, Wyoming

The Big Piney gas and oil field, located in T. 26-30 N., R. 112-114 W., Lincoln and Sublette counties, Wyoming, lies within the Green River Basin, east of the north-south trend of the Wyoming Range. Oil and gas are contained in lenticular and blanket sands ranging in ages from Tertiary to Jurassic, namely, Wasatch, Mesaverde, Baxter, Frontier, Muddy, and Nugget formations.

Drilling in this area began with the discovery of oil by the Wyoming Reserve Petroleum Corporation, from the Wasatch (Almy) sediments at the La Barge oil field in 1924. Promotional drilling ventures continued off and on until oil was discovered in the Mesaverde formation at North La Barge field by Circle Oil Company in 1930. Wyoming Petroleum Corporation's Budd No. 1, after a blow-out in 1938, stimulated an unpredicted lease play in the immediate area. With the advent of a pipeline for natural gas, development drilling programs were initiated by major and independent oil companies in 1954.

Variations in sedimentation, off shore bars, and thickness changes to the northeast, and south, provide updip gas and oil reservoirs in Wasatch sediments. Alphabetic nomenclature has been ascribed to various sands within this Wasatch section. Mesaverde sediments, although widespread, are not only influenced by an unconformity and faulting, but also by facies changes not unlike the overlying Wasatch sediments.

Consistent with the overlying Mesaverde and Wasatch sediments, the Baxter formation contains varying shaly sand conditions which, coupled with imbricate thrust faulting, further complicate subsurface studies adjacent to the Darby-La Barge thrust complex. Commercial gas zones have been defined at and adjacent to La Barge oil field. The Frontier formation is delineated into subthrust and overthrust members by the steep attitude of the La Barge thrust fault. Five benches are defined in the Second Frontier, four of which are lenticular in outline. The Second Bench of the Second Frontier provides the only true blanket sand in this entire interval.

Muddy production appears to be controlled by variable sand conditions and permeability barriers. To date only two isolated productive areas have been defined.

Nugget sediments are undoubtedly widespread through the Big Piney-La Barge area. Oil accumulation at Tip Top and Hogsback is structurally controlled but complicated in part by minor thrust faults.

Deeper Phosphoria, Tensleep, and Madison horizons have not been penetrated east of the Darby-La Barge thrust complex.

H. L. Halbertsma and F. L. Staplin, Imperial Oil Limited, Calgary, Alberta
Mississippian-Pennsylvanian Boundary from Peace River Area to Williston Basin

For many years the age and correlation of late Paleozoic (post Meramecian) strata in the eastern Rocky Mountains and plains of western Canada and the northwestern United States have been difficult to establish, because the stratigraphy is complicated by at least three major angular unconformities. These occur at the Mississippian-Pennsylvanian boundary, the Pennsylvanian-Permian boundary and the Permian-Triassic boundary. The most controversial has been the one at the Mississippian-Pennsylvanian boundary, until Willis (1959) established it at the Heath (Big Snowy Group)-Tyler contact. In Alberta (Peace River area) the Mississippian-Pennsylvanian boundary was found to be at the Golata-Kiskatinaw contact. The Golata formation is very likely correlative with part of the Big Snowy Group; the Kiskatinaw formation is believed to be the age equivalent of the Tyler formation. Fossil determinations have confirmed these lithological correlations.

To link equivalent formations from Peace River to Montana, the front ranges of the Rocky Mountains were included in the study. The Etherington formation (Mississippian Chester) here correlates with the Big Snowy Group and with the Golata formation. The Tunnel Mountain formation (Lower Pennsylvanian) is equivalent to the Tyler-Amsden (Kiskatinaw-Taylor Flat in Peace River) interval. A map showing the eastern edges of the Chesterian and Lower Pennsylvanian, cross sections through critical areas, and a nomenclature chart are included.

C. W. Hendel, Consulting Geologist, Salt Lake City, Utah
Wasatch Gas in Uinta Basin and Its Effect on Future Oil Exploration

Eight years after discovery of Redwash, Tertiary oil is being produced in significant amounts from only this one field. Lack of a dewaxing plant for high pour-point oil has discouraged prospecting the shallow south flank of the basin for the smaller Green River strat-traps. Standard of California Company markets Redwash oil through the Rangely pipeline, which can accept limited amounts of waxy crude. As a result, an impasse has existed: lack of market discourages exploration, and yet a large additional supply of oil is needed before a wax plant is feasible. The current gas exploration is a development which could help to end this impasse. Two near-commercial oil discoveries have been made already by wells scheduled as deeper tests to the Wasatch and Mesa Verde.

The 18-mile Wasatch gas trend may extend west or southwest and overlap a large area underlain by shallower Green River sand lenses. Gas, apparently commercial, has been found in the Ute Trail area, which includes the Ouray, Bitter Creek, Chapita Wells, and the Southman Canyon discoveries.

Gas occurs in lenticular sands near the middle of the red, drab and gray Wasatch shale section, at depths ranging from 5,000 to 6,500 feet. Porosity averages 12% and permeability less than 1 millidarcy. Some sand bodies are continuous for four or five miles. Two or three sands 20 feet thick are generally encountered in each well.

Paleogeographic maps and cross-sections show the gas sands to lie on the north edge of a wedge of deltaic clastics brought into the basin from the south, and possibly east, and deposited in a shallow lake. This interpretation differs from published descriptions of the Wasatch as "dominantly fluviatile." Orientation of sand lenses, sorting of sand grains, and relatively great lateral extent of the sand bodies supports this concept.

Trapping is by isolation of the sand bodies and by permeability barriers between lenses of porosity within a sand zone. The trend is limited on the south by a coalescence and thickening of sand bodies, which eliminates the barriers and permits the escape of gas. Hydrodynamic traps may be present here as well. The north edge is limited by poorer sorting of the sand depsoited in deeper water. Shales of the deeper water are generally dolomitic, black, bituminous and somewhat fossiliferous, and dark gray-green or drab with subordinate purplish "relict" red colors.

Richard L. Jodry and Donald E. Campau, Sun Oil Company, Billings, Montana

Small Pseudochitinous and Resinous Microfossils: New Tools for Subsurface Geologist

The study of palynomorphs (small, nearly indestructible fossils) is generally included in the field of palynology, along with the study of polospores. Palynomorphs and polospores are included in a group of fossils sometimes designated as micro-microfossils because of their small size. Work in the Williston Basin and other areas containing Paleozoic carbonate rocks indicate that certain groups of palynomorphs make an ideal tool for use by the subsurface geologist. These fossils, chiefly the Chitinozoa (possibly an extinct order of marine protozoans) and Tasmanites (probably a family of fossil algae), may be concentrated in and recovered from the insoluble residue from drill chips utilized in the course of normal sample examination. They are well adapted for use as an aid in solving problems of correlation, zonation, and age-dating. In the Williston Basin the Chitinozoa and Tasmanites have been used as an aid in the reconstruction of the Ordovician surface section, in the subdivision of this section, and in carrying these subdivisions into the subsurface. These micro-microfossils have aided in the solution of structural problems, and offer possibilities as a tool for age-dating of Paleozoic rocks over very wide areas.

Paul Kents, Saskatchewan Department of Mineral Resources, Regina, Saskatchewan

Three Forks and Bakken Stratigraphy in West Central Saskatchewan

The Three Forks and Bakken sequence in west-central Saskatchewan was laid down during a relatively brief period of mild uplift in late Devonian and early Mississippian time, preceding the beginning of the main stage in the development of the Williston Basin. This sequence, though only about 300 feet in thickness, contains a wide variety of different rock types: dolomites, anhydritic dolomites, red beds, green shales, black radioactive shales, sandstones, and clastic biostromal limestone, which make it easily recognized in well cuttings and readily correlated from well to well.

In the northwestern part of the area the pre-Mesozoic strata were folded in post-Mississippian times, truncated and then buried by Mesozoic sediments. Data assembled from nearly all exploratory wells in the area have revealed the presence of six anticlinal structures, two of which appear to be closed and of substantial length. These structures lie in a region adjacent to producing oil fields, and therefore offer good exploration possibilities. There are indications that more hidden structures may exist in which the pre-Mesozoic strata have been folded, thus adding to further oil and gas possibilities in the area.

Daniel Lum, South Dakota Geological Survey, Vermillion, South Dakota

Gravity Measurements East of Black Hills and along a Line from Rapid City to Sioux Falls, South Dakota

Gravity measurements were carried out in South Dakota during the summer of 1959 by the State Geological Survey, as part of a regional gravity study which is being supported by a National Science Foundation grant. A simple Bouguer gravity anomaly map was compiled from data of more than 500 stations in an area of approximately 2,600 square miles. A gravity traverse was established from the Black Hills eastward onto the Sioux uplift.

The configuration of the basement surface and the variations of intra-basement lithology, as suggested by the gravity measurements and some magnetic studies, are discussed. Interpretations of the gravity data are preliminary at this time.

Further gravity studies in South Dakota are planned.

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Gas in Gallup and "Tocito" Formations in San Juan Basin, New Mexico

Commercial quantities of gas can be produced from the Gallup and "Tocito" sandstones in nine fields on the southwest and west flanks of the San Juan basin. These fields are Bisti, Gallegos, Escrito, Otero, Doswell, Chimney Rock, Horseshoe Canyon, Verde-Gallup, and an unnamed field. The last four fields have only one to four wells with commercial quantities of gas. Most of the gas is produced with oil. Little gas was collected from the Gallup and "Tocito" prior to 1958. Some gas is being reinjected for secondary recovery purposes.

The Gallup sandstone is the basal member of the Mesaverde group. The "Tocito" sandstone is any sandstone lens below the Gallup formation and above the Sanastee calcareous shale and limestone. All accumulations are in stratigraphic traps which have increased trapping capacity because of favorable hydrodynamic environments with downdip water flow. Bisti field is used as an example of the trapping capacity of a stratigraphic trap. The sandstone decreases in permeability updip but does not pinch out. Under hydrostatic conditions the capillary pressure of the column of oil and gas present at Bisti would be sufficient to cause much of the oil and gas to migrate updip out of the permeability lenses. However, with favorable hydrodynamics, the oil and gas column of over 360 feet is retained.

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Cost of Finding Oil in Rocky Mountains