

Shaunavon, and Vanguard formations of Saskatchewan. However, they are not the exact equivalents of these formations since some overlapping occurs.

R. L. MILNER and G. W. BLAKSLEE, Tide Water Associated Oil Company, Regina, Saskatchewan
Jurassic of Southwestern Saskatchewan

The Jurassic in this area consists of four formations, the Vanguard, Shaunavon, and Gravelbourg of essentially marine nature, and an underlying Watrous formation composed of redbeds and evaporites. These formations were originally described by Milner and Thomas in 1952, and the subdivisions of these formations used here are essentially the same except for some slight modifications in the subdivision of the Vanguard formation.

The Watrous formation is considered to be of Jurassic age but the formation is largely unfossiliferous and many workers believe that at least the basal part of the formation may be Triassic in age. The Gravelbourg, Shaunavon, and most of the Vanguard formation are unquestionably Jurassic and extend from the Bajocian into at least the Oxfordian. In much of the area the top of the Jurassic is placed at a marked unconformity between obvious Jurassic and an unfossiliferous sequence of shale and sandstone thought to be of Lower Cretaceous age. In many wells, however, part of this unfossiliferous section may also be Jurassic in age and the top of the Jurassic is difficult to locate.

Correlations with adjacent areas are possible and the Saskatchewan section is most easily correlated with the Ellis group of Montana. The Saskatchewan section is considerably thicker than that found in the outcrop areas along the southwestern edge of the Jurassic basin, and the formations present in Saskatchewan are only partially represented in typical outcrop sections of the Ellis group. Despite this, equivalents of the Swift, Rierdon, and Sawtooth formations of Montana can be recognized in Saskatchewan.

The Jurassic seas covered most of Southern Saskatchewan and the northern shoreline of this Jurassic basin extended in a general east-west arc across the Province approximately 150–200 miles north of the International Boundary. Sediments deposited in this basin thicken southward, the maximum thickness in Saskatchewan being about 1,400 feet. The western side of the basin is marked by an extensive shelf area extending eastward from the Sweetgrass arch across Saskatchewan as far as a line running approximately through the Dollard-Fosterton trend.

Minor fluctuations in the strand line during Bajocian or Kimmeridgian time are expressed by the deposition of both clastic and carbonate sediments in the basin. The deposition of suitable reservoir rocks, including both sands and fossil debris, is closely related to transgression and retreat of the Jurassic seas, while local relief on the ocean floor due to the irregular topography on the old Paleozoic surface was important in controlling the deposition of these reservoir rocks.

Oil occurrences in the area are mainly stratigraphic in nature although minor structural features related to compaction and regional downwarping of the area in Jurassic and Cretaceous time have played some part in localizing oil accumulation. Oil production has been established in the upper and lower members of the Shaunavon formation, in the middle Vanguard, and in the basal sands of questionable Cretaceous age.

The geologic reasons for the deposition of reservoir rocks in the Jurassic of southwestern Saskatchewan are illustrated by means of isopach maps of the various formations and members, and an attempt is made to relate the occurrences of oil in these reservoirs to the geologic history of the area.

A. KLINGSPOR, Imperial Oil Limited, Regina, Saskatchewan
Jurassic Stratigraphy of Sweetgrass Arch—Manitoba Section

In southern Saskatchewan and Manitoba the interval between the late Paleozoic and late Jurassic epeirogenies is represented in stratigraphic order by continental redbeds, evaporites, carbonates, and clastics. The sequence is in excess of 1,400 feet thick in south-central Saskatchewan and thins north, west, and east. Depositional and erosional thinning are complementary and the northern limits are determined by late to post-Jurassic truncation.

The system was divided (Milner and Thomas, 1954) into the Watrous, Gravelbourg, Shaunavon, and Vanguard formations, each representing widely recognizable lithologic units.

Proof of Jurassic age is available for the Gravelbourg, the Shaunavon, and Vanguard formations. These formations together appear to represent the Bajocian to Kimmeridgian time interval. The evaporites of the Watrous formation possibly represent the lower Bajocian or earlier Jurassic stages. Recent findings, still unpublished (Peterson, 1955), indicate that rocks of Triassic age may be included in the lowermost continental sediments of the Watrous.

A minor unconformity of Middle Jurassic age is indicated by the occurrence of chert on top of marine carbonates of the Gravelbourg. The evidence for this unconformity is strongest in central and southeast Saskatchewan. There the anhydrite of the Watrous formation thickens markedly and the evaporite conditions appear to have lasted into a higher stratigraphic level than in western Saskatchewan. In the same area the marine sediments above the unconformity thin and gradually change facies. The carbonates to the west are substituted by clastics, and coarse clastics appear in increasing

amounts in an easterly direction. It would appear that a separate basinal area existed toward the end of Middle Jurassic time in Manitoba, receiving clastic sediments from the north and east.

The Shaunavon formation can not be traced lithologically in this facies district but approximately equivalent picks can be made from electric and radiation logs. The lithologic character of the uppermost Gravelbourg, Shaunavon, and Vanguard formations in Manitoba resembles closely that of the Sundance formation in North and South Dakota.

Callovian time is represented by the lower part of the Vanguard formation. During this time uniform basinal conditions were established across the entire area. A slight unconformity, recognizable in western Saskatchewan, marks a change from marine to brackish conditions which must have taken place in middle Oxfordian time. In the center of the basin 150 feet of marine middle Vanguard represent the Oxfordian interval. The upper Vanguard is partly marine, partly brackish and contains Kimmeridgian fauna. The lithologic character of the upper Vanguard, and the fact that it contains reworked fragments of older Jurassic faunas, indicate redeposition of material from the truncated basin flanks into the center.

The hiatus between Kimmeridgian and Lower Cretaceous is represented by a major unconformity which marks the top of the Jurassic system in Saskatchewan.

JAMES A. PETERSON, Shell Oil Company, Salt Lake City, Utah
Stratigraphy of Jurassic Type Localities of Northern United States and Correlation with Adjoining Areas

On the basis of faunal and lithologic correlations, Jurassic units can be traced northward from their type areas of the northern United States Rocky Mountains into southern Canada. The five-unit classification of the marine Jurassic in the Black Hills is useful in the subsurface for only a limited distance from the type area. The most useful nomenclature for subsurface work in the northern Rocky Mountains of the United States is probably that of the Ellis group of Montana. The Swift, Rierdon, and Piper units of the Ellis group can be correlated throughout most of the Western Interior United States. Within the central part of the Williston basin, however, these units are not yet recognizable on a lithologic basis alone, but micropaleontologic work indicates that these units may be distinguishable paleontologically.

The major tectonic elements affecting the marine Jurassic sedimentary pattern in the northern United States were the Belt island of western Montana, the Williston basin of North and South Dakota, eastern Montana, and southern Saskatchewan, and the Twin Creek trough of southeastern Idaho, central and northern Utah, and western Wyoming. Isopach maps indicate that several minor "positive" and "negative" elements were also present within the shelf area of Montana, Wyoming, western Colorado, and eastern Utah.

JURASSIC COMMITTEE

Cross Section: Jurassic Correlation in Western Canada Basin and Northern United States

The stratigraphic correlations herein proposed were prepared by a committee consisting of the following members: Hans Frebald (chairman), Miss D. M. Loranger (co-chairman), G. Blakslee, P. Chamney, M. B. Crockford, A. Klingspor, H. Lackie, W. D. MacDonald, R. Milner, J. Peterson, G. Springer, and Miss Ruth L. Thompson.

In Saskatchewan, the basal unit of the Mesozoic is the Watrous formation (Gypsum Spring). It is considered to be pre-Middle Bajocian and its lower beds might even be Triassic in age. The Watrous is overlain by the Sawtooth formation, which is equivalent to the Gravelbourg and part of the Shaunavon. The top of the Sawtooth is still under discussion, some favor placing it at the top of the upper Shaunavon. The Gravelbourg and the lower Shaunavon are equivalents of the Middle Bajocian Rock Creek member of the Fernie group. In the plains of Alberta and Saskatchewan the upper Sawtooth may include strata of Upper Bathonian age; however, no proof is currently available. The Montana and Alberta Rierdon formation represents the Lower Callovian. In Saskatchewan the lower Vanguard and perhaps a part of the upper Shaunavon are of the same age. In the Fernie group the Lower Callovian consists of the Gray beds, which are locally replaced by the facies of the *Corbula munda* and *Gryphaea* beds. In Saskatchewan the Oxfordian is represented by the middle and upper Vanguard which are equivalent to the Alberta and Montana Swift formations and to the Green beds and lower Passage beds of the Fernie group. The presence of an unconformity at the top of the middle Vanguard is possible. The sands of the middle Vanguard pinch out to the west toward the Sweetgrass arch.

Strata of Kimmeridgian age are represented in the Fernie group by at least part of the upper Passage beds. On a micro-paleontological basis, Loranger and others regard the uppermost part of the Vanguard formation as Kimmeridgian and consider this part of the section in the Alberta and Saskatchewan Plains as part of the Montana Morrison formation.

In the subsurface of the Peace River area the Jurassic is developed as Fernie group; the Nordeg member, the Toarcian and the Rock Creek member have been recognized on a lithological basis and