THE JURASSIC STRATIGRAPHY OF MANITOBA

A Thesis

presented to

the Faculty of the Department of Geology

The University of Manitoba

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in partial fulfillment

of the requirements for the degree

Master of Science

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by

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May 1954

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ABSTRACT

The Jurassic system extends from the Williston basin into Manitoba where it unconformably lies on Paleozoic rocks and below Cretaceous sediments. It is divided into four formations, which are from the base upward; Amaranth, Piper, Rierdon, and Swift.

An assemblage of gypsiferous red beds, anhydrite, and dolomite are included in the Amaranth formation. The remainder of the Middle Jurassic shales, argillaceous and oolitic limestones is placed in the Piper formation. The Upper Jurassic strata consist of the Rierdon formation which contains varicoloured shales and thin bands of limestone, and the Swift formation which contains sand and shale beds.

Depositional conditions and correlation problems related to the basal red beds, to the division between Middle and Upper Jurassic sediments, and to the upper limit of the Jurassic system are discussed.

CONTENTS

Page

LIST OF TABLES

LIST OF ILLUSTRATIONS

in this area have not been well known. Interest in the Jurassic stratigraphy of Manitoba has greatly increased within the last two years because of the discovery of oil in Jurassic beds at Wapella, about twenty-five miles west of the Manitoba-Saskatchewan border.

It was suggested to the writer that a stratigraphic study of this interval would be both interesting and challenging. An attempt is made in this paper to describe the stratigraphy of the Jurassic system in Manitoba, and to indicate the relationships of this section with similar deposits in northern United States and Canada.

The present study, made during the winter of 1953-1954 at The University of Manitoba, covers an area which includes the south-western corner of Manitoba, the south-eastern part of Saskatchewan and the northern area of North Dakota. The extent of the Jurassic sediments in the Great Plains area, the Jurassic "outcrop" area in Manitoba, and the area of the present study are shown in Figure 1.

The lithologic description was obtained from a study of cuttings from oil wells. Samples from fifty wells were examined, and lithologic descriptions of twenty-four sub-surface sections were available to the writer, who takes responsibility for the determination of the formational tops. The tops determined by the North Dakota Geological Survey were used for twelve wells. These are believed to be equivalent to those determined by the writer. When available,

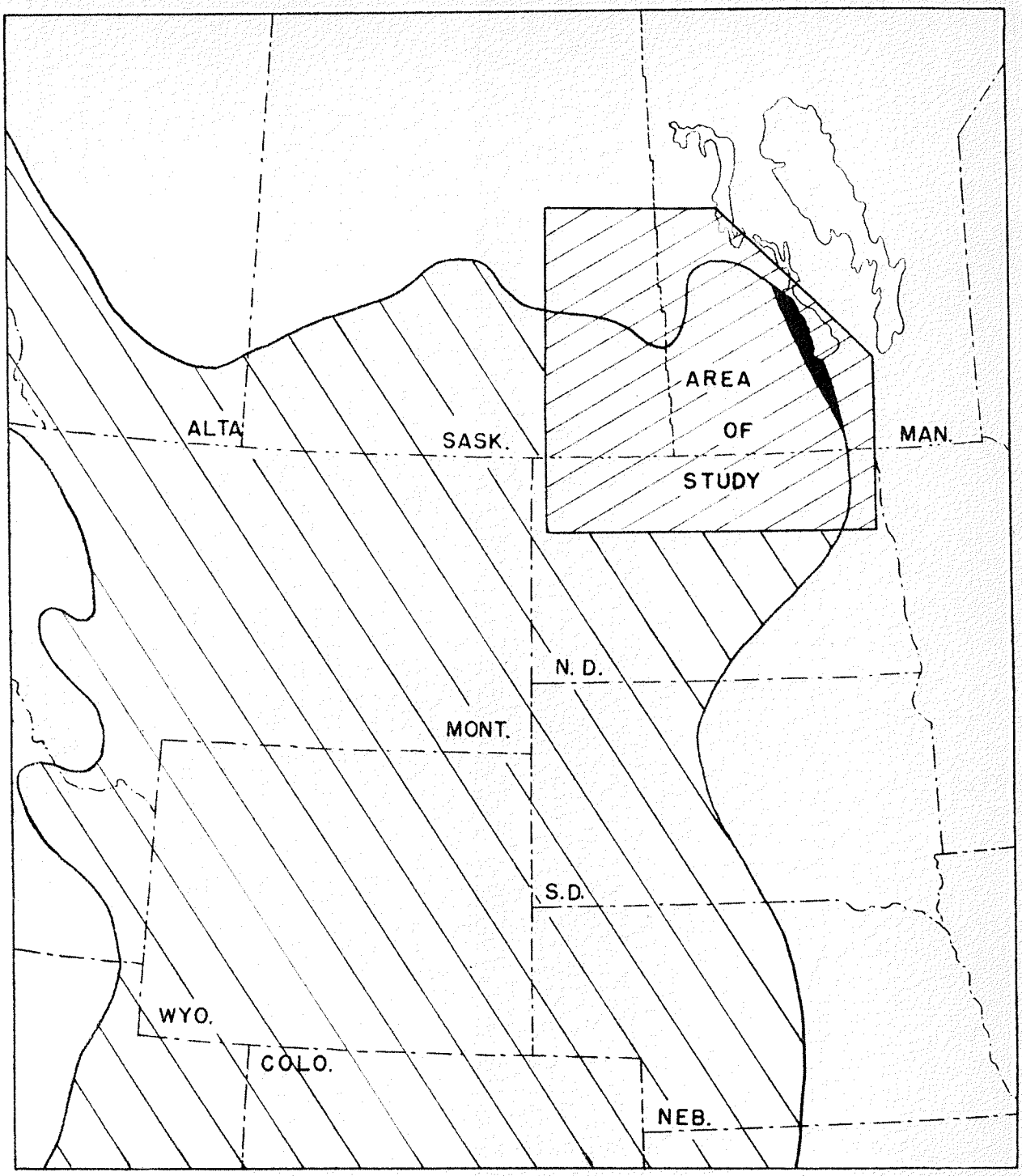

FIGURE I. DISTRIBUTION OF JURASSIC SEDIMENTS IN THE WESTERN INTERIOR REGION (after IMLAY, 1949).

JURASSIC ROCKS UNDER COVER OF GLACIAL DRIFT

AREA CONTAINING JURASSIC ROCKS

electric and/or radioactive logs were used in conjunction with this study. In the Jurassic section of Manitoba, core has been taken from only a few intervals and all of it was examined.

Each well has been given a reference number and these control points are shown on the index map (Plate 1)[1]. The data pertaining to these wells are given in Appendix I. Lithologic descriptions of wells shown on the cross-sections are included in Appendix II.

Previous Work

The literature describing rocks of Jurassic age in Manitoba is limited. This may be explained by the complete lack of exposures, and by the scarcity of subsurface information before 1950.

Although Tyrrell[2] did not recognize the Jurassic section, samples from three wells in Manitoba which probably penetrated it were described by him in 1892. The descriptions are too generalized to determine any units that might correspond with those outlined in this paper.

Dowling (1919) indicated that a total of 230 feet of samples from a well at Neepawa could possibly be Jurassic

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[1]All map plates are enclosed in an envelope placed at the end of this report.

[2]Complete references to discussions by persons indicated in this paper may be found in the bibliography.

shales, but no detailed description of the rocks was made at that time.

Other workers, however, did not consider that Jurassic sediments were present in Manitoba. Wallace (1925) suggested that during late Paleozoic, Triassic and Jurassic times, the Manitoba area was entirely above the sea. Kirk (1929) reported that no evidence was present to prove or disprove the presence of Jurassic rocks, although he believed that, in northern Manitoba at least, the basal Cretaceous beds rested upon Devonian rocks.

Rocks of Jurassic age were not definitely recognized until 1933 when Wickenden suggested, on the basis of paleontological evidence obtained from the Manitou and Dauphin wells, that three Jurassic members or possibly formations were present. Some of the foraminifera from these wells and from beds of similar lithology and stratigraphic position in Alberta and Saskatchewan were described by him in a paper in 1944, which indicated that these rocks were of late Middle or early Upper Jurassic age. In 1945, Wickenden defined the Amaranth formation as those rocks lying between known Jurassic and Devonian rocks.

Jurassic and Amaranth rocks were also described by Kerr in 1949.

In a paleoecologic study of the Jurassic system in the United States, Imlay (1949) indicated on his maps the

occurrence of Jurassic rocks in Manitoba and discussed the environmental conditions in which they were deposited.

Schmitt (1953) extended the nomenclature of the Jurassic formations of Wyoming and the Black Hills into Manitoba, using Moore #1 and Langford #1 wells for his correlations.

Acknowledgments

The work on this report was made possible by a bursary granted by The National Research Council of Canada whose financial assistance is deeply appreciated.

This report was prepared under the supervision of Professor E. I. Leith of The University of Manitoba. His guidance, advice, and constructive criticism are gratefully acknowledged.

To the other professors of the Geology Department, many thanks are offered for their help.

The writer is indebted to Mr. J. R. Ower who first suggested that the Jurassic stratigraphy would provide a variety of problems for a Master's thesis. Particular thanks are extended to him and to Mr. M. Stanton, both of the California Standard Company, for their encouragement, advice, and assistance in the preparation of this report.

The cooperation and assistance received from the staff of the Manitoba Mines Branch has been of invaluable aid. Thanks are given to Dr. Charlewood, Chief Geologist, who, from his interest in obtaining some information on the

Jurassic section, permitted the writer to use available subsurface records.

Dr. Wilson M. Laird, State Geologist, North Dakota, kindly supplied lithologic descriptions of several wells which enabled correlations to be made from Manitoba.

Thanks are extended to Mr. L. Vigrass whose suggestions and thesis on the Jurassic stratigraphy of Saskatchewan were helpful in correlation.

beds show remarkable lithologic continuity throughout the area, although some variations in thicknesses occur. Many lithologic and thickness variations occur both vertically and laterally in the shale section.

Subdivision and Nomenclature

At the present time, the nomenclature of the Jurassic stratigraphy in the Great Plains is in a state of discord because geologists in the Rocky Mountains and in the Black Hills of South Dakota have used different formational names. Recent work in Saskatchewan and the Williston basin area has resulted in several new divisions. A conference of geologists in February, 1953, attempted to establish a standard Jurassic nomenclature for the Williston basin area, but it has not been formally adopted. As pointed out by Hadley and Milner (1953), correlation difficulties have arisen because of "(a) voluminous and overlapping terminology; (b) presence of four and possibly more major unconformities[1]; (c) lateral discontinuity of sandstone units; (d) general tendency to rely on electric or radioactive logs for correlation instead of basic lithology."

Jurassic terminology has developed in three areas. Imlay (1947) described the section in the Black Hills and

[1]This refers to both Jurassic and Cretaceous systems.

Wyoming area. Cobban (1945) and Weir (1949) discussed the formations in Montana and Alberta. Schmitt (1953), and Hadley and Milner (1953) described the units in the Williston basin area of North Dakota and Saskatchewan. Correlations are shown in Table 1.

The Black Hills section, as described by Imlay, contains the Gypsum Spring and Sundance formations. In the correlation of the Jurassic formations in parts of the Western Interior region, Imlay (1949) indicated that the Gypsum Spring formation is of Bajocian age and equivalent to the lower part of the Piper-Sawtooth formation. The Sundance formation consists of, from bottom to top, the Canyon Springs sandstone member, Stockade Beaver shale member, Hulett sandstone member, Lak member, and Redwater shale member. The first four are Callovian in age, and the Redwater member is Oxfordian. The Piper formation was introduced by Imlay to include all Middle Jurassic deposits above the Gypsum Spring formation.

In the Montana area, another set of formational names has been used. Peale (1893) named the Ellis formation from exposures of marine Jurassic rocks near Fort Ellis, Montana. Cobban (1945) found that the Ellis formation in the Sweetgrass Arch area of Montana contained three major lithologic divisions which he recognized as formations, and therefore, he raised the Ellis to group rank. He applied the name Sawtooth to the oldest Jurassic formation which is Bathonian

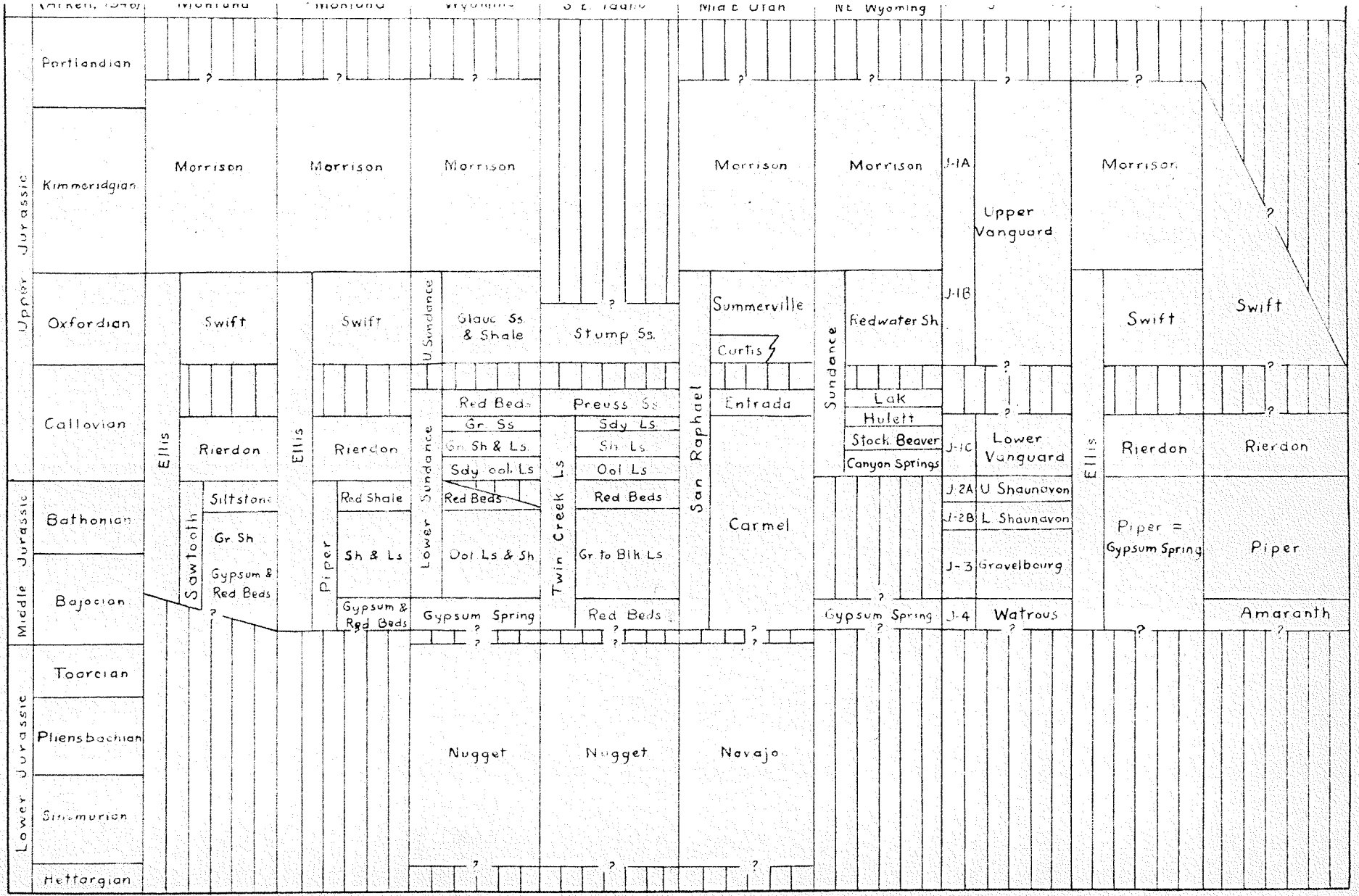

Table 1. Correlation of the Jurassic Formations in the Western Interior Region.
(First 7 Columns from Imlay, 1949)

see Table 1A, page 74.

in age. The middle formation of the Ellis group was named Rierdon, and is of middle and upper Callovian age. The upper formation, the Swift, is Oxfordian in age.

Weir (1949) found that "the three-fold division of the Ellis group established by Cobban in Montana can be recognized in Alberta."

A new nomenclature for the Jurassic section was introduced by the Williston Basin Correlation Committee in February, 1953 (see Hadley and Milner). The names of Saskatchewan towns were applied to units of a previous classification known as the J Classification. The basal anhydrite and red bed sequence was called the Davidson formation, a name previously used by Bailey (1953) for a formation of Devonian age. The name of the Jurassic Davidson formation has now been changed to Watrous. A sequence of sandstones, shales, and limestones, lying above the basal unit and equivalent to the J-3 and J-4A units of the older classification is called the Gravelbourg formation. Another sequence with well developed electric log characteristics is called the Shaunavon formation. It is equivalent to the J-2A and J-2B units of the J classification. The top of the Lower Shaunavon formation is usually taken as equivalent to the top of the Piper limestone. The uppermost Jurassic beds, equivalent to J-1A, J-1B, and J-1C have been included in the Vanguard formation.

Wickenden (1945) extended the use of the name Amaranth, as suggested by Kirk (1929) on his manuscript map for gypsum-bearing beds in the vicinity of Amaranth, to beds of similar lithology and stratigraphic position found in subsurface sections of Manitoba.

The use of Saskatchewan terminology has not proven feasible for the divisions in Manitoba. In the area near the eastern limit of Jurassic deposition, interfingering and thinning of beds result in the loss of distinguishing characteristics of these units.

Outline of Stratigraphic Units

The Jurassic system is divided into four major units of formational rank. These do not necessarily correspond to time units because the upper and lower units have been defined on lithologic changes. These divisions have been found to have cartographic limits.

Although the anhydrite and red bed sequence in Manitoba and Saskatchewan are equivalent, some discord exists over the name. As correlation has been made with the "outcrop" of the Amaranth formation and as it has priority over names applied to the beds elsewhere, the name Amaranth is used in the present discussion for the basal Jurassic beds. This formation has been divided into two units because of the change in lithology. The Lower Amaranth unit contains the