Eug. Tozer

CANADA

DEPARTMENT OF MINES AND RESOURCES

MINES AND GEOLOGY BRANCH

GEOLOGICAL SURVEY

PAPER 52-3

THE ST. MARY RIVER - WILLOW CREEK CONTACT ON OLDMAN RIVER, ALBERTA

By

E. T. Tozer

OTTAWA

1952

CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

Paper 52-3

THE ST. MARY RIVER-WILLOW CREEK CONTACT ON OLDMAN RIVER, ALBERTA

By
E. T. Tozer

OTTAWA
1952

The St. Mary River-Willow Creek Contact on Oldman River, Alberta

CONTENTS

INTRODUCTION

In southwestern Alberta, the Upper Cretaceous Bearpaw marine shales are overlain by a thick series of continental deposits of late Cretaceous and early Tertiary age. These beds have been studied by various investigators, particularly Dawson (1883, 1884)[1], Stewart (1919), Williams and Dyer (1930), Russell (1932a, 1932b, 1940), Hage (1943), Douglas (1950), and Williams (1951).

[1]Dates in parentheses are those of references at end of report.

The section recognized at present is, in descending order:

Porcupine Hills formation

Willow Creek formation

St. Mary River formation

Blood Reserve formation

Bearpaw formation

These formations occupy an asymmetrical fold, the Alberta syncline, of which the Porcupine Hills formation occupies the axial region, and the older formations outcrop on either side. The present discussion concerns the contact between the St. Mary River and Willow Creek formations on Oldman River on the east side of the syncline near Macleod, Alberta. The lithological characters of these two formations have been described by the above authors, but will be summarized here.

The St. Mary River formation is characterized by hard, fine-grained sandstones interbedded with grey and green, commonly silty, shales, and including thin beds of carbonaceous shale and nodular limestone or 'ironstone'. At the base, rusty weathering sandstones and dark grey fissile shales with abundant brackish water fossils form a persistent zone of variable thickness. The monotonous alternation of ledgy sandstones with recessive shale beds imparts a characteristic appearance to outcrops of the St. Mary River formation. On the east side of the Alberta syncline, its thickness is estimated to be about 1,160 feet on St. Mary River (Williams, 1951) and about 1,500 feet on the Oldman (Russell, 1932a). On the edge of the Disturbed belt, Hage (1943) estimates its thickness at about 2,500 feet on Oldman River in Cowley map-area.

The Willow Creek formation is composed mainly of soft grey sandstones and grey, maroon, and green clay shales. The shales commonly contain numerous, white weathering, calcareous concretions. In the upper part of the formation, harder, buff weathering sandstones appear, and are transitional into those of the underlying Porcupine Hills formation. Outcrops of the Willow Creek formation tend to form rounded, wash-covered outcrops, which commonly exhibit 'badlands' weathering. The combination of pink coloration, numerous concretions, and soft nature of the beds imparts a very characteristic appearance to outcrops of typical Willow Creek strata. Russell (1932b) calculated a thickness of about 1,200 feet on Oldman River on the east side of the Alberta syncline. On the west side, Hage (1943) reports a thickness of 2,760 feet on Castle River.

Although typical sediments of the two formations are readily differentiated, precise correlation of lithological contacts is commonly difficult, particularly on the west side of the Alberta syncline.

PREVIOUS WORK

Dawson (1884) discussed the nature of the contact between the two formations on Oldman River. He states: "There is no reason for the

separation of this (the St. Mary River formation) from the above series, but difference in colour, and to some extent in composition of the beds, and the line of separation is in consequence only an approximate one, justified by the facility which it affords of recognizing a definite horizon in the extremely thick Laramie formation of the district".

Williams and Dyer (1930) drew the contact at the lowest red shale, which occurs in NW.$\frac{1}{4}$ sec. 23, tp. 10, rge. 25, W. 4th mer. Russell (1932b, 1940) proposed placing the contact lower in the section, noting that soft sandstones and clay shales of Willow Creek type occur for about 200 feet below the lowest red shale, and that, in the centre of sec. 25, tp. 10, rge. 25, W. 4th mer., a sharp contact can be established at the top of a hard, fine-grained sandstone of typical St. Mary River lithology.

Bell (1949) has indicated that Equisetum perlaevigatum, which occurs in the St. Mary River formation, is also present in the sombre beds of disputed references on Oldman River, and, in common with Williams and Dyer, referred them to the St. Mary River formation.

DESCRIPTION OF SECTION

During the 1951 field season, while investigating the palaeontology of the St. Mary River and Willow Creek formations, the writer examined the beds on the left side of Oldman River near the centre of sec. 25, tp. 10, rge. 25, W. 4th mer. At this place the following section was measured.

Willow Creek Formation (Basal beds)	Thickness Feet
13. Clay, dark grey, very deeply weathered; covered with thick bentonitic wash	5.0
12. Shale, green, silty, very soft	8.0
11. Sandstone, greenish, fine-grained, very soft; covered with thick layer of wash	16.0
10. Shale, light brown, silty, friable	1.0
9. Shale, green, friable	1.0
8. Clay, dark grey, wash-covered	0.5

St. Mary River Formation (Upper beds)

7. Tuff, light grey, very fine-grained, porous, weathers to angular fragments that form a talus. In thin section, this rock is seen to consist of small angular quartz and feldspar fragments embedded in an isotropic matrix	0-0.5
6. Shale, dark grey, bentonitic; covered by 6-inch layer of tough wash	12.0
5. Sandstone, light grey, fine-grained, weathers white to pea-green	11.0
4. Shale, mottled grey-green, soft, wash-covered	7.0
3. Sandstone, grey, fine-grained, weathers white, wash-covered	4.5
2. Shale, grey, very friable; fragments hard and angular	1.5
1. Sandstone, grey, fine-grained, hard, weathers with greenish tinge. Traced laterally, this bed interfingers with grey silty shale	5.6

Unit 1 represents the horizon described by Russell (1932b, p. 139) as the uppermost bed of the St. Mary River formation.

CORRELATION

In the above section, Units 5, 6, and 7 resemble closely the 'white sandstone', 'mauve shale', and Kneehills tuff, respectively, of Allan and Sanderson (1945), which comprise a persistent horizon in the Edmonton formation of Red Deer Valley. Samples of the 'tuff' bed from the two localities appear almost identical, both in hand specimen and thin section. On Red Deer River, the Kneehills tuff marks the boundary between the Upper and Lower[1] parts of the Edmonton formation.

---

[1] With reference to the terms 'Lower' and 'Upper' Edmonton, the writer is following the usage of Bell (1949, p. 17). Allan and Sanderson (1945) divide the Edmonton formation into Lower, Middle, and Upper parts; the boundary between the Lower and Middle Edmonton is placed at the top of the Drumheller 'marine' tongue, and that between the Middle and Upper at the top of the Kneehills tuff. As the Drumheller 'marine' tongue cannot be recognized throughout Red Deer River Valley, the division into Lower and Upper parts seems more satisfactory at the present time.

Sternberg (1946) has shown that the Upper Edmonton beds contain a fauna of Lance vertebrates.

The 'white sandstone', 'mauve shale', and Kneehills tuff have also been observed north of Gleichen by Stewart (1943) and by Furnival (1946, p. 88), and on Bow River west of Bartstow siding by Rutherford (1947, p. 55). The relation of these beds to the overlying Paskapoo formation is shown by the following section, measured on the right side of Bow River, in sec. 13, tp. 22, rge. 24, W. 4th mer.:

	Paskapoo Formation	Thickness Feet
3.	Sandstone, grey, crossbedded, rather coarse, weathers buff	38.5
2.	Conglomerate, pebbles and cobbles of quartzite up to 6 inches in length embedded in a coarse sandstone matrix. In places this unit consists largely of fragments of white nodular limestone embedded in sandstone	5.0
	(Unconformity)	
	Edmonton Formation	
1.	Sandstone, grey, soft, medium-grained; contact with overlying bed undulating	10.0
	Base of exposure	

On the left side of the river, the equivalent of Unit 1 underlies a white weathering sandstone 12 to 15 feet thick (Unit 5 of Williams and Dyer, 1930, p. 46). This white sandstone is overlain by deeply weathered, dark grey, bentonitic shale upon which loose fragments of tuff were collected. This shale bed exhibits a maximum thickness of about 20 feet on the large cutbank 3½ miles west of Bartstow siding. On the west side of the coulée entering the left side of Bow River 1 mile farther west, the thickness of the grey bentonitic shale is reduced to 3.6 feet. Paleocene molluscs, including Viviparus planolatere Russell, Lioplacodes tenuicarinata (M. and H.), and Plesielliptio priscus (M. and H.), have been collected on the left side of the Bow in NW.¼ sec. 27, tp. 21, rge. 26, W. 4th mer. This fossil bed is probably not more than 300 feet above the sandstone identified as the base of the Paskapoo in the above section. It, therefore, appears that on Bow River the Upper Edmonton is missing and the basal Paskapoo beds rest

unconformably upon the Kneehills tuff and associated sediments. Locally, however, they also have been removed.

Although stratigraphic correlations over widely separated areas are usually suspect, particularly in non-marine sediments, the correlation of the three successive units, the 'white sandstone', 'mauve shale', and Kneehills tuff from the Red Deer to Bow and Oldman Rivers seems to be justified. Sanderson (1931, 1945), Russell (1932b, p. 134), and Furnival (1946, p. 88) have stressed the similarity of these beds with the section in the Cypress Hills, and correlate the 'mauve shale' and 'white sandstone' with the Battle and Whitemud formations respectively. Tuff beds regarded as equivalent to the Kneehills tuff occur in the upper part of the Battle formation in the western Cypress Hills, but do not persist to the east. The 'white sandstone' and 'mauve shale' developed on the west side of the Sweet Grass arch in Alberta may be referred to conveniently as the Whitemud and Battle equivalents. The Whitemud formation is generally correlated with the Colgate sandstone, the upper member of the Fox Hills formation of North Dakota and Montana.

The presence of equivalents of the Battle and Whitemud formations in the Oldman River section is important in that it provides more precise information than hitherto available regarding the age of the overlying and underlying beds.

Russell (1932b) correlated the St. Mary River formation with part of the Pierre and the entire Fox Hills and Lance stages, although the inclusion of Lance equivalents was only tentative. Bell (1949) considered the possibility of a Lance age for the upper part of the St. Mary River formation on the basis of a florule from Oldman River on the west side of the Alberta syncline, but indicated that the evidence was not conclusive. The stratigraphic evidence now indicates that beds of Lance age are missing in the St. Mary River formation on Oldman River near Macleod.

It would seem appropriate to include the Whitemud and Battle equivalents with the St. Mary River formation; this treatment would make the formational boundary with the overlying Willow Creek beds equivalent to the division between the Lower and Upper parts of the Edmonton formation. This criterion cannot be applied to the definition of the contact elsewhere, as the Battle and Whitemud equivalents have not been recognized. Russell (1940) states that a sharp contact can be established on Milk River, where the lithological change is abrupt. On the west side of the Alberta syncline the Willow Creek and St. Mary River formation retain their lithological characteristics, but the change is rather transitional, and attempts to correlate precise horizons, chosen as contacts, between adjacent sections are unsatisfactory.

In view of the conformable relations between the Willow Creek and St. Mary River formations, the recognition of Battle and Whitemud equivalents in the uppermost beds of the latter formation suggests that the Willow Creek includes beds of Lance age. Palaeontological confirmation of this stratigraphic conclusion is lacking on the east side of the Alberta syncline. In sections on the east margin of the Disturbed belt, fossil molluscs are common in the Willow Creek formation. Throughout the lower thousand feet the fauna, largely undescribed, resembles that of the St. Mary River formation, although it does contain some indigenous forms. Characteristic Paleocene species are not represented. The upper part of the Willow Creek formation near Granum (Russell, 1932b), and elsewhere, contains molluscs of Paleocene age, including Grangerella mcleodensis (Russell), and Oreohelix thurstoni (Russell). On the left side of Crowsnest River, in l.s. 8, sec. 32, tp. 7, rge. 1, W. 5th mer., from beds approximately 1,000 feet above the base of the Willow Creek formation, a bone fragment was collected, which, according to Dr. L. S. Russell of the National Museum of Canada (personal communication), is "definitely Dinosaur". This indicates that the lower part of the formation in the Disturbed belt is of Cretaceous age.

This evidence supports the suggestion of Bell (1949) that the Willow Creek formation is in part of late Cretaceous (Lance) and in part of Paleocene age, and the stratigraphic division suggested by him seems compatible with the present findings, and may represent the Cretaceous-Tertiary boundary.

The assignment of the entire Willow Creek formation to the Cretaceous suggested by Rutherford (1947) cannot be accepted, in view of the widespread occurrence of Paleocene molluscs in the upper part of the formation.

The unconformity, which has removed Lance equivalents on Bow River, apparently decreases in amplitude to the south, as no evidence of its presence has been detected in the sections in southwest Alberta. It is quite possible that an intermediate relationship exists on Little Bow River, particularly as a conglomerate noted by Bell (1949) overlies beds of typical Willow Creek lithology in NW.$\frac{1}{4}$ sec. 26, tp. 14, rge. 25, W. 4th mer.

CONCLUSIONS

Equivalents of the Whitemud and Battle formations are represented in the uppermost beds of the St. Mary River formation on Oldman River near Macleod, Alberta. The St. Mary River formation in this area may be correlated with an upper part of the Pierre and the entire Fox Hills stage. In view of the conformable relations of the overlying Willow Creek formation a Lance age may be postulated for the lower part of this formation. Palaeontological evidence available from other sections supports the reference of the lower part of the Willow Creek formation to the Cretaceous, and the upper part to the Paleocene. The Edmonton-Paskapoo unconformity on Bow River apparently decreases in amplitude to the south and loses its identity on Oldman River.

REFERENCES

Allan, J. A., and Sanderson, J. O. G. (1945): Geology of Red Deer and Rosebud Sheets, Alberta; Sc. and Industr. Research Council, Alberta, Rept. No. 13.

Bell, W. A. (1949): Uppermost Cretaceous and Paleocene Floras of Western Alberta; Geol. Surv., Canada, Geol. Surv. Bull. No. 13.

Dawson, G. M. (1883): Preliminary Report on the Geology of the Bow and Belly River Region, North West Territory, with Special Reference to the Coal Deposits; Geol. Surv., Canada, Rept. of Prog. 1880-82, pt. B.

_____ (1884): Report on the region in the Vicinity of the Bow and Belly Rivers, North West Territory; Geol. Surv., Canada, Rept. of Prog. 1882-83-84, pt. C.

Douglas, R. J. W. (1950): Callum Creek, Langford Creek, and Gap Map-areas, Alberta; Geol. Surv., Canada, Mem. 255.

Furnival, G. M. (1946): Cypress Lake Map-area, Saskatchewan; Geol. Surv., Canada, Mem. 242.

Hage, C. O. (1943): Cowley Map-area, Alberta; Geol. Surv., Canada, Paper 43-1.

Russell, L. S. (1932a): Stratigraphy and Structure of the Eastern Portion of the Blood Indian Reserve, Alberta; Geol. Surv., Canada, Sum. Rept. 1931, pt. B, pp. 152-53.

_____ (1932b): The Cretaceous-Tertiary Transition of Alberta; Roy. Soc., Canada, Trans., vol. XXVI, ser. 3, sec. IV, pp. 121-156.

_____ (1940): See Russell, L. S., and Landes, R. W. (1940).

_____ and Landes, R. W. (1940): Geology of the Southern Alberta Plains; Geol. Surv., Canada, Mem. 221.

Rutherford, R. L. (1947): The Cretaceous-Tertiary Boundary in the Foothills of Central Alberta; Roy. Soc., Canada, Trans., vol. XXV, ser. 3, sec. IV, pp. 47-59.

Sanderson, J. O. G. (1931): Upper Cretaceous Volcanic Ash beds in Alberta; Roy. Soc., Canada, Trans., vol. XXV, ser. 3, sec. IV, pp. 61-70.

_____ (1945): See Allan, J. A., and Sanderson, J. O. G. (1945).

Sternberg, C. M. (1947): The Upper Part of the Edmonton Formation of Red Deer Valley, Alberta; Geol. Surv., Canada, Paper 47-1.

Stewart, J. S. (1919): Geology of the Disturbed Belt of Southwestern Alberta; Geol. Surv., Canada, Mem. 112.

Williams, E. P. (1951): St. Mary River Formation in Spring Coulee-Magrath Area, Alberta, Canada; Bull. Amer. Assoc. of Pet. Geol., vol. 35, pp. 885, 898.

Williams, M. Y., and Dyer, W. S. (1930): Geology of Southern Alberta and Southwestern Saskatchewan; Geol. Surv., Canada, Mem. 163.