ERCB/AGS Open File Report 2011-06

Measured Outcrop Section T13-R9W4-01 of the Foremost and Oldman Formations (Belly River Group), Suffield Area, South Saskatchewan River Valley, Southeastern Alberta (NTS 72L/03)

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Contents

Acknowledgments v
Abstract vi
1 Introduction 1
2 Location 1
3 Description 1
3.1 Upper Part of Foremost Formation (0 to 34.9 m) 1
3.2 Lower Part of Oldman Formation (34.9 to 67.1 m) 1
4 Gamma-Ray Data 8
5 Summary 10
6 References 11
Appendix 1 – GPS Location Data for Measured Section T13-R9W4-01 12
Appendix 2 – Graphic Log of Measured Outcrop Section T13-R9W4-01 (Southeastern Alberta) with Outcrop Gamma-Ray Curve. Large-Format Version of Figure 3 with Descriptive Notes 13
Appendix 3 – Outcrop Gamma-Ray Methodology 14

Figures

Figure 1. Simplified geological map (modified from Hamilton et al., 1999) showing the distribution of Belly River Group and surrounding rocks in Alberta and the location of measured section T13-R9W4-01. 2
Figure 2. Location of measured section T13-R9W4-01 (southeastern Alberta) plotted on 1 m resolution orthorectified airphoto base with 1 km grid (UTM Zone 12, NAD 83).. 3
Figure 3. Graphic log of measured section T13-R9W4-01 (southeastern Alberta) with outcrop gamma-ray curve. 4
Figure 4. Panoramic view looking west from line of subsection A (viewpoint at UTM Zone 12, 489917E, 5546980N, NAD 83) toward opposite wall of gully. 5
Figure 5. Top of 85 cm thick coal seam at 15.0 m in subsection A (measured section T13-R9W4-01, southeastern Alberta). 6
Figure 6. View looking toward southeast of upper part of subsection A (measured section T13-R9W4-01, southeastern Alberta). 6
Figure 7. Inclined heterolithic stratification (IHS) in Foremost Formation sandstone at 25.3 m in subsection A (measured section T13-R9W4-01, southeastern Alberta). 7
Figure 8. Contact (white arrows) between carbonaceous mudstone of the Foremost Formation and overlying basal Oldman Formation sandstone is at 34.9 m in subsection A (measured section T13-R9W4-01, southeastern Alberta) 8
Figure 9. View looking east toward subsection B (measured section T13-R9W4-01, southeastern Alberta).. 9
Figure 10. Planar-tabular cross-stratification (wedge set) overlain by horizontal planar stratification in Oldman Formation fine- to medium-grained sandstone. 10

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Abstract

Measured outcrop section T13-R9W4-01 in the Belly River Group, located on the northern side of the South Saskatchewan River valley 32 km west of Medicine Hat, includes the uppermost part of the Foremost Formation and the lowermost part of the Oldman Formation. This report includes a graphic log of the measured section with an outcrop gamma-ray curve and a detailed description of the section (avoiding lithofacies interpretation but detailing stratigraphic context where appropriate) with selected photos.

The exposed Foremost Formation interval appears to lie wholly within the Taber coal zone and consists largely of silty mudstone and siltstone, with subordinate coal, carbonaceous mudstone and very fine grained sandstone. A 6.2 to 7.2 m thick sandstone interval at the base of the Oldman Formation, situated immediately above the Taber coal zone, is thought to represent the Herronton sandstone zone. Gamma-ray counts for this interval are markedly lower than those for sandstone of similar grain-size higher in the Oldman Formation, indicating a significant compositional difference.

1 Introduction

Measured outcrop section T13-R9W4-01 in the Belly River Group, located in the South Saskatchewan River valley in southeastern Alberta (Figure 1), includes the upper part of the Foremost Formation and the lower part of the Oldman Formation. This report includes a graphic log of the measured section with an outcrop gamma-ray curve and a detailed description of the section (avoiding lithofacies interpretation but detailing stratigraphic context where appropriate) with selected photos. The section was measured in August 2009 using an Abney level attached to a 1.6 m Jacob staff.

2 Location

The measured section is located 32 km west of Medicine Hat in Twp. 13, Rge. 9, W. 4th Mer., within 500 m of Range Road 92 on the northern side of the South Saskatchewan River valley (Figure 2). It consists of two subsections located 300 m apart (A and B; Figure 2) correlated at the top of the Foremost Formation. The base and top of the resulting composite section (Figure 3) are at the level of the lowest and highest well-exposed bedrock in the area. The position of the boundary between the Foremost and Oldman formations shown in Figure 2 coincides with that mapped by Irish (1968). Appendix 1 contains detailed GPS location data.

3 Description

3.1 Upper Part of Foremost Formation (0 to 34.9 m)

The lower part of the measured section, from 0 to 34.9 m, is assigned to the Foremost Formation (Figure 3). It consists largely of grey-brown–weathering silty mudstone and siltstone, with subordinate coal, carbonaceous mudstone and very fine grained sandstone (Figure 4). Coal seams are present throughout the section from 5.1 to 34.9 m and it seems likely that the complete interval below 34.9 m lies within the Taber coal zone at the top of the Foremost Formation (Crockford, 1949; MacDonald et al., 1987). The thickest coal seam is 85 cm thick (at 14.1 m; Figure 5).

Much of the section consists of repeated, sharp-based, fining-upward cycles, typically 0.5 to 1.5 m thick, with paler siltstone at the base grading up into dark purple-brown to black, typically platy-weathering carbonaceous mudstone, which may pass up into coal. Bands of siderite concretions are commonly present within the siltstone and mudstone.

Very fine grained sandstone units typically form the basal divisions of similar, but thicker (up to 5 m) fining-upward cycles, again with coal or carbonaceous mudstone at the top. Three of these thicker cycles dominate the upper part of the Foremost Formation section (20.0 to 34.9 m). Most sandstone units are pale yellow-grey to yellow weathering, less than 1 m thick, and ripple crosslaminated. The thickest Foremost Formation sandstone (1.7 m thick, base at 25.3 m in the measured section) shows well-developed inclined heterolithic stratification (IHS) defined by darker, more carbonaceous silty intervals (Figures 6 and 7). Bands of siderite concretions are developed along some of the inclined surfaces.

The individual fining-upward cycles form part of at least three larger scale fining-upward packages at 0 to 15.0 m, 15.0 to 25.3 m and 25.3 to 34.9 m. These large-scale packages are easiest to distinguish on the gamma-ray curve (see Figure 3), but some (e.g., 0 to 15.0 m and 25.3 to 34.9 m) are readily recognizable from observed lithofacies (Figure 3).

3.2 Lower Part of Oldman Formation (34.9 to 67.1 m)

In this report, we follow Russell and Landes (1940) and Eberth and Hamblin (1993) in placing the top of the Foremost Formation at the top of the Taber coal zone (34.9 m; Figure 3). The erosionally based, fine- to medium-grained sandstone unit at the base of the Oldman Formation (34.9 to 42.1 m in subsection A;

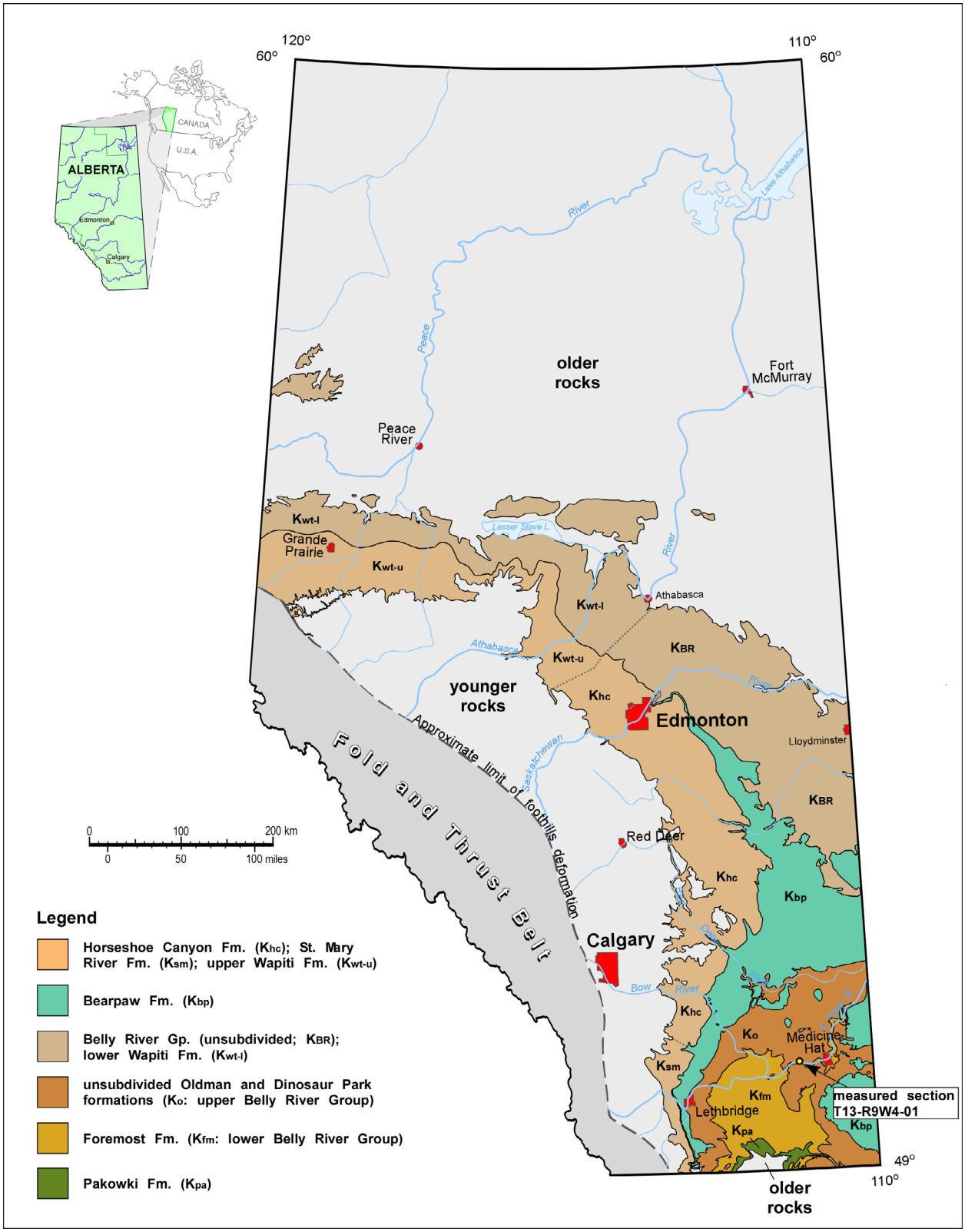

Figure 1. Simplified geological map (modified from Hamilton et al., 1999) showing the distribution of Belly River Group and surrounding rocks in Alberta and the location of measured section T13-R9W4-01.

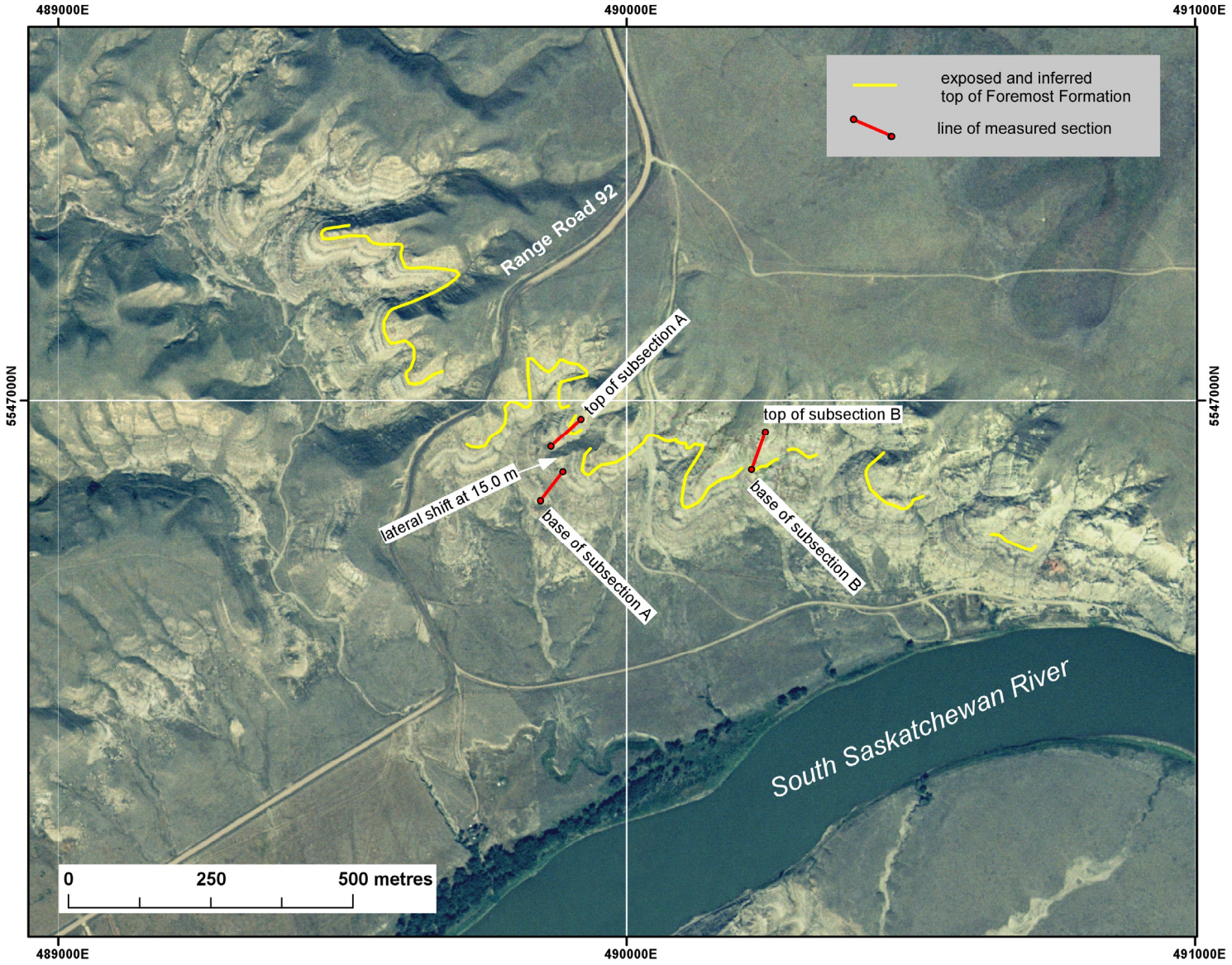

Figure 2. Location of measured section T13-R9W4-01 (southeastern Alberta) plotted on 1 m resolution orthorectified airphoto base with 1 km grid (UTM Zone 12, NAD 83). Position of exposed top of Foremost Formation based on ground observation and colour airphoto interpretation.

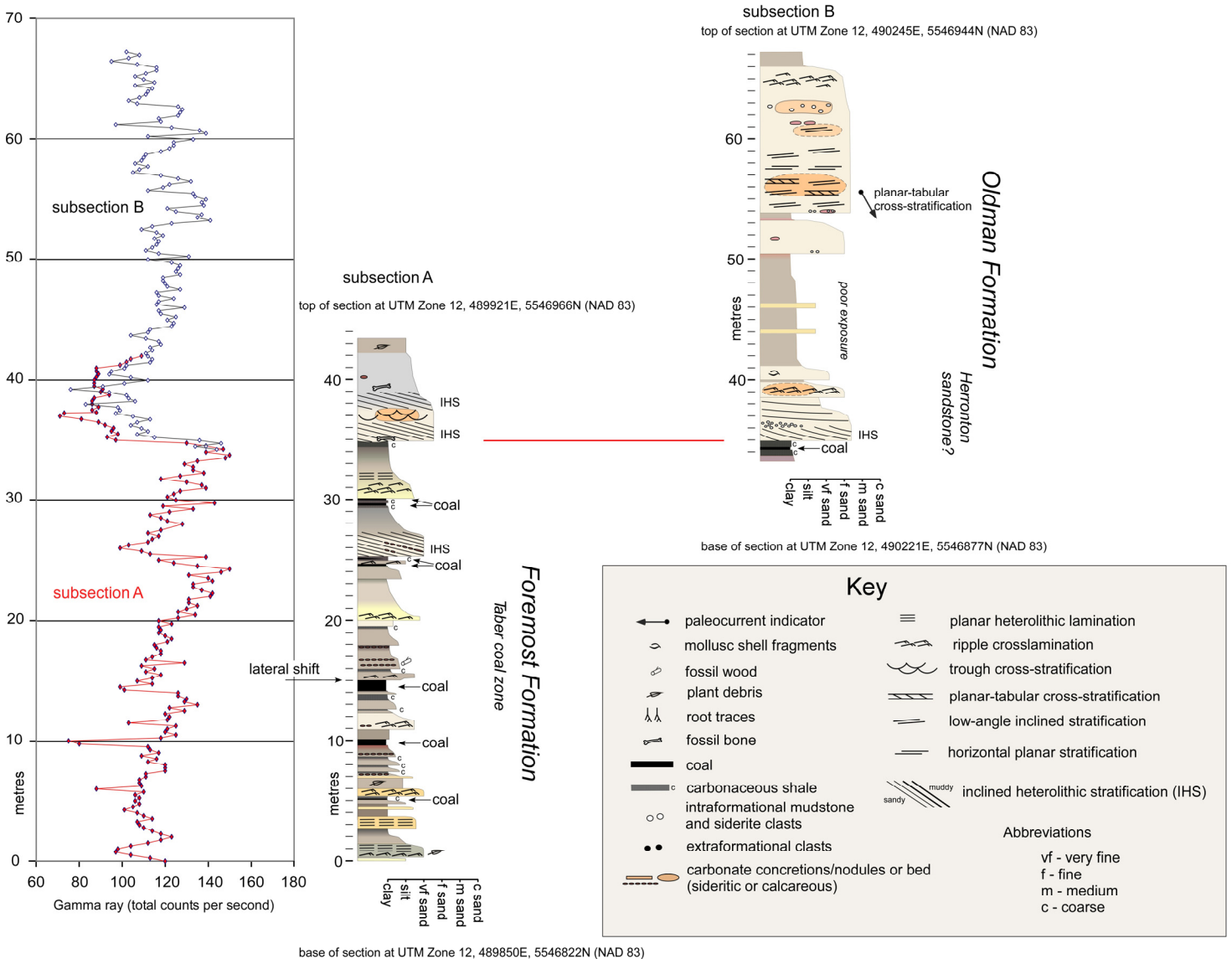

Figure 3. Graphic log of measured section T13-R9W4-01 (southeastern Alberta) with outcrop gamma-ray curve. See large-format version in Appendix 2 for descriptive notes.

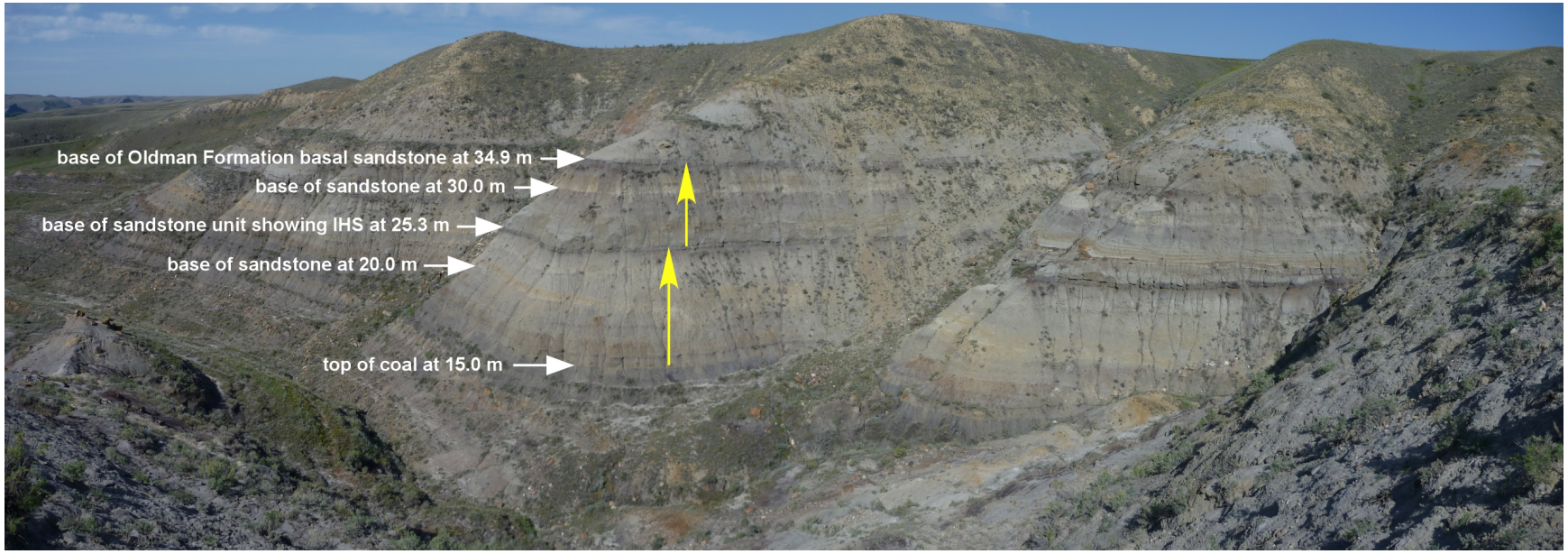

Figure 4. Panoramic view looking west from line of subsection A (viewpoint at UTM Zone 12, 489917E, 5546980N, NAD 83) toward opposite wall of gully. Units in the upper part of the Foremost Formation are indicated, with their corresponding heights in the measured section. Vertical yellow arrows indicate larger scale, fining-upward packages recognizable from observed lithofacies and outcrop gamma-ray data.

Figure 5. Top of 85 cm thick coal seam at 15.0 m in subsection A (measured section T13-R9W4-01, southeastern Alberta).

Figure 6. View looking toward southeast of upper part of subsection A (measured section T13-R9W4-01, southeastern Alberta). Units in the upper part of the Foremost Formation are indicated, with their corresponding heights in the measured section. Figure (circled) for scale.

Figure 7. Inclined heterolithic stratification (IHS) in Foremost Formation sandstone at 25.3 m in subsection A (measured section T13-R9W4-01, southeastern Alberta). Jacob staff (1.6 m long; circled in red) for scale.

34.9 to 41.1 m in subsection B) exhibits sand-dominated IHS (Figure 8) and locally, trough cross-stratification, and includes dinosaur bone and concentrations of siderite intraclasts. This unit appears to represent the Herronton sandstone zone of Eberth (2005), which lies above the Taber coal zone, but shares compositional affinities with the Foremost Formation rather than the overlying Oldman Formation (see discussion of gamma-ray data below). This led Eberth (2002, 2005) to include the Herronton sandstone in the Foremost Formation, adjusting the contact between the Foremost and Oldman formations upsection compared with earlier work (e.g., Russell and Landes, 1940).

The interval overlying the basal Oldman Formation sandstone (41.1 to 50.4 m in subsection B) is largely recessive and poorly exposed (Figure 9). It consists mainly of grey-brown–weathering muddy siltstone and silty mudstone, with several thin (<50 cm) yellow-orange–weathering sandy siltstone units. This thick fine-grained interval is overlain by a sharp-based, 2.8 m thick, fining-upward. fine-grained sandstone unit (50.4 to 53.2 m). This unit is friable and again poorly exposed and internal sedimentary structures, apart from mudstone intraclasts near its base, could not be distinguished. The sandstone is overlain by 0.6 m of grey-brown to reddish grey mudstone (53.2 to 53.8 m).

The upper part of the Oldman section is dominated by a sharp-based, 12.2 m thick interval of fine- to medium-grained, fining-upward to fine-grained sandstone (53.8 to 66.0 m). This largely well-cemented and well-exposed interval exhibits low-angle inclined and horizontal planar stratification, with subordinate planar-tabular cross-stratified lenses (Figure 10). The fine-grained sandstone at the top of the interval is ripple crosslaminated. Sideritic intraclasts are abundant immediately above the base of the sandstone and in a discrete zone toward the top. Lithologically, and in terms of its gamma-ray signature (see discussion of gamma-ray data below), this sandstone resembles the Comrey sandstone present in sections measured in the Milk River valley to the south (Hathway et al., 2011b), although here the sandstone is much closer to the base of the Oldman Formation. The sandstone is gradationally overlain by grey-brown silty mudstone at 66.0 m. Exposure is poor above 67.1 m and the exact level of the base of drift could not be determined.

Figure 8. Contact (white arrows) between carbonaceous mudstone of the Foremost Formation and overlying basal Oldman Formation sandstone is at 34.9 m in subsection A (measured section T13-R9W4-01, southeastern Alberta).

4 Gamma-Ray Data

The methodology for collecting the outcrop gamma-ray data (shown in Figure 3) is detailed in Appendix 3.

Gamma-ray counts for the Foremost Formation define three cycles (9.6 to 15.0 m thick) with upward increasing gamma-ray values. These represent overall upward-fining cycles, each with a coal or carbonaceous shale at the top. Coals and thicker sandstone units yielded the lowest gamma-ray counts.

Gamma-ray counts for the 6.2 to 7.2 m thick basal Oldman Formation sandstone are the lowest for any sandstone in the measured section. Counts for the thick overlying silty mudstone-dominated interval are higher and broadly similar to those for similar lithologies in the Foremost Formation. Gamma-ray counts for the 50.4 to 66.0 m sandstone-dominated interval above this are variable, but significantly higher than those for the basal Oldman Formation sandstone. The difference in gamma-ray signatures between the two sandstone intervals is similar to that observed in a measured section 50 km north-northeast of Medicine Hat (Hathway et al., 2011a) and indicates a significant compositional difference, in accordance with that noted between the Herronton sandstone zone and overlying Oldman Formation sandstones by Eberth (2002, 2005).

Figure 9. View looking east toward subsection B (measured section T13-R9W4-01, southeastern Alberta). Units in the Oldman Formation are indicated, with their corresponding heights in the measured section. Figures (circled) are on the line of section.

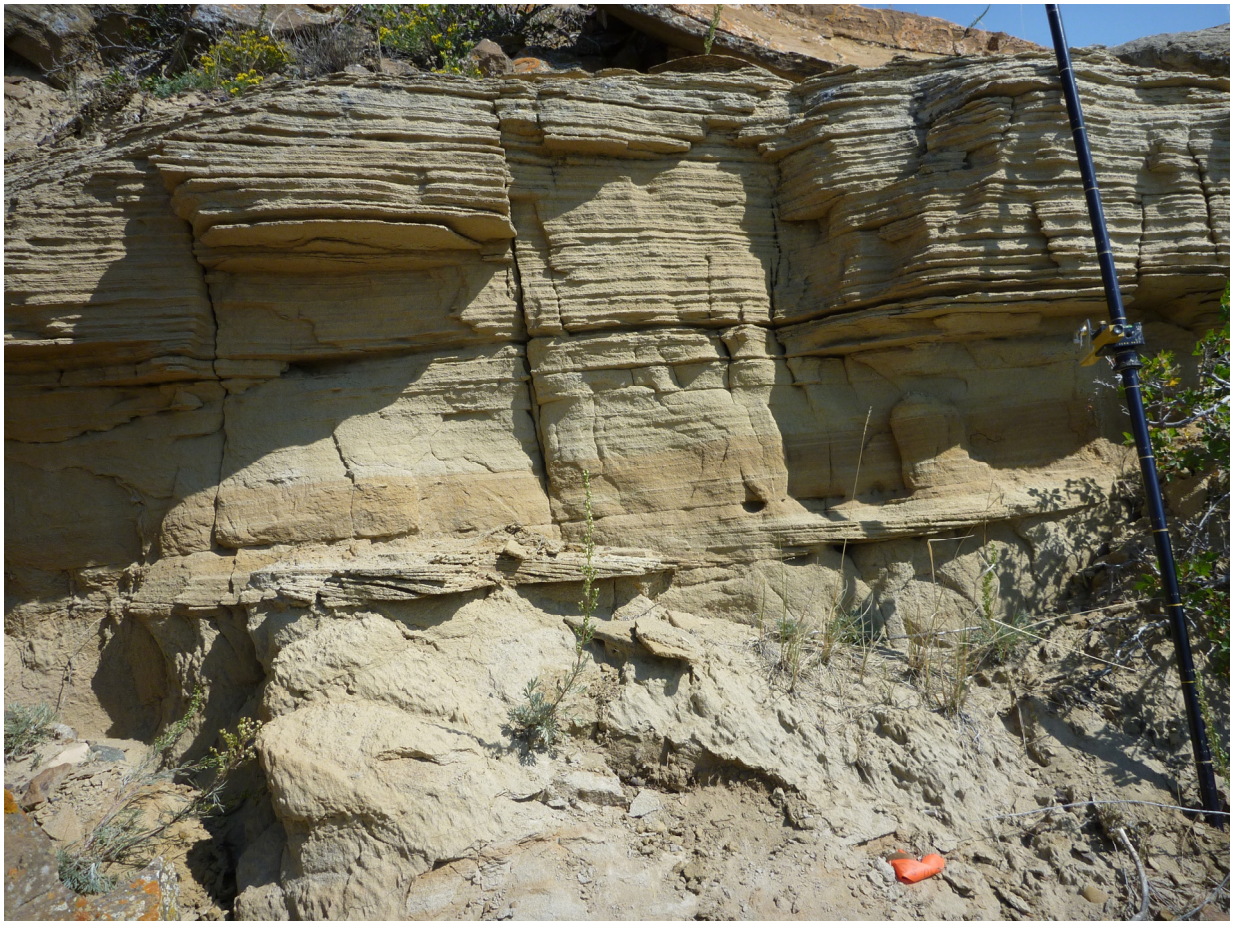

Figure 10. Planar-tabular cross-stratification (wedge set) overlain by horizontal planar stratification in Oldman Formation fine- to medium-grained sandstone. Base of 1.6 m Jacob staff at 56.0 m level in subsection B (measured section T13-R9W4-01, southeastern Alberta).

5 Summary

Measured outcrop section T13-R9W4-01 includes the upper part of the Foremost Formation and the lower part of the Oldman Formation. The exposed Foremost Formation section appears to lie wholly within the Taber coal zone and consists largely of silty mudstone and siltstone, with subordinate coal, carbonaceous mudstone and very fine grained sandstone. Small-scale (0.5 to 5 m) and large-scale (9.6 to 15 m) fining-upward cycles are clear from observed lithofacies and outcrop gamma-ray data.

The 6.2 to 7.2 m thick sandstone interval at the base of the Oldman Formation, immediately above the Taber coal zone, is thought to represent the Herronton sandstone zone of Eberth (2002, 2005). Gamma-ray counts for this interval are markedly lower than those for sandstone of similar grain-size higher in the Oldman Formation, indicating a significant compositional difference.

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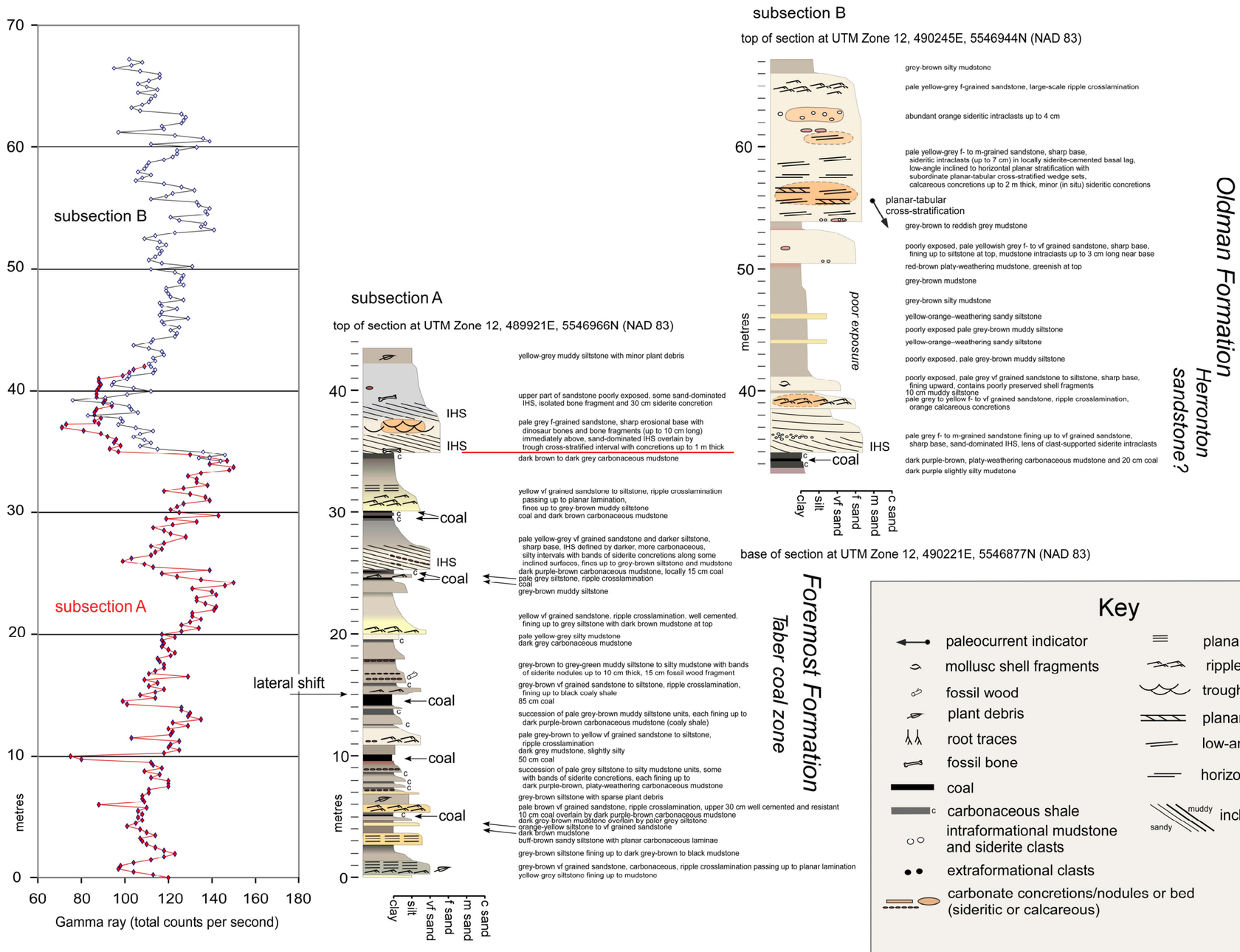
Appendix 1 – GPS Location Data for Measured Section T13-R9W4-01

The GPS location data for measured section T13-R9W4-01 in southeastern Alberta were obtained using Garmin® GPSMAP® 60CSx hand-held units. The UTM co-ordinates are Zone 12, NAD 83. The ± values indicate estimates of horizontal error generated by the GPS units.

Easting	Northing	Horizontal Error (±)	Elevation-(m)	Comment
489850	5546822	5	701	base of subsection A (0.0 m)
489889	5546873	12	712	15.0 m in subsection A (before lateral shift)
489868	5546918	6	712	15.0 m in subsection A (after lateral shift)
489921	5546966	4	743	42.0 m in subsection A (near top of subsection)
490221	5546877	8	730	base of subsection B (0.0 m)
490245	5546944	4	764	34.0 m in subsection B (top of subsection)

Appendix 2 – Graphic Log of Measured Outcrop Section T13-R9W4-01 (Southeastern Alberta) with Outcrop Gamma-Ray Curve. Large-Format Version of Figure 3 with Descriptive Notes.



subsection A

top of section at UTM Zone 12, 489921E, 5546966N (NAD 83)

yellow-grey muddy siltstone with minor plant debris

upper part of sandstone poorly exposed, some sand-dominated IHS, isolated bone fragment and 30 cm siderite concretion

pale grey f-grained sandstone, sharp erosional base with dinosaur bones and bone fragments (up to 10 cm long) immediately above, sand-dominated IHS overlain by trough cross-stratified interval with concretions up to 1 m thick

dark brown to dark grey carbonaceous mudstone

yellow vf grained sandstone to siltstone, ripple crosslamination passing up to planar lamination, fines up to grey-brown muddy siltstone
coal and dark brown carbonaceous mudstone

pale yellow-grey vf grained sandstone and darker siltstone, sharp base, IHS defined by darker, more carbonaceous, silty intervals with bands of siderite concretions along some inclined surfaces, fines up to grey-brown siltstone and mudstone

dark purple-brown carbonaceous mudstone, locally 15 cm coal
pale grey siltstone, ripple crosslamination
coal
grey-brown muddy siltstone

yellow vf grained sandstone, ripple crosslamination, well cemented, fining up to grey siltstone with dark brown mudstone at top

pale yellow-grey silty mudstone
dark grey carbonaceous mudstone

grey-brown to grey-green muddy siltstone to silty mudstone with bands of siderite nodules up to 10 cm thick, 15 cm fossil wood fragment

grey-brown vf grained sandstone to siltstone, ripple crosslamination, fining up to black coaly shale
85 cm coal

succession of pale grey-brown muddy siltstone units, each fining up to dark purple-brown carbonaceous mudstone (coaly shale)

pale grey-brown to yellow vf grained sandstone to siltstone, ripple crosslamination
dark grey mudstone, slightly silty
50 cm coal

succession of pale grey siltstone to silty mudstone units, some with bands of siderite concretions, each fining up to dark purple-brown, platy-weathering carbonaceous mudstone

grey-brown siltstone with sparse plant debris

pale brown vf grained sandstone, ripple crosslamination, upper 30 cm well cemented and resistant
10 cm coal overlain by dark purple-brown carbonaceous mudstone
dark grey-brown mudstone overlain by paler grey siltstone
orange-yellow siltstone to vf grained sandstone
dark brown mudstone
buff-brown sandy siltstone with planar carbonaceous laminae

grey-brown siltstone fining up to dark grey-brown to black mudstone

grey-brown vf grained sandstone, carbonaceous, ripple crosslamination passing up to planar lamination
yellow grey siltstone fining up to mudstone

base of section at UTM Zone 12, 489850E, 5546822N (NAD 83)

subsection B

top of section at UTM Zone 12, 490245E, 5546944N (NAD 83)

grey-brown silty mudstone

pale yellow-grey f-grained sandstone, large-scale ripple crosslamination

abundant orange sideritic intraclasts up to 4 cm

pale yellow-grey f- to m-grained sandstone, sharp base, sideritic intraclasts (up to 7 cm) in locally siderite-cemented basal lag, low-angle inclined to horizontal planar stratification with subordinate planar-tabular cross-stratified wedge sets, calcareous concretions up to 2 m thick, minor (in situ) sideritic concretions

planar-tabular cross-stratification

grey-brown to reddish grey mudstone

poorly exposed, pale yellowish grey f- to vf grained sandstone, sharp base, fining up to siltstone at top, mudstone intraclasts up to 3 cm long near base

red-brown platy-weathering mudstone, greenish at top

grey-brown mudstone

grey-brown silty mudstone

yellow-orange–weathering sandy siltstone

poorly exposed pale grey-brown muddy siltstone

yellow-orange–weathering sandy siltstone

poorly exposed, pale grey-brown muddy siltstone

poorly exposed, pale grey vf grained sandstone to siltstone, sharp base, fining upward, contains poorly preserved shell fragments
10 cm muddy siltstone
pale grey to yellow f- to vf grained sandstone, ripple crosslamination, orange calcareous concretions

pale grey f- to m-grained sandstone fining up to vf grained sandstone, sharp base, sand-dominated IHS, lens of clast-supported siderite intraclasts

dark purple-brown, platy-weathering carbonaceous mudstone and 20 cm coal

dark purple slightly silty mudstone

base of section at UTM Zone 12, 490221E, 5546877N (NAD 83)

Key

- paleocurrent indicator
- mollusc shell fragments
- fossil wood
- plant debris
- root traces
- fossil bone
- coal
- carbonaceous shale
- intraformational mudstone and siderite clasts
- extraformational clasts
- carbonate concretions/nodules or bed (sideritic or calcareous)
- planar heterolithic lamination
- ripple crosslamination
- trough cross-stratification
- planar-tabular cross-stratification
- low-angle inclined stratification
- horizontal planar stratification
- inclined heterolithic stratification (IHS)

Abbreviations

vf - very fine
f - fine
m - medium
c - coarse

Appendix 3 – Outcrop Gamma-Ray Methodology

Gamma-ray values, in counts per second, were measured on the outcrop section in southeastern Alberta at nominal measurement intervals of 0.25 m using a hand-held GR-135 spectrometer. The counting time was 10 seconds and total counts were measured (above a lower threshold of 20 keV). Each measurement was obtained by placing the base of the front part of the GR-135 (near the detector) directly against the outcrop at the measurement location. Measurement locations were chosen to be as planar as possible over areas of approximately 0.5 m in diameter. If necessary, loose material was scraped away to expose outcrop before the gamma-ray data were collected.

GR-135 Specifications

Manufacturer: SAIC (Mississauga, Ontario)
Model: Exploranium® GR-135 Plus "The Identifier" (GR-135GEO, geophysical model)
Year of Manufacture: 2007
Version: 6V01.02
Detector: sodium-iodide (thallium) [NaI(Tl)] detector with a 65 cm^3 (4.0 cu in.) volume (38 mm in diameter and 57 mm in length)
Stabilization: external cesium (^{137}Cs) source (stabilization completed daily)
Mode: manual (search mode)
Count Rate Measurement: counts per second
Sample Time: 10 seconds
Scan Window: total (above lower threshold of 20 keV)
Averaging: off
Channels: 1024