EUB/AGS Special Report 61

Phases 1 to 4 Extech IV Study of the Early Proterozoic Athabasca Group, Northeastern Alberta

Alberta Energy and Utilities Board
Alberta Geological Survey

AGS

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[1]MF Resources Inc., under contract to Alberta Geological Survey

December 2003

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Abstract

Fifty-five diamond drillholes (DDH) within the Alberta portion of the Athabasca Basin were reviewed.

The Athabasca Group is subdivided into six formations within Alberta, which are, from base to top, the Fair Point, Manitou Falls, Lazenby Lake, Wolverine Point, Locker Lake and Otherside formations. These lithostratigraphic units are overlain in places by Devonian strata and ubiquitously by Quaternary and Recent surficial unconsolidated sediments. A basal coarse-grained lag (slightly reworked regolith) is variably present at the base of the Fair Point (FP) and the Manitou Falls (MF) formations, where each overlies the basement. The Fair Point Formation is divided into three regionally mappable units on the basis of maximum grain size and percentage of granules/pebbles. The Manitou Falls Formation contains thick, well-sorted sandstones of the MFc member, with the pebbly MFb member absent in the southern third of the basin. Thin siltstone units at the base of the FP and MF indicate the variable presence of a basal fine-grained unit (FPa, MFa). The Lazenby Lake Formation (LzL) is restricted to the southern two-thirds of the basin and forms a wedge thinning to the north. Two new mappable stratigraphic units were identified in the Wolverine Point Formation (WP), which shows progressive thinning to the south due to erosion or non-deposition. The disconformably overlying, pebbly Locker Lake Formation (LL) thickens to the north and shows a middle coarser member. The Otherside Formation overlies the Locker Lake Formation in the north central half of the study area, but is not present in any of the drillcore examined in this study. The Paleozoic section, Devonian with perhaps some older units at its base, intermittently overlies the southern quarter of the Athabasca Basin in Alberta. It consists largely of fine-grained clastics with minor amounts of carbonates at the top, where coarser clastics are restricted to the base and along the southwest margin of the basin.

1 Introduction

This project was completed under contract to the Alberta Geological Survey (AGS) in four phases. Phases 1 to 3 consisted of select drillcore examination at the AGS's Mineral Core Research Facility (MCRF) in Edmonton (Figures 1 to 4). Phase 4 has a preliminary interpretation and write-up of the Phases 1 to 3 logging methods (this report EUB/AGS SPE 61). A subsequent report (EUB/AGS SPE 62, Ramaekers, 2003) provides a more extensive interpretation and analysis of results. The purpose of the Extech core-logging program in Alberta is

1) to help resolve the differences between the surface geological maps of the Alberta and Saskatchewan surveys;
2) to further define the stratigraphic understanding of the area;
3) to help define criteria useful in logging Athabasca Group sandstone core; and
4) to provide a preliminary evaluation of the stratigraphy and alternation at and near the Maybelle River uraniferous zone (Figure 4).

Phase 1 envisioned logging a north-south fence (Section A-A') and an east-west fence (Section B-B') of drillcores through the Alberta portion of the Athabasca Basin. In Phases 2 and 3, the object was to obtain enough data to construct a section along the southwestern margin of the basin (Section C-C') and a fence along a conductor trend at the Maybelle River area that contains the mineralized diamond drillhole (DDH) MR-39 (Section D-D'). The latter section runs subparallel to the southwest margin of the basin, about 10-20 km towards the basin centre (Figure 2). Finally, a short section (Section E-E') perpendicular to the basin edge and to basement geological strike was chosen in the general area of the Maybelle mineralized hole to help illustrate the relation between basement, Athabasca Group and Paleozoic geology. A generalized location of the sections and the revised subcrop geology is provided in Figure 1. Figures 2 and 4 provide details of the five sections, diamond drillhole locations and drillhole identifiers. All the spreadsheet log data for the DDHs of this project are available upon request at the AGS.

2 Logging Procedure

The logging procedure was developed during 2000 and 2001 in conjunction with other Extech IV workers, especially Dr. G. Yeo of the Saskatchewan Geological Survey and Dr. C.W. Jefferson of the Geological Survey of Canada. It was modified to accommodate the complex geology on the Alberta side. The logging procedure is defined in Appendix 1.

Detailed descriptions of the core studied during Phases 1 to 3 are on file at AGS. Depths, elevations and thickness of selected stratigraphic units identified during the Phase 1 to 3 loggings are summarized in Appendix 2.

Sections Through the Athabasca Basin

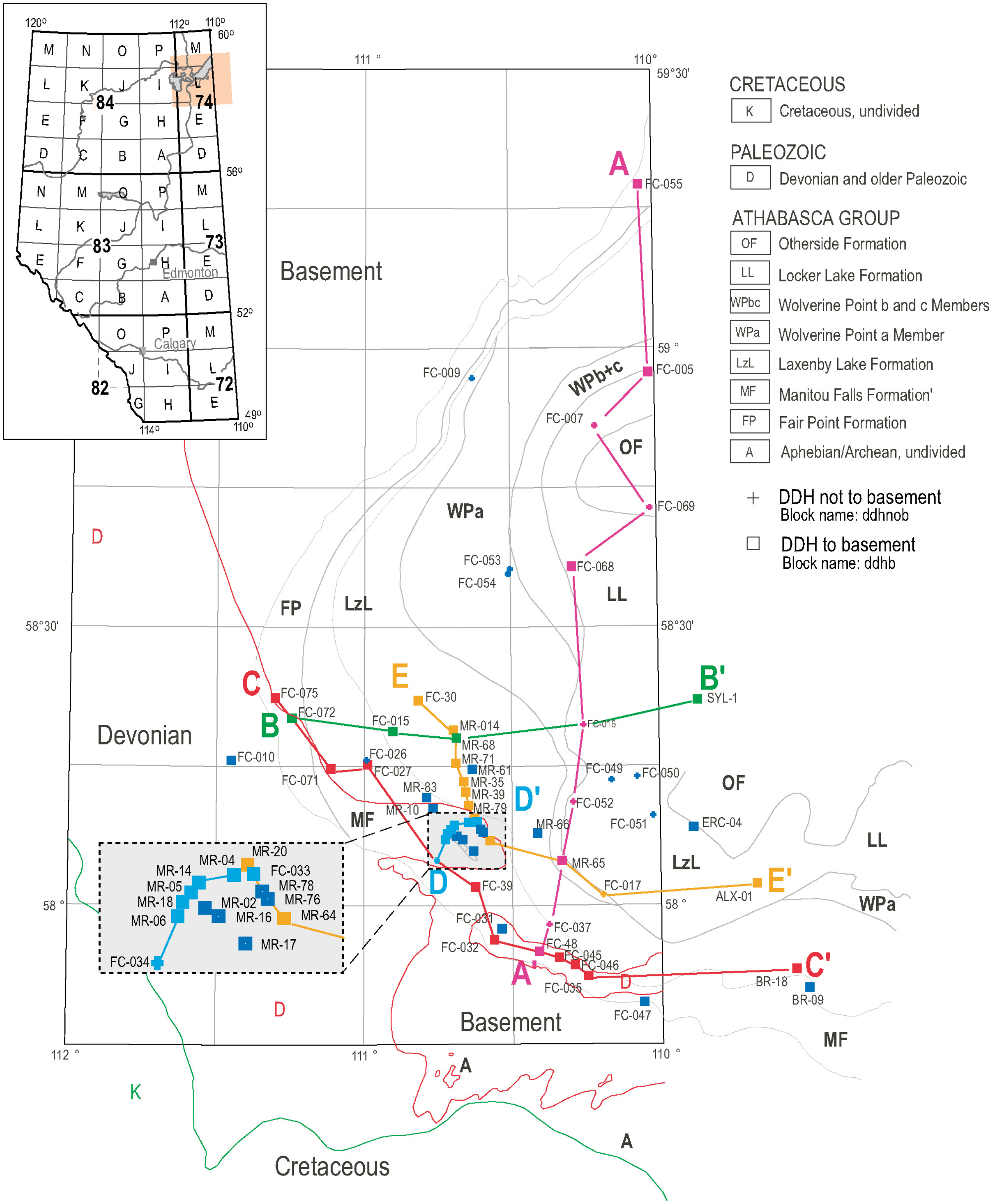

Figure 1. Location, sections and subcrop geology, Athabasca Basin, Alberta.

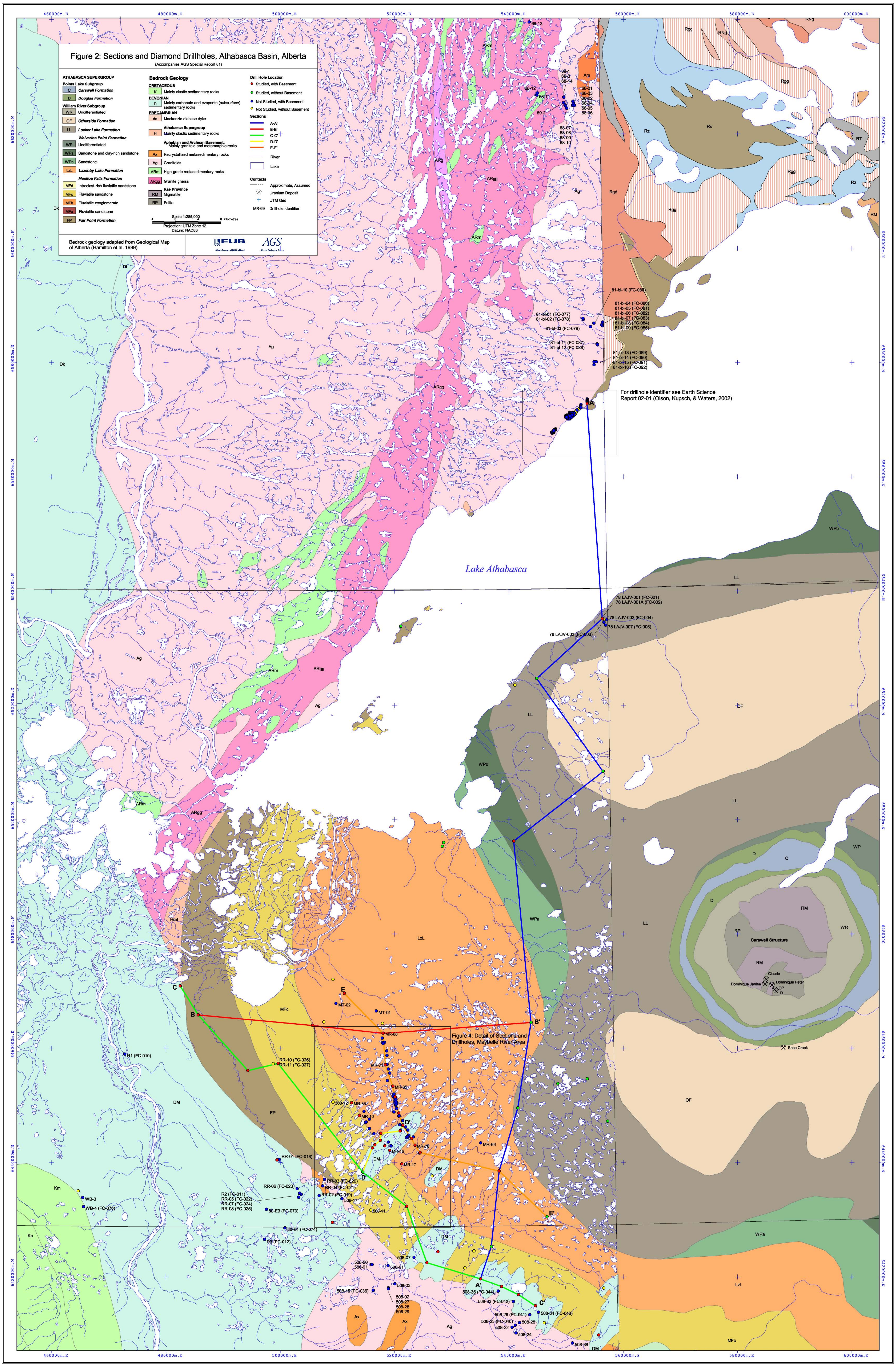

Figure 2: Sections and Diamond Drillholes, Athabasca Basin, Alberta
(Accompanies AGS Special Report 61)
ATHABASCA SUPERGROUP
Points Lake Subgroup
C Carswell Formation
D Douglas Formation
William River Subgroup
WR Undifferentiated
OF Otherside Formation
LL Locker Lake Formation
Wolverine Point Formation
WP Undifferentiated
WPa Sandstone and clay-rich sandstone
WPb Sandstone
LzL Lazenby Lake Formation
Manitou Falls Formation
MFd Intraclast-rich fluviatile sandstone
MFc Fluviatile sandstone
MFb Fluviatile conglomerate
MFa Fluviatile sandstone
FP Fair Point Formation
Bedrock Geology
CRETACEOUS
K Mainly clastic sedimentary rocks
DEVONIAN
D Mainly carbonate and evaporite (subsurface) sedimentary rocks
PRECAMBRIAN
dd Mackenzie diabase dyke
Athabasca Supergroup
H Mainly clastic sedimentary rocks
Aphebian and Archean Basement: Mainly granitoid and metamorphic rocks
Ax Recrystallized metasedimentary rocks
Ag Granitoids
ARm High-grade metasedimentary rocks
ARgg Granite gneiss
Rae Province
RM Migmatite
RP Pelite
Drill Hole Location
Studied, with Basement
Studied, without Basement
Not Studied, with Basement
Not Studied, without Basement
Sections
A-A'
B-B'
C-C'
D-D'
E-E'
River
Lake
Contacts
Approximate, Assumed
Uranium Deposit
UTM Grid
MR-69 Drillhole Identifier
Scale 1:285,000
4 0 4 8 kilometres
Projection: UTM Zone 12
Datum: NAD83
Bedrock geology adapted from Geological Map of Alberta (Hamilton et al. 1999)
EUB
AGS
Lake Athabasca
For drillhole identifier see Earth Science Report 02-01 (Olson, Kupsch, & Waters, 2002)
Figure 4: Detail of Sections and Drillholes, Maybelle River Area
Carswell Structure
Shea Creek

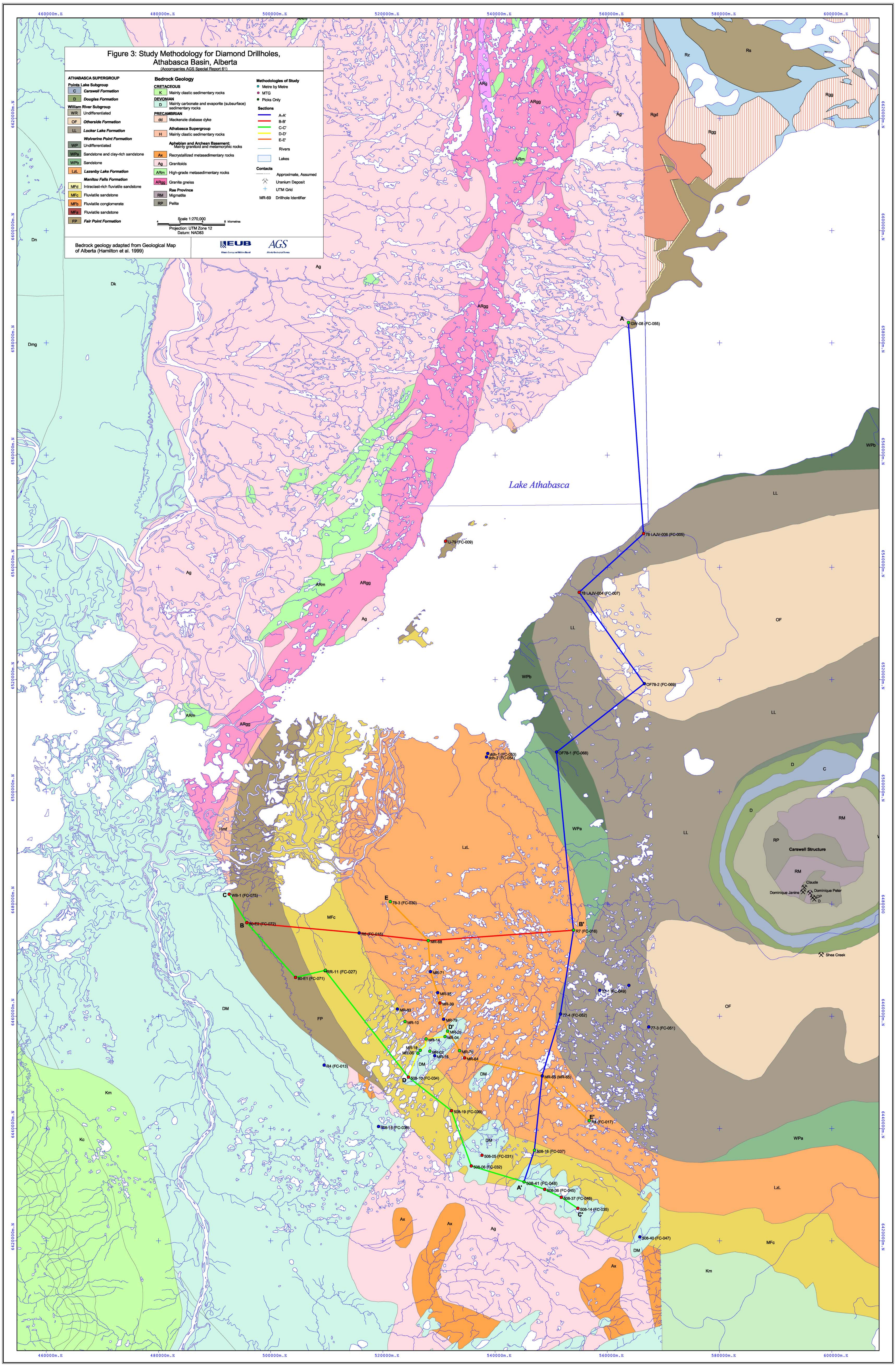
Figure 3: Study Methodology for Diamond Drillholes, Athabasca Basin, Alberta
(Accompanies AGS Special Report 61)
ATHABASCA SUPERGROUP
Points Lake Subgroup
C Carswell Formation
D Douglas Formation
William River Subgroup
WR Undifferentiated
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Ax Recrystallized metasedimentary rocks
Ag Granitoids
ARm High-grade metasedimentary rocks
ARgg Granite gneiss
Rae Province
RM Migmatite
RP Pelite
Methodologies of Study
Metre by Metre
MTG
Picks Only
Sections
A-A'
B-B'
C-C'
D-D'
E-E'
Rivers
Lakes
Contacts
Approximate, Assumed
Uranium Deposit
UTM Grid
MR-69 Drillhole Identifier
Scale 1:270,000
4 0 4 8 kilometres
Projection: UTM Zone 12
Datum: NAD83
Bedrock geology adapted from Geological Map of Alberta (Hamilton et al. 1999)
Lake Athabasca
Carswell Structure
Shea Creek
460000m.E
480000m.E
500000m.E
520000m.E
540000m.E
560000m.E
580000m.E
600000m.E

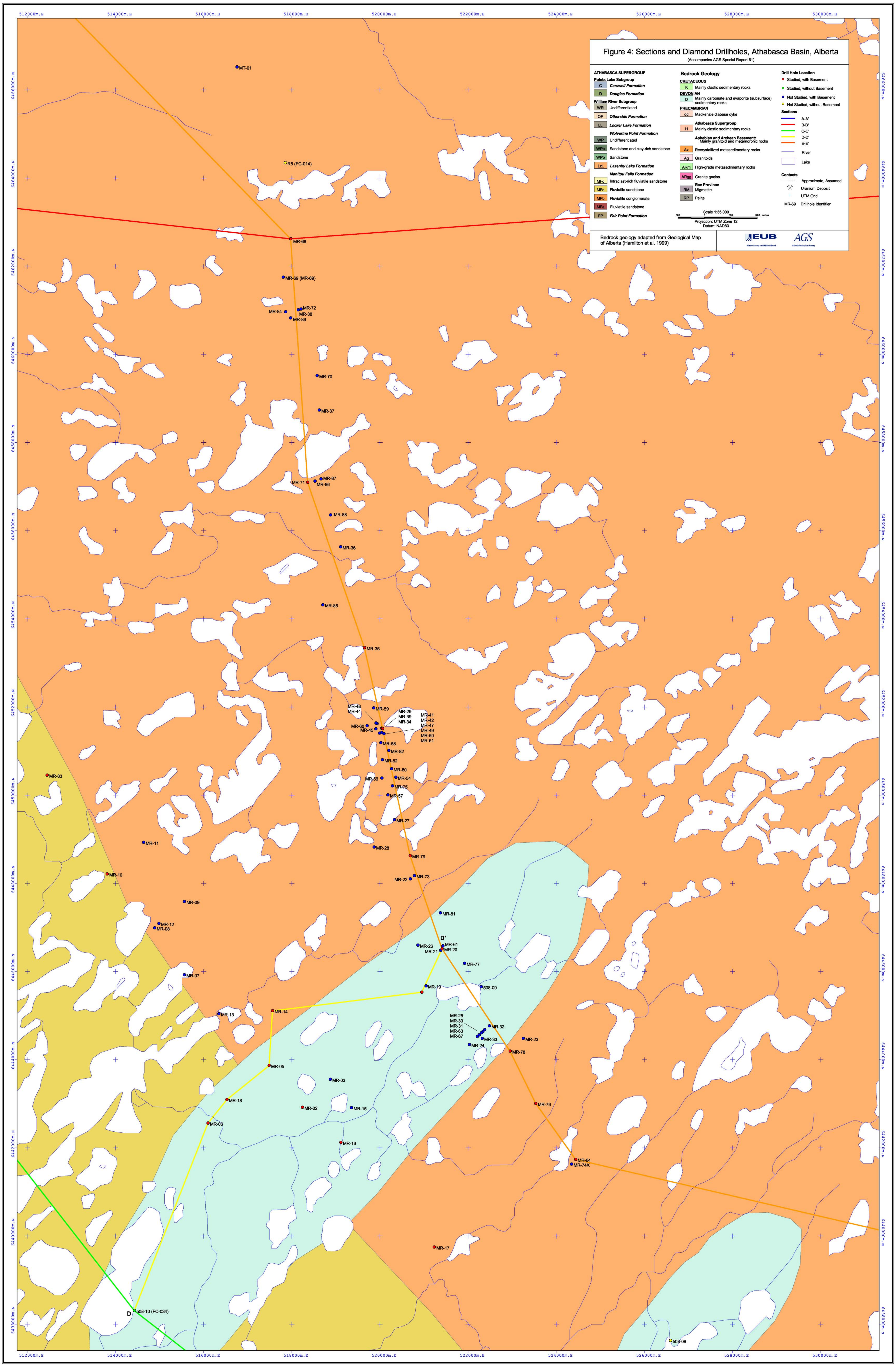
Figure 4: Sections and Diamond Drillholes, Athabasca Basin, Alberta
(Accompanies AGS Special Report 61)
ATHABASCA SUPERGROUP
Points Lake Subgroup
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D Douglas Formation
William River Subgroup
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Drill Hole Location
Studied, with Basement
Studied, without Basement
Not Studied, with Basement
Not Studied, without Basement
Sections
A-A'
B-B'
C-C'
D-D'
E-E'
River
Lake
Contacts
Approximate, Assumed
Uranium Deposit
UTM Grid
MR-69 Drillhole Identifier
Scale 1:35,000
600 0 600 1200 metres
Projection: UTM Zone 12
Datum: NAD83
Bedrock geology adapted from Geological Map of Alberta (Hamilton et al. 1999)
512000m.E
514000m.E
516000m.E
518000m.E
520000m.E
522000m.E
524000m.E
526000m.E
528000m.E
530000m.E
6438000m.N
6440000m.N
6442000m.N
6444000m.N
6446000m.N
6448000m.N
6450000m.N
6452000m.N
6454000m.N
6456000m.N
6458000m.N
6460000m.N
6462000m.N
6464000m.N
6466000m.N
MT-01
R5 (FC-014)
MR-68
MR-69 (MR-69)
MR-84
MR-72
MR-38
MR-89
MR-70
MR-37
MR-71
MR-87
MR-86
MR-88
MR-36
MR-85
MR-35
MR-48
MR-44
MR-59
MR-29
MR-39
MR-34
MR-41
MR-42
MR-47
MR-49
MR-50
MR-51
MR-60
MR-40
MR-58
MR-82
MR-52
MR-80
MR-56
MR-54
MR-75
MR-57
MR-27
MR-28
MR-79
MR-22
MR-73
MR-83
MR-11
MR-10
MR-09
MR-12
MR-08
MR-81
D'
MR-26
MR-21
MR-61
MR-20
MR-77
MR-07
MR-19
508-09
MR-14
MR-13
MR-25
MR-30
MR-31
MR-63
MR-67
MR-32
MR-33
MR-24
MR-23
MR-78
MR-05
MR-03
MR-18
MR-02
MR-15
MR-76
MR-06
MR-16
MR-64
MR-74X
MR-17
D
508-10 (FC-034)
508-08

3 Drillholes Examined

Drillholes (DDHs) logged during Phases 1 to 3 of the study are listed in Table 1. This table indicates the detail in which they were logged, as well as which of the five cross-sections the cores were used.

Table 1. Drill holes used, detail of logging and their utilization in sections

Diamond drillhole		Logging Methodology				Section Fences (See Figures 2 to 4)				
Company ID	AGS ID	Several variables (m by m)	MTG only (m by m)	Litho-facies units	Picks only	A-A' (N-S)	B-B' (W-E)	C-C' (SW Margin)	D-D' (SW-NE near Maybelle)	E-E' (Maybelle and East into SK)
BP Min 78-3	FC-030		x							x
Chevron 77-1	FC-049				x					
Chevron 77-2	FC-050				x					
Chevron 77-3	FC-051				x					
Chevron 77-4	FC-052				x	x				
Eld 508-05	FC-031	x								
Eld 508-06	FC-032	x						x		
Eld 508-10	FC-034	x						x	x	
Eld 508-14	FC-035	x						x		
Eld 508-16	FC-037		x			x				
Eld 508-18	FC-038				x					
Eld 508-19	FC-039	x						x		
Eld 508-36	FC-045	x						x		
Eld 508-37	FC-046	x						x		
Eld 508-40	FC-047				x					
Eld 508-41	FC-048		x			x		x		
Esso of78-1	FC-068				x	x				
Esso of78-2	FC-069				x	x				
Flin Flonij-79	FC-009	x								
Golden Eagle lajv-004	FC-007	part	x			x				
Golden Eagle lajv-006	FC-005	x				x				
Macleod ddh-1	FC-053				x					
Macleod ddh-2	FC-054				x					
Norcen 80-e1	FC-071	x						x		
Norcen 80-e2	FC-072	x					x	x		
Norcen r-4	FC-013				x					
Norcen r-6	FC-015				x		x			
Norcen r-7	FC-016		x			x	x			
Norcen r-8	FC-017		x							x
Norcen rr-10	FC-026		x							
Norcen rr-11	FC-027		x					x		
SMDC wb-1	FC-075	x						x		
Uranerz gw-8	FC-055		x			x				
Uranerz mr-02	mr-02		x							
Uranerz mr-04	mr-04		x						x	
Uranerz mr-05	mr-05			x					x	
Uranerz mr-06	mr-06		x						x	
Uranerz mr-10	mr-10		x							
Uranerz mr-14	mr-14		x						x	
Uranerz mr-16	mr-16				x					
Uranerz mr-17	mr-17			x						
Uranerz mr-18	mr-18		x						x	

The use of the complete logging form was too time consuming to permit completion of enough holes to obtain an overview of the area within the planned time limit. Thus, most of the DDHs were logged in less detail. Only DDH FC-005 and the upper 214 m of DDH FC-007 were logged metre-by-metre using those parameters outlined in Appendix 1. The rest of FC-007 and the remaining holes were described using the entire logging form for sections judged to be of similar lithological character, using a metre-by-metre maximum grain size log as a guide to define the intervals. The amount of detail logged for each hole is shown in Table 1.

Note: For DDH FC-049 to FC-054, stratigraphic picks were made, but these holes were not otherwise logged in detail, with only limited core available at the MCRF. None of these holes reach basement. Core from DDH FC-068 and FC-069 remain at the original field drill sites and were burned in a forest fire. These holes are in an area from which little other data are available and are probably drilled to basement in the deepest part of the basin. The company logs permit accurate picking of the Fair Point-Manitou Falls contact and an approximate indication of the intersection of the mudstone-rich Wolverine Point b (WPb) member. These interpretations are also used in the sections.

4 Stratigraphic Results

The location of formation and unit boundaries relative to sea level and unit thickness are provided in Appendix 2. Table 2 provides a list of the mappable units of the Athabasca Group in Alberta defined in this study and provides a short description of the corresponding lithologies with correlation to older reports of the area. Following is a short description of the stratigraphy observed in the study. A more thorough description is provided in SPE-62 (Ramaekers, 2003).

Table 2. Formations and members of the Athabasca Group, Alberta.

Formation/ Member	Alberta		Saskatchewan	Lithology
	Wilson (1985)	This study	Ramaekers, 1990	
Carswell	not present	not present	CF	Dominantly carbonates
Douglas	not present	not present	DF	Sandstone, siltstone, and thin black, red, and green mudstone
Fault Contact (Unconformity?)				
Tuma Lake	not recog.	not recog.	TL	Pebbly sandstone, sandstone
Otherside b	OF, undif.	OFb	OF, undif.	Sandstone, MTG < 2 mm
Otherside a	OF, undif.	OFa	OF, undif.	Sandstone, MTG < 8 mm
Locker Lake c	LL, undif.	LLc	LL, undif.	Pebbly sandstone, MGS 8 to 16 mm
Locker Lake b	LL, undif.	LLb	LL, undif.	Pebbly sandstone, MGS > 16 mm
Locker Lake a	LL, undif.	LLa	LL, undif.	Pebbly sandstone, MGS 2 to 16 mm
Unconformity				
Wolverine Point c	WPb	WPc	WPb	Clay-rich, very well sorted, fine to medium sandstone, minor siltstone
Wolverine Point b3	WPb	WPb3	WPb	Interbedded fine to medium sandstone, tuffaceous mudstone
Wolverine Point b2	WPb	WPb2	WPb	Clay rich, very well sorted sandstone, minor siltstone
Wolverine Point b1	WPb	WPb1	WPb	Interbedded fine to medium sandstone, tuffaceous mudstone
Wolverine Point a2	WPa	WPa2	WPa	Sandstone
Wolverine Point a1	WPa	WPa1	WPa	Sandstone, minor siltstone and mudstone
Lazenby Lake	Not recog.	LzL	LzL	Sandstone with pebbly layers, basal pebbly layer
Manitou Falls d	MFd	not present	MFd	Sandstone with common clay pebble layers
Manitou Falls d’	Not recog.	MFd’	MFd	Sandstone with common clay pebble layers and G1[1]
Manitou Falls c	MFc	MFc	MFc	Sandstone with few clay pebbles or other pebbles

Table 2. Formations and members of the Athabasca Group, Alberta (continued).

Formation/ Member	Alberta		Saskatchewan	Lithology
	Wilson (1985)	This study	Ramaekers, 1990	
Manitou Falls c’	Not recognized	MFc’	MFc	Sandstone with thin horizontal mudstone, few clay or other pebbles
Manitou Falls c”	Not recog.	MFc”	MFc	Sandstone, very well sorted, medium to fine, little else
Manitou Falls b	MFb	MFb	MFb	Sandstone with bedded conglomerate
Unconformity?				
Manitou Falls a2	not present	MFa2	MFa	Sandstone, pebbly sandstone, siltstone, conglomerate, minor mudstone
Manitou Falls a1	not present	MFa1	MFa	Finer sandstone, pebbly sandstone, siltstone, mudstone, conglomerate
Unconformity				
Fair Point c	FP undif.	FPc	FP, undif.	Sandstone, disseminated pebbles; MTG < 50 mm
Fair Point b2	FP undif.	FPb2	FP, undifferentiated	Sandstone, disseminated pebbles, thin conglomerate, MTG > 50 mm
Fair Point b1	FP undif.	FPb1	FP, undifferentiated	Thin and thick conglomerate, pebbly sandstone, sandstone, MTG > 50 mm
Fair Point a2	FP undif.	Fpa2	FP, undif.	Pebbly sandstone, sandstones, minor siltstone
Fair Point a1	FP undif.	Fpa1	FP, undif.	Siltstone, mudstone, pebbly sandstone, sandstone
Basal Lag	Basal Lag	Basal Lag	Basal Lag	Disseminated or bedded pebbles, cobbles and boulders

4.1 Basal Lag

A conglomerate that is usually less than 1 m thick marks the base of the Athabasca Group in a number of holes. It is generally composed of thin conglomerate units interbedded with thin sandstone beds. This unit is referred to as the Basal Lag and is included with the overlying unit in cross-sections. Similar units develop at the base of the Manitou Falls Formation where this overlies the crystalline basement.

4.2 Fair Point Formation (FP)

The Fair Point Formation is dominated by very coarse-grained sandstone with abundant clay matrix. The unconformable contact with the overlying Manitou Falls Formation is marked by the abrupt disappearance of pebbles accompanying a change in clast lithology. The Fair Point Formation is subdivided into three informal members: FPa, FPb and FPc. The basal FPa consists of pebbly sandstone interbedded with well-sorted siltstone and very fine sandstone up to 30 m thick. FPb contains pebbles over 50 mm in diameter. It is divided into two submembers: the lower submember (FPb1) contains the greatest abundance of coarse sandstone and conglomerate; the overlying upper unit (FPb2) has a lower percentage of the coarse sandstone with minor thin conglomerates. The top of the Fair Point Formation consists of a finer-grained unit (FPc), with pebbles less than 50 mm in diameter and local thin conglomerate.

Pebbles and cobbles in the Fair Point Formation range from 16 mm to 80 mm in diameter. The pebbles occur as isolated pebbles within a very coarse sandstone matrix, as one pebble thick layers (two or more pebbles present at the same level), and as amalgamated gravel beds up to 15 cm thick. The pebbles of the Fair Point Formation are of polymict composition, in marked contrast to the quartz and quartzite pebbles prevalent in the upper part of the Formation. Well-rounded, subspherical quartzite pebbles are common throughout. Flatter, dark brown, well-indurated, fine-grained sandstone to mudstone pebbles are less common. Gneissic pebbles are local.

4.3 Manitou Falls Formation (MF)

The Manitou Falls Formation is present throughout the Athabasca Basin, except along the western edge. It unconformably overlies either crystalline basement or the Fair Point Formation. Stratigraphic breakdown of the MF in the study area is based on the application of terminology developed in the eastern Athabasca Basin (Ramaekers, 1990). There, the Manitou Falls Formation has been subdivided on the basis of predominant lithofacies into four informal members. In ascending order these are MFa, MFb, MFc and MFd. Within Alberta, a local basal unit with mudstones is usually hematite-rich and often grades upward into pebbly horizontally bedded sandstone similar to FPc. This unit is referred to as part of the MFa member. MFb, characterized by thin-bedded conglomerate with rare clay intraclasts, overlies MFa in the northern half of the Alberta portion of the Athabasca Basin. The amount and size of pebbles in the MFb in the study area are much less than that seen along the eastern side of the Athabasca Basin in Saskatchewan. MFc overlies this and serves as the basal MF unit in much of the southern part of the Alberta study area where MFb is lacking. MFc comprises medium grained sandstone that lacks conglomerate and clay intraclast-rich layers. Paleocurrent directions measured in the upper part of MFc in DDH MR-68 are westerly. This coincides with the general pattern of paleocurrent directions in the MF from the eastern parts of the basin. Directions in DDH FC-48 trend easterly with a high variance, and possibly reflects local topographic control. The clay intraclast rich unit (MFd) that forms much of the Manitou Falls Formation in the eastern parts of the Athabasca Basin is absent in Alberta.

4.4 Lazenby Lake Formation (LzL)

The Lazenby Lake Formation (Ramaekers, 1980) consists of pebbly sandstone that overlies the non-pebbly sandstone of the MFc member and is conformably overlain by the relatively mudstone-rich Wolverine Point Formation (WP). The basal pebble beds of the LzL usually have a maximum grain size of 16-20 mm along the southern limits of the LzL.

The LzL may be the lateral equivalent, entirely or in part, of the WPa member in the central Athabasca Basin in Alberta and Saskatchewan, as well as where a thick unit with sparse siltstone beds and local coarse pebbly horizons are present below the prominent thick mudstones of WPb. In the latter unit, the siltstones become less common, whereas the pebbly layers are more frequent to the south, making it very difficult to devise a criterion that separates the pebbly zones of the basal LzL from the more clay-rich, finer-grained sandstone of WPa. In addition, the presence of two coarse pebbly units in DDH FC-049, FC-050, FC-051 and FC-052 indicate the absence of all or most of the intervening Wolverine Point Formation, with the pebbly Locker Lake Formation directly overlying the Lazenby Lake Formation.

4.5 Wolverine Point Formation (WP)

The Wolverine Point Formation is present in the north-central part of the study area. The contact with the underlying Lazenby Lake Formation is arbitrarily placed at the first occurrence of thin mudstone beds. WP is subdivided into three informal members: WPa, WPb and WPc. The WPa member is characterized as having fewer and thinner siltstone beds than the WPb member. WPa is subsequently divided into two submembers where the lower WPa1 unit contains frequent thin mudstones, whereas the overlying WPa2 unit generally lacks mudstone. The coarse material high in the WPa2 suggests that to the south (where silt content decreases) the unit may be laterally equivalent to all or part of the Lazenby Lake Formation.

The WPb member consists of very well sorted, very fine- to fine-grained sandstone with intervals containing abundant siltstone and mudstone interbeds > 50 cm thick. WPb is subdivided into three submembers on the basis of a middle sandstone unit (WPb2) similar in lithology to the WPc member. The basal unit (WPb1) is a thin siltstone and mudstone-rich sandstone, the middle sandstone unit (WPb2) contains few fine interbeds, and the upper unit (WPb3) is a thick siltstone and mudstone-rich sandstone. In Alberta, the WPb member overlies the WPa without an obvious disconformity.

WPc consists of very well sorted, fine- to medium-grained sandstones with few thin silty units similar to those of WPa. Abundant matrix clay is present, largely in the form of clay pseudomorphs. The core is friable and has a coarse-grained appearance because of its rough pitted surface caused by washing out of the clay during drilling. The sandstone is typically mottled and contains prominent overturned crossbedding.

4.6 Locker Lake Formation (LL)

The lower contact between the coarser-grained, pebble-bearing Locker Lake Formation with the Wolverine Point Formation is disconformable, marked by a change in mean grain size, clay content and sorting. Heavy mineral bands and prominent stylolites are less common in the Locker Lake Formation. The upper contact between the Locker Lake Formation and the Otherside Formation is only encountered in one drillhole in Alberta: Esso 78-2 (FC-069). Unfortunately this core was burned in a forest fire. The Locker Lake Formation has been subdivided into three informal members in Alberta. The basal LLa unit is a finer grained section, often containing pebbles over 8 mm. LLa is usually overlain by the coarser, large pebble-bearing LLb. The stratigraphically highest LLc is similar to LLa, containing pebbles over 8 mm. The lowest LLa unit is present in the northeastern Athabasca Basin in Saskatchewan where there is an exposed section of the WP-LL contact area near Riou Lake and, thus, seems to be of regional extent.

4.7 Otherside Formation (OF)

The Otherside Formation overlies the Locker Lake Formation and is present in Alberta in the north-central half of the study area. It is not intersected by any drillhole in this study.

4.8 Devonian (D)

A thin Paleozoic section is present in many holes along the southwest Athabasca Basin. It is more extensive than illustrated on previous maps. It consists largely of fine-grained clastics (Df), mostly mudstones, often slightly dolomitic, with thin carbonates (Dc) usually occurring at the top of the section. Along the southern margin of the basin a basal, coarser clastic unit is developed (DOc) with granules and pebbles often set in fine sands or muds. In some areas intense silicification of these clastics is present. The age of the basal units is unknown, possibly Devonian or Ordovician.

5 Recommendations for Further Work

This project has examined numerous drillcores, spaced as close as 5 km apart from each other, to be used in stratigraphic fences within the Alberta Athabasca Basin. Future studies of the remaining Athabasca Group holes will probably not uncover major stratigraphic surprises. However, further work should examine the sedimentology and the fluvial architecture of the Fair Point, Manitou Falls, Lazenby Lake and Locker Lake formations. Of most benefit to mineral exploration would be a major structural study using the approximately 60 inclined cores available from the Maybelle River Project. This should be coupled with a multi-element (40 to 60 elements) geochemical study of the hydrothermal systems encountered in this structural study. Future work based on this study includes

- picking representative cores or parts of cores for more detailed lithological and sedimentological logging;
- selecting fences that will best represent or evaluate particular stratigraphic or alteration facies;
- establishing case studies focused on a particular problem, such as hydrothermal alteration or oil saturation (geochemical studies may be of top priority); and
- initiating an air photo and/or Landsat study, including the basement areas surrounding the basin. This will facilitate interpolation between drillholes for subcrop maps.

6 References

Dunham, R.J. (1962): The classification of carbonate rocks according to depositional texture; American Association of Petroleum Geologists, Memoir 1, p. 108-121.

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Folk, R.L. (1962): Spectral subdivision of limestone types; American Association of Petroleum Geologists, Memoir 1, p. 62-84.

Miall, A.D. (1996): The geology of fluvial deposits; Springer, Berlin, 582 p.

Ramaekers, P. (1990): The geology of the Athabasca Group (Helikian) in northern Saskatchewan; Saskatchewan Energy and Mines, Report 195, 49 p.

Ramaekers, P. (1980): Stratigraphy and tectonic history of the Athabasca Group (Helikian) of northern Saskatchewan; *in* Summary of Investigations 1980, Saskatchewan Geological Survey, Saskatchewan Minerals Resources, Miscellaneous Report 80-4, p. 99-106.

Appendix 1 – Logging Protocol

The following list describes the headings used in the drill log data collection sheets (Excel files).

Note:

1) For quicker logging it was decided not to rotate the core in the boxes.
2) In all columns ‘n’ was used to emphasize that a feature is lacking despite conscious search.
3) The codes are geared to the Extech IV Athabasca Project and need to be modified and supplemented for other formations and sedimentary environments.
4) The organization of the later editions of the logging sheet have been changed to place all grain size characters together, followed by primary detrital clastic features (trends up, paleocurrents), followed by chemical rock descriptors (i.e., still primary characteristics). Next are secondary features: SSS and trace fossils that are followed by diagenetic features. Tectonic features and their associated alteration products are described last. Some diagenetic features that form basic rock descriptors, such as colour, are placed at the start.

A1.1 Interval

From: Depth in metres. As much as possible, information should be directly from the core boxes.
To: Depth in metres.

A1.2 Recovery in Percentage

A1.3 Matrix Clay

Estimates exclude clay intraclasts and clay in fine-grained beds that are recorded in other columns.

n = not visible
t = trace evident
tm = trace to moderate, more sections of interval have trace amounts
mt = moderate to trace, more sections of interval have moderate amounts
m = minor amounts evident over most of the core
a = abundant as a pore fraction

A1.4 Darkness

This is not intensity of colour; i.e., a very intense yellow would only rate a “p”; an intense brick red would only rate an “m.”

w = totally bleached out, white
p = very pale to pale
m = moderate to dark
d = dark

A1.5 Colour

This is the dominant background colour when wet. Writing two color codes without a space between them indicates a transitional colour. If two or more colours are present in the logging interval, the colours are recorded in order of most to least common and are separated by commas; e.g., RGn, Y, Gy.

Bk=black
Bn=brown
BR=black-red
C=cream
Gn=green
Gy=grey
R=red, bright
M=maroon
O=orange
P=pink
Pu=purple
W=white
Y=yellow
YG=yellow-grey

A1.6 Colour Pattern

Pattern symbols are uppercase and may be modified by a following lower case letter denoting colour. Two colour letters, e.g., Srw, indicate an outside of the first colour, with a core of the second.

B=bedding related
F=fracture related
G=grain size related
Ld=liesegang, dark
Lp=liesegang, pale
M=mottled
P=patches (random, large)
S=spots
Srw=spots, red outside, white inside
U=uniform

A1.7 Rock Name

Only used with some holes. Abbreviations and text used are in the following table.

ba=crystalline basement
bg=basement gneiss
bs=basement schist
Bm=basement migmatite
bp=basement pegmatite
bfi=basement felsic intrusive
Bmi=basement mafic intrusive
Bfv=basement felsic fine grained rock
bmv=basement mafic fine grained rock
Carbonates after Dunham, 1962; Embry and Klovan, 1971
Cm=carbonate mudstone
cw=carbonate wackestone
cp=carbonate packstone
cg=carbonate grainstone
Cbo=carbonate boundstone
Cbi=carbonate bindstone
cf=carbonate framestone
cx=carbonate coarsely crystalline
cd=dolostone
cl=limestone
Clastics after McBride, 1963 and later revisions
sq=sandstone, quartzarenite
Ssa=sandstone, subarkose
sa=sandstone, arkose
Sla=sandstone, lithic arkose
ssl=sandstone, sublitharenite
sl=sandstone, litharenite
sfl=sandstone, feldspathic litharenite
sls=sandstone, lithic subarkose

A1.8 Minerals

Only used with some holes. Abbreviations and text used are in the following table.

q=quartz plus chert
f=feldspar, feldspathic polycrystalline
u=unstable rock fragments
y=clay
c=calcite
d=dolomite
p=plagioclase
k=k-spar
m=muscovite, pale mica
b=biotite, dark mica
a=amphibole

A1.9 Transported Grain Size

10th percentile: Grain size in abbreviation, at the top of the finest 10%.
90th percentile: Grain size in abbreviation, at the base of the coarsest 10%.
Mode 1: Grain size in abbreviation of the largest mode; determines the rock name.
Mode 2: Grain size in abbreviation of the second largest mode, determines the prime modifier of the rock name.

Sorting: Not entered in the logs, but can be calculated from the 10th and 90th percentiles. If the difference is less than three, it is considered well sorted; between three and five, the classes are medium sorted; and greater than five is poorly sorted.

Rounding: Not entered as a separate variable. R= rounded; A= angular - in remarks.

Maximum transported grain size (MTG): The maximum transported grain size (mm) is the size of the single largest grain. It gives a minimum estimate of maximum stream power (in fluvial deposits), but obviously reflects availability of coarse material. Clastic size classes for percentiles, modes and MTG are as follows:

Bs=boulder, small (256-512 mm)
cl=cobble, large (128-256 mm)
Cs=cobble, small (64-128 mm)
Pv=pebble, very large (32-64 mm)
pl=pebble, large (16-32 mm)
Pm=pebble, medium (8-16 mm)
Ps=pebble, small (4-8 mm)
g=granules (2-4 mm)
vc=sand, very coarse (1-2 mm)
c=sand, coarse (0.5-1 mm)
m=sand, medium (0.25-0.5 mm)
f=sand, fine (0.125-0.25 mm)
vf=sand, very fine (0.062-0.125 mm)
s=silt (0.004-0.062 mm)
y=clay (<0.004 mm)

Percentage of grains over 2 mm in diameter (%> 2 mm): The estimated volume per cent of grains larger than 2 mm in a given sedimentary unit, in whole numbers for small intervals (e.g. 1 m) to 0.01%.

Percentage of mud (% M): Aggregate thickness mudstone and siltstone beds.

Percentage of fines (%F): Aggregate thickness of fine-grained beds (muddy sandstone and fine sandstone).

Percentage of conglomerates (%C >2 cm thick): Aggregate thickness of bedded granule and coarser conglomerate beds greater than 2 cm thick.

Percentage of pebbles greater then 16 mm in diameter (%C>16 mm): Aggregate percentage of pebbles greater than 16 mm thick.

A1.10 Intraclasts

These are clay intraclasts unless noted otherwise. They occur largely on bedding planes, in layers of one intraclast thick.

Intraclast Type:

w=wads, large (>15x30x30 mm), thick, usually soft, angular
d=dollars, large, thin (>30x30x<3 mm)
p=pennies, small, thin (<30x30x3 mm)
g=grains, small, equidimensional (<3x3x3 mm)
b=banks, accumulations of intraclasts more than one layer thick

Aggregate thickness percentage (agg. thickness%): Aggregate thickness of the actual intraclast.

Intraclast Colour: From outside to inside, using colour pattern conventions (e.g., rw). In the description the colour codes for colour banding within one intraclast were simply juxtaposed; if there is more than one intraclast with different colours, separate colour codes by a comma.

A1.11 Accessory Minerals

"Type/Colour": The colour code to describe colour of accessory minerals or 'n' for none.
"Distribution": Enter as follows:

d=disseminated; l=in lamina; n=none seen.

This was meant for primary grains. An attempt was made to avoid its use for disseminated or laminar specular hematite, which, however, can look and be distributed in identical fashion.

A1.12 Multiple Bed Parameters (MBP)

This records trends up and down the core both within and in relation to adjacent logging intervals.

MBP: Architectural Elements

This column permits comments (i.e., an interpretation) on how the PSS fit into larger associations.

d=debris flow
g=glacial deposits
hy=hyperconcentrated flow
t=turbidite
h=hummocky or swaley cross-stratification
e=eolian
f=fluviatile channel
b=fluviatile bars

fi=fl. channel, incised and fill
fl=fl. channel, low aggradation
fr=fl. Channel, rapid aggradation
Bps=point bar, sandy
Bpm=point bar, muddy
Bm=bar, midchannel
ed=eolian dunes
ei=eolian interdunes

Trends Up:

f=fining up
c=coarsening up
n=no trend apparent
i=increasing bed thickness up
d=decreasing bed thickness up

Bed Cycle Scale: The average thickness of beds in a particular trend in centimetres.

A1.13 Primary Sedimentary Structures (PSS) (after Miall, 1996)

These are the structures formed by surface physical processes and do not include postdepositional modifications, such as scours, dewatering pillars, mud volcanoes, etc.

PSS Bedform: The symbols consist of a capitalized grain size indicator followed by one or two lower case sedimentary structure indicators.

These are entered in the logs in a single PSS column separated by commas in order from most common to least common within the interval. To save space, when several PSS with the same size indicator follow each other, the size indicator of all but the first of the series is omitted; e.g., St, p, I, Gh, Sl, G1 for St, Sp, Si, Gh, Sl, G1. The main size classes used are listed below and do not imply a genetic connotation.

G= Gravel (> 30% > 2 mm)
P= Pebbly sand (5-30% > 2 mm)
S= Sand (>50% vc to m sand, < 5% > 2 mm)
F= Fine sand (>50% fine to very fine sand, <5% >2 mm)
M= Mud (>50% silt and/or clay, <5%)

The sedimentary structure indicators are:

m = massive; with Athabasca Basin sandstones these frequently are Sp, shown in outcrop laterally
h = horizontal bedded or laminated
hy = hyperconcentrated flow deposits: horizontal laminae, fining up and coarsening up, disseminated pebbles or cobbles lacking indications of scour or draping
1 = pebble layer one layer thick (l=number one, not lower case letter)

x = crossbedded
xc = condensed crossbeds, <5 cm thick, often coarse material: stacked basal parts of St; reflects climbing troughs or wandering thalweg
t = trough crossbedded; working criteria: none or less prominent fining-up laminae, thinner (0.05-0.5 cm), typically material within laminae are less well sorted, toe sets commonly tangential
p = planar crossbedded; working criteria: thicker (0.1-2 cm) planar cross-laminae, often prominently graded, toeset is angle of repose or only incipiently tangential
r = ripple cross-laminated; fine grained, < 5 cm thick
l = low angle crossbedded (lower case letter)
i = intraclast (clay) rich layer
? = indistinct layering
f = flasers

PSS Max thick/Ample (cm): Height of PSS in centimetres, measured by the maximum distance between discordant sets of laminae or bedding planes. Where the maximum PSS straddled the log interval boundary, the height in the interval containing most of that PSS was entered. This is a measure of minimum water depth as well as preservation/degree of aggradation. The majority of these appear to be planar crossbeds rather than troughs in the Manitou Falls Formation. In bed-by-bed logging, the ripple amplitude is recorded here.

PSS Wavelength (cm): In bed-by-bed logging, this permits the wavelength, especially of ripples, so that a ripple index may be calculated.

PSS Base, Unconformities: Used if doing detailed log; omit otherwise.

c=abrupt, conformable
b=abrupt, bounding surface
d=abrupt, disconformable
e=abrupt, erosional
r=abrupt, reactivation
l=abrupt, lateral accretion surface
p=physically disrupted
g=gradational

PSS Crossbed Base Angle: Only used in detailed logging.

t = tangential
i = incipiently tangential
a = angle of repose

PSS Distinctness: Only used in detailed logging.

i=indistinct
w=weakly distinct
d=distinct

A1.14 Paleocurrents

Paleocurrent measurements are based on: **Type of PSS** used, **Azimuth** of paleocurrent, **Foreset dip** of the crosslaminae, **Width** in cm of the PSS (for outcrop data), and the **Number of bedding planes used** to orient vertical cores if the regional trend is known from outcrop work or work on nearby angled holes.

Type of PSS Used

t=trough crossbed
p=planar crossbed
r=current ripple
er=eolian ripple
ef=eolian foreset direction
fp=pebble fabric
fl=fabric, parting lineation
sf=scour, flute mark
st=scour, tool marks

A1.15 Carbonates (Car)

Four columns are used to record some of the gross characteristics of carbonates. This is by no means an exhaustive list. For serious logging of the Carswell Formation or other carbonate units, this section should be expanded. Included here is the Dunham textural classification, the Folk classification that records component types among other characteristics, a descriptor for laminae, and a descriptor for stromatolitic (organically bound laminae) units that are very common in Proterozoic carbonates.

Car Depositional Texture: These use the Dunham (1962) classification as modified by Embry and Klovan (1971).

cm=carbonate mudstone
cw=carbonate wackestone
cp=carbonate packstone
cg=carbonate grainstone
Cbo=carbonate boundstone
cbi=carbonate bindstone
cf=carbonate framestone
cx=carbonate coarsely crystalline
cd=dolostone
cl=limestone

Car Lithology (Folk, 1962): This classification is used to enhance the descriptors to Dunham's (1962) widely used classification, if detailed sedimentology is of interest.

Car Laminates:

h=horizontal
c=crenulated, wavy
gn=graded, normal
gr=graded, reversely
b=biogenic

Car Stromatolitic Laminae:

l=LLH
o=oncolites
c=columnar
h=hemisperoids, spaced
cp=conophyton

A1.16 A1.17 Secondary Sedimentary Structures (SSS)

The following abbreviations have been used:

l=load casts
b=ball and pillow
c=convolute bedding
s=steepened/overturned crossbedding
s2=steepened/overturned, two or more PSS
m=mudcracks, sandfilled
sy=syneresis cracks
d=clastic dikes
f=flame, dish structures
pc=carbonates, pedogenic
ps=silicification, pedogenic
u=understeepened crosslaminae
r=scour
sg=sandy gouge (in soft sedimentary fault)
sl=slump

A1.18 Hydrocarbons

Type: p=pyrobitumen
t=tar
h=heavy oil
l=light oil
d=odour of hydrocarbon only
n=none

Distribution: b=buttons
f=fractures
i=saturated intergranular

Percentage: Aggregate thickness of beds containing hydrocarbon as a per cent of the interval.

A1.19 Porosity

This section is most applicable to the description of carbonates.

v=vuggy
f=fenestral
m=moldic
i=intergranular
ia=intragranular
s=secondary
fr=fracture

Porosity Percentage: The percentage of visible porosity.

A1.20 Intergranular Cements

Permeability: High, medium or low. Estimated qualitatively by appearance of porosity and rate of absorbing water into core. Apparent permeability and porosity may be caused by weathering-in-box, water evaporating rapidly outdoors, or in warm indoors environments.

Friability: Be aware of a problem of development by weathering-in-box.

c=Competent (only breaks with hammer)
e=Competent, breaks easily
f=Friable (individual grains rub off)
v=Very friable (easily crumbled by hand)
u=Unconsolidated

Silicification

n=No trace
w=Weakly silicified (trace quartz in matrix)
m=Moderately silicified (visible quartz in matrix, sparkles in the sun)
s=Strongly silicified (most pores filled with silica, no sparkle left)

Cement/Fill (in remarks note whether patchy, concretionary)

a=apatite
c=calcite
d=dolomite
s=siderite
h=hematite (if saturated)
l=limonite
m=marcasite
py=pyrite
pi=pitchblende
td=tourmaline, dravite
ts=tourmaline, schorl
y=clay
g=gouge
su=gouge, sandy, uncemented
sc=gouge, sandy, cemented
qc=chalcedony
qd=quartz, drusy
qo=quartz, overgrowths
o=other
n=none

A1.21 Maximum Counts Per Second (MAX CPS)

Radioactivity in counts per second on SPPS 2 - could be obtained from industry. Do not use ‘<’ symbol.

A1.22 Stylolites

A guide to hydrothermal alteration with only obvious stylolites recorded.

Number per meter (#/m): Number per metres.

Colour (Alteration): Colour changes around stylolites; use colour codes as above. Note that a study of clay mineralogy needs to include comparison between stylolite zones and other clay-rich zones. Describe colour from outside to inside separated by a ‘/’ if there is more than one colour. If the stylolites show different patterns in the logging interval, record both or all, separated by a comma.

A1.23 RQD

Rock quality descriptor; measured in fractures/metre; use decimals as needed.

A1.24 Tectonic Structures (TS)

A list of columns to record measurements of structures both on oriented core, using a core goniometer, and qualitative observations.

TS Type: Fault/fracture type.

ft=fault, unspecified
fd=fault, dipslip
fs=fault, strikeslip
fr=fracture, no movement
bx=breccia
br=breccia, milled (fault breccia)
bc=breccia, crackle (hydraulic fracturing)
su=sandy gouge, uncemented
sc=sandy gouge, cemented
b=bedding plane
n=not determined

TS Number of Parallel Structures: Avoids having to list sets of parallel structures separately.

TS Open/Closed: Indicates whether structure is cemented.

o = open
c = closed

TS Dip Azimuth: Dip azimuth in degrees.

TS Dip: In degrees.

TS Sense of Movement: May be used if offsets or slickensides are visible.

ll = left lateral
rl = right lateral
nl = normal
rv = reverse
w = wrench fault
d = dipslip (nl or rv)

TS Slickenside Rake: Clockwise from horizontal on slickenside surface in degrees. This is recorded to obtain the azimuth of actual movement with steep faults.

TS Azimuth of Slip Dip: Provides direction of movement, measurable directly on shallower dipping faults.

TS Angle to Core Axis: Measured clockwise with the top of the core pointing up.

A1.25 Fracture Fill (FF)

Describes the cements on fracture surfaces and in wall rock.

FF Thickness of fill (mm): Measured perpendicular to fracture surface.

FF Cement in Wall Rock: Records cementation adjacent to faults that may differ from unaltered rock. Use same abbreviations as for cement/fill.

FF Cement Oldest to Youngest: The actual list of minerals in the fracture or fault. Note that the filling may not be symmetrical, and that the oldest may be on one side, with younger material precipitating just on one side. Use same abbreviations as for cement/fill.

A1.26 Replacement

Records actual replacement of the primary rock by hydrothermal or other alteration.

Type:

b=botryoidal
ps=pseudomorphing
ms=massive
mn=manto, stratabound
v=vuggy
pa=patchy
d=disseminated
l=void linings
fi=replace rock within fault zone
fo=replace fault zone & wall rock

Protolith: Use the same list of abbreviations as the rock names, or add in as needed.

New Mineral: Use the cement/fill mineral list.

Percentage of rock: The percentage of rock replaced.

A1.27 Remarks and Sample Lists

Remarks: Optional comments and observations.
Samples: Lists sample numbers taken. Include DDH number and depth in number.
Thin Sections: List sample numbers of thin section samples. Include DDH number and depth in number.
Photographs: Number and short description of photographs. Include DDH number and depth in number.

A1.28 Units, (From, To), Thickness, Stratigraphic Unit

Gives space to put in provisional stratigraphic names. The thickness is calculated. Use the “Copy” provision of Excel to duplicate the entire group at any depth where there is a stratigraphic or lithological boundary.

A1.29 True Depths and True Thickness

If hole inclination is entered in header (Cell AN3 in the later editions of the spreadsheet), then this group of cells calculates the true depths for angled holes. Copy the hole set (keeping it in the same columns) to match the Units, Thickness, Stratigraphic Unit entries.

Appendix 2 – Depths, Elevations and Thickness of Stratigraphic Units

Appendix 2.1. Depth to Formation/Member Tops

Ids		Location (UTM)			Depth (m) from Collar to Unit Tops (Positive Depth)																																						
AGS ID	Company ID	Easting	Northing	Collar Elev (m)	Quarter-nary	Devo-nian	Dev Carb	Dev fine clastic	Dev/Ord crs clast	Atha-basca Group	Other-side	Locker Lake	LLc	LLb	LLa	Wolv-erine Point	WPc	WPb	WPb3	WPb2	WPb1	WPa	WPa2	WPa1	Lazenby Lake	Man-itou Falls	MFd	MFc	MFb	MFa	MFa2	MFa1	Fair Point	FPc	FPb	FPb2	FPb1	FPa	FPa2	FPa1	Basal Lag	Base-ment	End Of Hole
FC-005	GE 78lajv-006	556327.6076	6535165.8189	220	0	NP	NP	NP	NP	30.50	NP	30.50	NP	NP	30.50	71.90	71.90	108.25	108.25	151.80	167.00	171.45	NI	NI	377.65	409.90	NP	NP	409.90	502.20	NP	502.20	508.45	508.45	603.35	603.35	796.80	NP	NP	NP	822.50	823.45	847.60
FC-007	GE 78lajv-004	544851.9937	6524699.4533	230	0	NP	NP	NP	NP	3.70	NP	3.70	3.70	96.45	144.70	208.53	208.53	251.35	251.35	302.00	317.30	325.20	NI	NI	756.10	784.75	NP	784.75	847.80	NP	NP	NP	959.70	959.70	1073.45	1073.45	1172.00	NR	NR	NR	NR	NR	1255.00
FC-009	Flin Flon ij-79	521044.6056	6533824.6967	213	0	NP	NP	NP	NP	3.00	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	3.00	11.43	NP	11.43	87.00	NP	NP	NP	98.30	98.30	148.30	148.30	NP	329.20	NP	329.20	NR	NR	359.01
FC-013	Norcen r-4	499414.1178	6440449.4843	282	0	62.50	NP	62.50	91.40	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	96.70	102.80
FC-015	Norcen r6	505654.7111	6463987.8805	226	0	NP	NP	NP	NP	12.80	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	12.80	19.90	NP	19.90	NP	NP	NP	NP	130.23	130.23	181.25	NP	181.25	205.30	NP	205.30	NP	214.70	219.70
FC-016	Norcen r7	543846.2492	6464498.5090	305	0	NP	NP	NP	NP	47.60	NP	47.60	NP	NP	47.60	99.00	NP	NP	NP	NP	NP	99.00	NI	NI	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	184.20
FC-017	Norcen r8	546647.4631	6430523.1496	366	0	NP	NP	NP	NP	34.80	NP	NP	NP	NP	NP	34.80	NP	NP	NP	NP	NP	34.80	34.80	NP	46.20	102.00	NP	102.00	225.00	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	227.80
FC-026	Norcen rr-10	499584.4977	6457267.2982	274	0	NP	NP	NP	NP	58.52	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	58.52	NP	58.52	NP	NP	NP	NP	137.94	137.94	NR	NR	NR	NR	NR	NR	NR	NR	151.49
FC-027	Norcen rr-11	499614.5058	6457348.4158	274	0	NP	NP	NP	NP	58.30	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	58.30	NP	58.30	NP	NP	NP	NP	138.30	138.30	180.45	180.45	223.21	227.30	227.30	242.04	NP	267.31	276.45
FC-030	BP Minerals 78-3	511183.6259	6469573.3700	274	0	NP	NP	NP	NP	61.00	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	61.00	84.75	NP	84.75	NP	NP	NP	NP	204.60	204.60	256.10	256.10	NP	NP	NP	NP	NP	259.21	291.70
FC-031	Eldorado 508-05	527537.8996	6424395.2924	342	0	31.88	31.88	41.67	NP	78.03	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	78.03	NP	78.03	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	81.08	118.00
FC-032	Eldorado 508-06	525617.8450	6422478.1296	343	0	49.07	NP	49.07	59.60	80.76	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	80.76	NP	80.76	NP	91.74	NP	91.74	NP	NP	NP	NP	NP	NP	NP	NP	NP	98.38	105.46
FC-034	Eldorado 508-10	514426.0259	6438309.1542	308	0	36.88	36.88	43.20	76.10	81.81	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	81.81	NP	81.81	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	117.96
FC-035	Eldorado 508-14	544623.6643	6414927.9522	384	0	59.70	NP	NP	59.70	67.66	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	67.80	NP	67.80	NP	117.39	NP	117.39	NP	NP	NP	NP	NP	NP	NP	NP	130.16	133.02	145.60
FC-037	Eldorado 508-16	536891.4303	6425274.6332	366	0	NP	NP	NP	NP	33.50	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	33.50	NP	33.50	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	173.70
FC-038	Eldorado 508-18	509095.5455	6429518.5334	302	0	26.50	NP	NP	26.50	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	36.00	112.70
FC-039	Eldorado 508-19	522112.3769	6432322.8216	320	0	NP	NP	NP	NP	15.80	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	15.80	15.80	108.50	NP	165.10	NP	165.10	NP	NP	NP	NP	NP	NP	NP	NP	NP	172.60	214.50
FC-045	Eldorado 508-36	538701.6537	6418301.6130	366	0	35.90	NP	35.90	80.90	100.70	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	100.70	NP	100.70	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	110.20	110.30	124.00
FC-046	Eldorado 508-37	541657.8693	6416888.8760	371	0	57.90	NP	57.90	72.70	89.50	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	89.50	NP	NP	NP	89.50	89.50	110.00	NP	NP	NP	NP	NP	NP	NP	NP	NP	113.30	142.30
FC-047	Eldorado 508-40	555658.3120	6409824.0071	444	0	64.30	NP	64.30	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	87.50	102.10
FC-048	Eldorado 508-41	535021.7418	6419646.8398	364	0	37.09	37.09	42.80	62.77	105.57	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	105.57	NP	105.57	NP	126.50	NP	126.50	NP	NP	NP	NP	NP	NP	NP	NP	NP	129.53	141.42
FC-049	Chevron 77-1	548521.5797	6453798.6467	329	0	NP	NP	NP	NP	12.00	NP	12.00	NI	NI	NI	48.50	NI	NI	NI	NI	NI	NI	NI	NI	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	176.00
FC-050	Chevron 77-2	553696.3933	6454649.1568	335	0	NP	NP	NP	NP	25.00	NP	25.00	NI	NI	NI	NP	NP	NP	NP	NP	NP	NP	NP	NP	44.00	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	261.00
FC-051	Chevron 77-3	557246.6994	6447249.1938	341	0	NP	NP	NP	NP	6.00	NP	6.00	NI	NI	NI	143.00	NP	NP	NP	NP	NP	143.00	NI	NI	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	143.00
FC-052	Chevron 77-4	541521.7403	6449548.4417	332	0	NP	NP	NP	NP	16.10	NP	16.10	NP	NP	16.10	66.60	NP	NP	NP	NP	NP	66.60	66.60	83.50	134.70	181.40	NP	181.40	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	245.90
FC-053	Macleod ddh-1	528570.3175	6495974.4217	230	0	NP	NP	NP	NP	75.30	NP	NP	NP	NP	NP	75.30	NP	NP	NP	NP	NP	75.30	NP	75.30	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	147.50
FC-054	Macleod ddh-2	528345.1900	6495349.6666	230	0	NP	NP	NP	NP	36.20	NP	NP	NP	NP	NP	36.20	NP	NP	NP	NP	NP	36.20	NP	36.20	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	152.40
FC-055	Uranerz gw-8	553648.5122	6572780.0992	220	0	NP	NP	NP	NP	11.80	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	11.80	NP	11.80	11.80	30.10	NP	NP	NP	NP	45.10	62.40
FC-068	Esso of78-1	540825.4813	6496238.9096	255	0	NP	NP	NP	NP	46.90	NP	46.90	NI	NI	NI	80.00	80.00	110.00	NI	NI	NI	191.70	NI	NI	390.00	530.00	NP	530.00	645.00	NP	NI	NI	661.10	NI	NI	NI	NI	NI	NI	NI	NP	1010.10	1017.10
FC-069	Esso of78-2	556466.6163	6508429.2852	283	0	NP	NP	NP	NP	8.20	8.20	30.00	30.00	135.00	200.00	320.00	320.00	357.00	NI	NI	NI	438.00	NI	NI	720.00	820.00	NP	820.00	940.00	NP	NI	NI	959.20	NI	NI	NI	NI	NI	NI	NI	NR	NR	1105.50
FC-071	Norcen 80-e1	494314.1180	6456085.9747	274	0	NP	NP	NP	NP	61.20	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	61.20	NP	61.20	NP	108.32	NP	108.32	110.60	110.60	165.13	165.13	NP	193.78	193.78	NP	NP	206.20	215.50
FC-072	Norcen 80-e2	485628.7281	6465823.1869	247	0	90.45	90.45	102.70	NP	124.00	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	124.00	124.00	137.20	137.20	167.40	190.01	NP	190.01	NP	192.70	197.80
FC-075	SMDC wb-1	482480.9698	6470899.5460	269	0	NP	NP	NP	NP	93.88	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	93.88	93.88	NP	NP	NP	150.22	NP	150.22	NP	154.46	191.10
MR-02	Uranerz mr-02	518239.3499	6442919.8362	305	0	26.85	NP	26.85	61.49	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	68.42	156.32
MR-04	Uranerz mr-04	520948.1154	6445531.5212	308	0	21.65	NP	21.65	NP	45.29	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	45.29	NP	45.29	NP	87.12	87.12	103.64	NP	NP	NP	NP	NP	NP	NP	NP	NP	105.22	214.77
MR-05	Uranerz mr-05	517483.2234	6443866.4075	310	0	30.31	NP	30.31	66.68	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	73.27	162.81
MR-06	Uranerz mr-06	516096.5414	6442560.8615	300	0	31.78	NP	31.78	NP	33.60	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	33.60	NP	NP	NP	33.60	NP	33.60	NP	NP	NP	NP	NP	NP	NP	NP	NP	49.45	165.41
MR-10	Uranerz mr-10	513810.7963	6448210.8937	300	0	32.04	NP	32.04	NP	58.20	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	58.20	NP	58.20	NP	92.17	92.17	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	129.47	168.01
MR-14	Uranerz mr-14	517561.2006	6445108.6856	305	0	56.83	NP	NP	56.83	61.45	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	61.45	NP	61.45	NP	80.48	80.48	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	92.17	167.67
MR-16	Uranerz mr-16	519111.1722	6442121.5873	305	0	30.31	30.31	48.24	53.61	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	54.91	147.22
MR-17	Uranerz mr-17	521231.3670	6439749.0998	303	0	31.61	NP	31.61	56.55	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	66.08	162.81
MR-18	Uranerz mr-18	516526.3425	6443093.6391	303	0	22.00	22.00	46.80	54.10	61.20	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	61.20	NP	61.20	NP	64.20	64.20	70.85	NP	NP	NP	NP	NP	NP	NP	NP	NP	78.50	182.00
MR-20	Uranerz mr-20	521407.9978	6446515.9995	312	0	18.19	NP	18.19	NP	53.69	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	53.69	NP	53.69	NP	139.43	139.43	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	153.72	196.24
MR-29	Uranerz mr-29	520035.9315	6451518.3964	305	0	NP	NP	NP	NP	32.38	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	32.38	50.75	NI	NI	NI	NI	NI	NI	138.43	NI	NI	NI	NI	NI	NI	NI	NP	180.91	235.56
MR-34	Uranerz mr-34	520053.2538	6451509.8787	305	0	NP	NP	NP	NP	32.23	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	32.23	55.95	NP	55.95	NP	NP	NP	NP	165.81	NI	NI	NI	NI	NI	NI	NI	NP	190.59	227.41
MR-35	Uranerz mr-35	519648.3505	6453344.1029	300	0	NP	NP	NP	NP	21.30	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	21.30	59.24	NP	59.24	NP	NP	NP	NP	165.50	165.50	184.91	NP	184.91	NP	NP	NP	NP	207.15	272.32
MR-39	Uranerz mr-39	520060.0316	6451510.8104	306	0	NP	NP	NP	NP	33.28	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	33.28	52.95	NP	52.95	NP	NP	NP	NP	168.26	168.26	NP	NP	NP	187.21	187.21	NP	NP	193.45	237.33
MR-64	Uranerz mr-64	524438.6637	6441738.4235	328	0	24.25	NP	24.25	NP	38.02	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	38.02	NP	38.02	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	102.02	234.09
MR-65	Uranerz mr-65	538272.2831	6438523.2835	347	0	NP	NP	NP	NP	14.00	NP	NP	NP	NP	NP	14.00	NP	NP	NP	NP	NP	14.00	NP	14.00	27.65	169.05	NP	169.05	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	423.55	424.80	514.20
MR-68	Uranerz mr-68	517972.4271	6462619.6878	308	0	NP	NP	NP	NP	65.38	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	65.38	127.69	NP	127.69	200.87	NP	NP	NP	237.67	237.67	256.25	256.25	281.71	321.33	NP	321.33	NP	328.73	411.00
MR-71	Uranerz mr-71	518359.9346	6457096.8894	297	0	NP	NP	NP	NP	44.17	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	44.17	73.87	NP	73.87	NP	NP	NP	NP	194.47	194.47	224.49	224.49	NP	NP	NP	NP	NP	238.59	302.76
MR-76	Uranerz mr-76	523534.1360	6443005.9517	317	0	17.32	NI	NI	NI	32.48	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	32.48	NP	32.48	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	61.75	118.65
MR-78	Uranerz mr-78	522953.0935	6444192.6395	315	0	25.03	NP	25.03	NP	45.90	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	45.90	NP	45.90	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	51.53	71.88
MR-79	Uranerz mr-79	520684.2932	6448626.0060	310	0	NP	NP	NP	NP	23.82	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	23.82	30.22	NP	30.22	NP	NP	NP	NP	132.28	132.28	NP	NP	NP	NP	NP	NP	157.70	158.40	225.17
MR-83	Uranerz mr-83	512446.9200	6450452.4653	288	0	NP	NP	NP	NP	21.10	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	21.10	NP	21.10	NP	NP	NP	NP	84.10	NI	NI	NI	NI	NI	NI	NI	NP	117.90	182.00

All measurements in m | NP=not present; NR=not reached; ND=not deposited/eroded; NI=not identified | All depths are corrected for inclination. | Neither of the Uppermost Athabasca Group Douglas or Carswell Formations are present | For FC-068 and FC-069 picks were made from Esso logs, using FC-005 as a guide. | Uranerz picks were used for MR-83

Appendix 2.2. Thicknesses of Formations/ Members

Ids		Location (UTM)			Thicknesses (m) (Minimum thicknesses are in ***bold italics***)																																
AGS ID	Company ID	Easting	Northing	Collar Elev (m)	Quar-ter-nary	Dev Carb	Dev fine clastic	Dev/ Ord crs clast	Total Dev	Other-side	LLc	LLb	LLa	Total Locker Lake	WPc	WPb3	WPb2	WPb1	WPa2	WPa1	Total Wolverine Point	Lazenby Lake	MFd	MFc	MFb	MFa2	MFa1	Total Manitou Falls	FPc	FPb2	FPb1	FPa2	FPa1	Total Fair Point	Basal Lag	Total Athabasca Group	Basement
FC-005	GE 78lajv-006	556327.6076	6535165.8189	220	30.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	41.40	41.40	36.35	43.55	15.20	4.45	NI	NI	305.75	32.25	0.00	0.00	92.30	0.00	6.25	98.55	94.90	193.45	25.70	0.00	0.00	314.05	0.95	792.95	***24.15***
FC-007	GE 78lajv-004	544851.9937	6524699.4533	230	3.70	0.00	0.00	0.00	0.00	0.00	92.75	48.25	63.83	204.83	42.82	50.65	15.30	7.90	NI	NI	547.57	28.65	0.00	63.05	111.90	0.00	0.00	174.95	113.75	98.55	***83.00***	NR	NR	***295.30***	NR	***1251.30***	NR
FC-009	Flin Flon ij-79	521044.6056	6533824.6967	213	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.43	0.00	75.57	11.30	0.00	0.00	86.87	50.00	180.90	0.00	0.00	***29.81***	***260.71***	NR	***356.01***	NR
FC-013	Norcen r-4	499414.1178	6440449.4843	282	62.50	0.00	28.90	5.30	34.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	***6.10***
FC-015	Norcen r6	505654.7111	6463987.8805	226	12.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.10	0.00	110.33	0.00	0.00	0.00	110.33	51.02	0.00	24.05	0.00	9.40	84.47	0.00	201.90	***5.00***
FC-016	Norcen r7	543846.2492	6464498.5090	305	47.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	51.40	51.40	0.00	0.00	0.00	0.00	NI	NI	***85.20***	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	***136.60***	NR
FC-017	Norcen r8	546647.4631	6430523.1496	366	34.80	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	11.40	NP	11.40	55.80	NP	123.00	***2.80***	NR	NR	***125.80***	NR	NR	NR	NR	NR	NR	NR	***193.00***	NR
FC-026	Norcen rr-10	499584.4977	6457267.2982	274	58.52	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	79.42	NP	NP	NP	79.42	***13.55***	NR	NR	NR	NR	***13.55***	NR	***92.97***	NR
FC-027	Norcen rr-11	499614.5058	6457348.4158	274	58.30	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	80.00	NP	NP	NP	80.00	42.15	42.76	4.09	14.74	25.27	129.01	NP	209.01	***9.14***
FC-030	BP Minerals 78-3	511183.6259	6469573.3700	274	61.00	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	23.75	NP	119.85	NP	NP	NP	119.85	51.50	3.11	NP	NP	NP	54.61	NP	198.21	***32.49***
FC-031	Eldorado 508-05	527537.8996	6424395.2924	342	31.88	9.79	36.36	NP	46.15	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	3.05	NP	NP	NP	3.05	NP	NP	NP	NP	NP	NP	NP	3.05	***36.92***
FC-032	Eldorado 508-06	525617.8450	6422478.1296	343	49.07	NP	10.53	21.16	31.69	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	10.98	NP	NP	6.64	17.62	NP	NP	NP	NP	NP	NP	NP	17.62	***7.08***
FC-034	Eldorado 508-10	514426.0259	6438309.1542	308	36.88	6.32	32.90	5.71	44.93	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	***36.15***	NR	NR	NR	***36.15***	NR	NR	NR	NR	NR	NR	NR	***36.15***	NR
FC-035	Eldorado 508-14	544623.6643	6414927.9522	384	59.70	NP	NP	7.96	7.96	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	49.59	NP	NP	12.77	62.36	NP	NP	NP	NP	NP	NP	2.86	65.36	***12.58***
FC-037	Eldorado 508-16	536891.4303	6425274.6332	366	33.50	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	***140.20***	NR	NR	NR	***140.20***	NR	NR	NR	NR	NR	NR	NR	***140.20***	NR
FC-038	Eldorado 508-18	509095.5455	6429518.5334	302	26.50	NP	NP	9.50	9.50	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	***76.70***
FC-039	Eldorado 508-19	522112.3769	6432322.8216	320	15.80	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	92.70	56.60	NP	NP	7.50	156.80	NP	NP	NP	NP	NP	NP	NP	156.80	***41.90***
FC-045	Eldorado 508-36	538701.6537	6418301.6130	366	35.90	NP	45.00	19.80	64.80	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	9.50	NP	NP	NP	9.50	NP	NP	NP	NP	NP	NP	0.10	9.60	***13.70***
FC-046	Eldorado 508-37	541657.8693	6416888.8760	371	57.90	NP	14.80	16.80	31.60	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	20.50	3.30	23.80	NP	NP	NP	NP	NP	NP	NP	23.80	***29.00***
FC-047	Eldorado 508-40	555658.3120	6409824.0071	444	64.30	NP	23.20	NP	23.20	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	***14.60***
FC-048	Eldorado 508-41	535021.7418	6419646.8398	364	37.09	5.71	19.97	42.80	68.48	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	20.93	NP	NP	3.03	23.97	NP	NP	NP	NP	NP	NP	NP	23.97	***11.89***
FC-049	Chevron 77-1	548521.5797	6453798.6467	329	12.00	NP	NP	NP	NP	NP	NI	NI	NI	36.50	NI	NI	NI	NI	NI	NI	***127.50***	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	***164.00***	NR
FC-050	Chevron 77-2	553696.3933	6454649.1568	335	25.00	NP	NP	NP	NP	NP	NI	NI	NI	19.00	NP	NP	NP	NP	NP	NP	NP	***217.00***	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	***236.00***	NR
FC-051	Chevron 77-3	557246.6994	6447249.1938	341	6.00	NP	NP	NP	NP	NP	NI	NI	NI	137.00	NP	NP	NP	NP	NI	NI	NP	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	***137.00***	NR
FC-052	Chevron 77-4	541521.7403	6449548.4417	332	16.10	NP	NP	NP	NP	NP	NP	NP	50.50	50.50	NP	NP	NP	NP	16.90	51.20	68.10	46.70	NP	***64.50***	NR	NR	NR	***64.50***	NR	NR	NR	NR	NR	NR	NR	***229.80***	NR
FC-053	Macleod ddh-1	528570.3175	6495974.4217	230	75.30	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	***72.20***	***72.20***	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	***72.20***	NR
FC-054	Macleod ddh-2	528345.1900	6495349.6666	230	36.20	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	***116.20***	***116.20***	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	***116.20***	NR
FC-055	Uranerz gw-8	553648.5122	6572780.0992	220	11.80	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	18.30	15.00	NP	NP	33.30	NP	33.30	***17.30***
FC-068	Esso of78-1	540825.4813	6496238.9096	255	46.90	NP	NP	NP	NP	NP	NI	NI	NI	33.10	30.00	NI	NI	NI	NI	NI	310.00	140.00	NP	115.00	16.10	NI	NI	131.10	NI	NI	NI	NI	NI	349.00	NP	963.20	***7.00***
FC-069	Esso of78-2	556466.6163	6508429.2852	283	8.20	NP	NP	NP	NP	21.80	105.00	65.00	120.00	290.00	37.00	NI	NI	NI	NI	NI	400.00	100.00	NP	120.00	19.20	NI	NI	139.20	NI	NI	NI	NI	NI	***146.30***	NR	***1097.30***	NR
FC-071	Norcen 80-e1	494314.1180	6456085.9747	274	61.20	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	47.12	NP	NP	2.28	49.40	54.53	28.65	NP	12.42	NP	95.60	NP	145.00	***9.30***
FC-072	Norcen 80-e2	485628.7281	6465823.1869	247	90.45	12.25	21.30	NP	33.55	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	13.20	30.20	22.61	NP	2.69	68.70	NP	68.70	***5.10***
FC-075	SMDC wb-1	482480.9698	6470899.5460	269	93.88	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	56.34	NP	NP	NP	4.24	60.58	NP	60.58	***36.64***
MR-02	Uranerz mr-02	518239.3499	6442919.8362	305	26.85	NP	34.64	6.93	41.57	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	***87.90***
MR-04	Uranerz mr-04	520948.1154	6445531.5212	308	21.65	NP	23.64	NP	23.64	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	41.83	NP	16.52	1.58	59.93	NP	NP	NP	NP	NP	NP	NP	59.93	***109.55***
MR-05	Uranerz mr-05	517483.2234	6443866.4075	310	30.31	NP	36.37	6.58	42.95	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	***89.54***
MR-06	Uranerz mr-06	516096.5414	6442560.8615	300	31.78	NP	1.82	NP	1.82	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	15.85	15.85	NP	NP	NP	NP	NP	NP	NP	15.85	***115.96***
MR-10	Uranerz mr-10	513810.7963	6448210.8937	300	32.04	NP	26.16	NP	26.16	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	33.97	NP	37.30	NP	71.27	NP	NP	NP	NP	NP	NP	NP	71.27	***38.54***
MR-14	Uranerz mr-14	517561.2006	6445108.6856	305	56.83	NP	NP	4.62	4.62	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	19.03	NP	11.69	NP	30.72	NP	NP	NP	NP	NP	NP	NP	30.72	***75.50***
MR-16	Uranerz mr-16	519111.1722	6442121.5873	305	30.31	17.93	5.37	1.30	24.60	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	***92.31***
MR-17	Uranerz mr-17	521231.3670	6439749.0998	303	31.61	NP	24.94	9.53	34.47	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	***96.73***
MR-18	Uranerz mr-18	516526.3425	6443093.6391	303	22.00	24.80	7.30	7.10	39.20	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	3.00	NP	6.65	7.65	17.30	NP	NP	NP	NP	NP	NP	NP	17.30	***103.50***
MR-20	Uranerz mr-20	521407.9978	6446515.9995	312	18.19	NP	35.50	NP	35.50	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	85.74	NP	14.29	NP	100.03	NP	NP	NP	NP	NP	NP	NP	100.03	***42.52***
MR-29	Uranerz mr-29	520035.9315	6451518.3964	305	32.38	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	18.37	NI	NI	NI	NI	NI	87.68	NI	NI	NI	NI	NI	42.48	NP	148.53	***54.65***
MR-34	Uranerz mr-34	520053.2538	6451509.8787	305	32.23	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	23.72	NP	109.86	NP	NP	NP	109.86	NI	NI	NI	NI	NI	24.78	NP	158.36	***36.82***
MR-35	Uranerz mr-35	519648.3505	6453344.1029	300	21.30	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	37.94	NP	106.26	NP	NP	NP	106.26	19.41	NP	22.24	NP	NP	41.65	NP	185.85	***65.17***
MR-39	Uranerz mr-39	520060.0316	6451510.8104	306	33.28	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	19.67	NP	115.31	NP	NP	NP	115.31	18.95	NP	NP	6.24	NP	25.19	NP	160.17	***43.88***
MR-64	Uranerz mr-64	524438.6637	6441738.4235	328	24.25	NP	13.77	NP	13.77	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	64.00	NP	NP	NP	64.00	NP	NP	NP	NP	NP	NP	NP	64.00	***132.07***
MR-65	Uranerz mr-65	538272.2831	6438523.2835	347	14.00	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	13.65	13.65	141.40	NP	254.50	NP	NP	NP	254.50	NP	NP	NP	NP	NP	NP	1.25	410.80	***89.40***
MR-68	Uranerz mr-68	517972.4271	6462619.6878	308	65.38	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	62.31	NP	73.18	36.80	NP	NP	109.98	18.58	25.46	39.62	NP	7.40	91.06	NP	263.35	***82.27***
MR-71	Uranerz mr-71	518359.9346	6457096.8894	297	44.17	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	29.70	NP	120.60	NP	NP	NP	120.60	30.02	14.10	NP	NP	NP	44.12	NP	194.42	***64.17***
MR-76	Uranerz mr-76	523534.1360	6443005.9517	317	17.32	NI	NI	NI	15.16	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	29.27	NP	NP	NP	29.27	NP	NP	NP	NP	NP	NP	NP	29.27	***56.90***
MR-78	Uranerz mr-78	522953.0935	6444192.6395	315	25.03	NP	20.87	NP	20.87	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	5.63	NP	NP	NP	5.63	NP	NP	NP	NP	NP	NP	NP	5.63	***20.35***
MR-79	Uranerz mr-79	520684.2932	6448626.0060	310	23.82	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	6.40	NP	102.06	NP	NP	NP	102.06	25.42	NP	NP	NP	NP	25.42	0.70	134.58	***66.77***
MR-83	Uranerz mr-83	512446.9200	6450452.4653	288	21.10	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	63.00	NP	NP	NP	63.00	NI	NI	NI	NI	NI	33.80	NP	96.80	***64.10***

All measurements in m

NP=not present; NR=not reached; ND=not deposited/eroded; NI=not identified

Neither of the Athabasca Group Douglas or Carswell Formations are present

For FC-068 and FC-069 picks were made from Esso logs, using FC-005 as a guide.

Uranerz picks were used for MR-83