Kamik Formation study, Richardson Mountains,
Devon Canada Corporation,

June 13 to July 26, 2006, NEB Program ID 9337-D072-002E,

Area of Study

SE Corner	Latitude:	68° 00' 00"
	Longitude :	135° 20' 00
NW Corner	Latitude	68 ° 25' 00"
	Longitude	136° 00' 00"

Operation

Helicopter-supported geological mapping based out of Aklavik, N.W.T., July 13-16, 2005 and July 25-26, 2005; outcropping formations examined correlate to subsurface geology in the Tuk gas field.

Operating Company

Devon Canada Corporation (W.I. 50%)

Field Party Participants

Greg Soule
Geologist, Devon Canada
Geoff Minielly
Geologist, Petro-Canada

Wildlife Monitors

Charles Wright (Gwich'in, June 2006)
Mr. Wilson (Inuvialuit, July 2006)

Prime Contractor

Gwichi'in Helicopters, 2006

STATISTICAL AND LOGISTICAL SUMMARY

The geological team was based in Aklavik in June and Inuvik in July, although the helicopter remained based in Inuvik throughout. We flew each day with a wildlife monitor to various localities in the Richardson Mountains to examine the outcrops of the Kamik Formation strata. We were active in the field for 4 days in June, and 2 days in July. There were no accidents or injuries during the program.

Field Days
June 13 – 17 2006
July 25 – 26 2006

Stratigraphic Architecture and Dimensional Characteristics of the Kamik Formation Sandstone – an Examination from Outcrop

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1. INTRODUCTION

Fieldwork locations were in the NWT on Inuvialuit and Gwich'in tribal lands. Outcrops examined were in the Aklavik Range; a complete listing follows.

Mount Gifford UTM 480700E 7559000N
Husky Creek UTM 480300E 7544900N
Martin Creek UTM 475800E 7565600N
Kamik Butte UTM 463250E 7545450N
Grizzly Gorge – several localities - General UTM 471200E 7572800N

An introductory day was spent scouting the Aklavik Range so that field party members could review regional geological relationships and to review the previous work done in the area, especially the work by Petro-Canada, Devon Canada and the Geological Survey of Canada mapping parties of 2001, 2002 and 2003 (see North Richardson Mountains Field Party, NEB Project Identifier 9337-P28-1E submitted by Petro-Canada, and Geological Fieldwork Results, North Richardson Mountains, Devon Canada Corporation, July 15-20, 2002 and September 2-10, 2003 NEB Project Identifiers 9337-D30-1E and 9337-D31.1E submitted by Devon Canada).

This report is very specific to the sandstone units of the Kamik Formation. As such, it relies on the regional work and conclusions of prior years. The Kamik Formation is addressed in Dixon (1991) and in reports submitted by Petro-Canada (NEB Project 9337-P28-1E in 2001, and the regional context is provided in section 6, report #3 entitled **Structural geology, Aklavik Range, Richardson Mountains, and Barn Mountains, 2003 (Dennis Johnston, Larry Lane, GSC)** which is filed in the Devon Canada submission, 2005.

2. OBJECTIVES

The focus of Devon Canada's 2006 fieldwork program was the Cretaceous Kamik Formation exposed in the northernmost Richardson Mountains. The primary objectives were to review the stratigraphic relationships with the strata above and below, and to analyze the internal architecture of the reservoir sandstone layers. The Kamik Formation is the reservoir rock for the Tuk and Parson's Lake natural gas fields in the Mackenzie Delta. The Tuk field is owned jointly by Devon Canada Corporation and Petro-Canada. The information obtained about the internal architecture of the reservoir sandstone units was to assist in the stochastic modeling of gas flow and ultimate recovery from the Tuk gas field.

3. PREVIOUS WORK

Figure 1 View to the southwest of part of the Grizzly Gorge canyon. The basal slightly reddish sandy strata form the top of the Martin Creek Formation. The dark shale and overlying white sandstone between the bottom two contacts outlined in the photograph are assigned to the McGuire Formation in this report. The Kamik Formation is expressed here as a basal sandstone incised into the top of the McGuire overlain by a recessive, largely bush covered middle Kamik with a thin sandstone at the top. The top line marks the top of the Kamik and the base of the Mount Goodenough shales which do outcrop in some places along the canyon.

Dixon (1991) describes the regional geology of the Parsons Group which is comprised of the Martin Creek, McGuire and Kamik Formations. Dixon (1991) identifies a regional unconformity at the top of the Kamik Formation below the Siku shale member of the Mount Goodenough Formation. Good evidence is seen in the Aklavik Range (Dixon, 1991; this report) and in the subsurface especially in the Tuk Peninsula (see Fig. 13, Dixon 1991). The Parsons Group was deposited in the Neocomian tectonic lows from the Kugmalit Trough in the Tuk Peninsula area, through the Canoe Depression, Blow Trough, Keele Trough and the Kandik Trough of the western Yukon (Dixon, 1991).

Dixon (1991) described the Aklavik Range in some detail concluding that the assemblage of facies present over the area as a whole indicates a marginal marine setting. Our observations would support that. This report breaks with Dixon (1991) in that what we assign as an upper McGuire sandstone unit Dixon (1991) assigns to a lower unit of the Kamik Formation. We agree with Dixon (1991) that the sandstone represents a transition from the McGuire shale deposition to the sandier facies associations above. We do not propose any formal stratigraphic changes, this was simply a utilitarian definition based on reservoir quality potential.

The Kamik Formation was also described and interpreted by prior years' field work, as documented in Petro-Canada submission (2002). Please refer to that report and Dixon (1991) for measured sections and descriptions of the Kamik Formation. It was also briefly described in the second report of the Devon Canada submission (2005).

Figure 1 illustrates the stratigraphic interval of interest. Above the Martin Creek Formation at the base of the canyon is a regionally consistent black shale of the McGuire Formation which passes up into a fine grained sandstone with a white appearance in Figure 1. This unit was included in the McGuire Formation in our mapping and is characterized by white, swaley cross-stratified fine-grained sand interpreted as lower shoreface. The base of the Kamik Formation in outcrop is recognizable in the report area as a medium to coarse grained, trough cross-bedded amalgamated channel sands. It is incised into the top of the white sandstone of the McGuire Formation (Figures 3, 4, 8, 10

and 11). The basal bed varies in thickness from 3 to 7 metres. The total thickness of the Kamik Formation varies from 10 – 27 metres over approximately 2 kilometres in the canyon pictured above, and from 3 to 50 metres in the Aklavik Range over approximately 20 kilometres distance.

Report 3 by Dr. L. Lane entitled Structural geology, Aklavik Range, Richardson Mountains, and Barn Mountains, 2003 from the Devon Canada submission (2005) describes the regional context. The Aklavik Range where the Kamik Formation was examined is bounded to the west by a crustal scale, deep-seated right-lateral strike slip fault, the Donna River Fault. The area is likely a transpressional setting since most significant structures are contractional. There are also extensional faults which both predate and postdate contractional faults. The timing relationships are therefore complicated and as yet poorly constrained (Lane, 2005). Figure 2 shows the geology of the area, and highlights the outcrop locations.

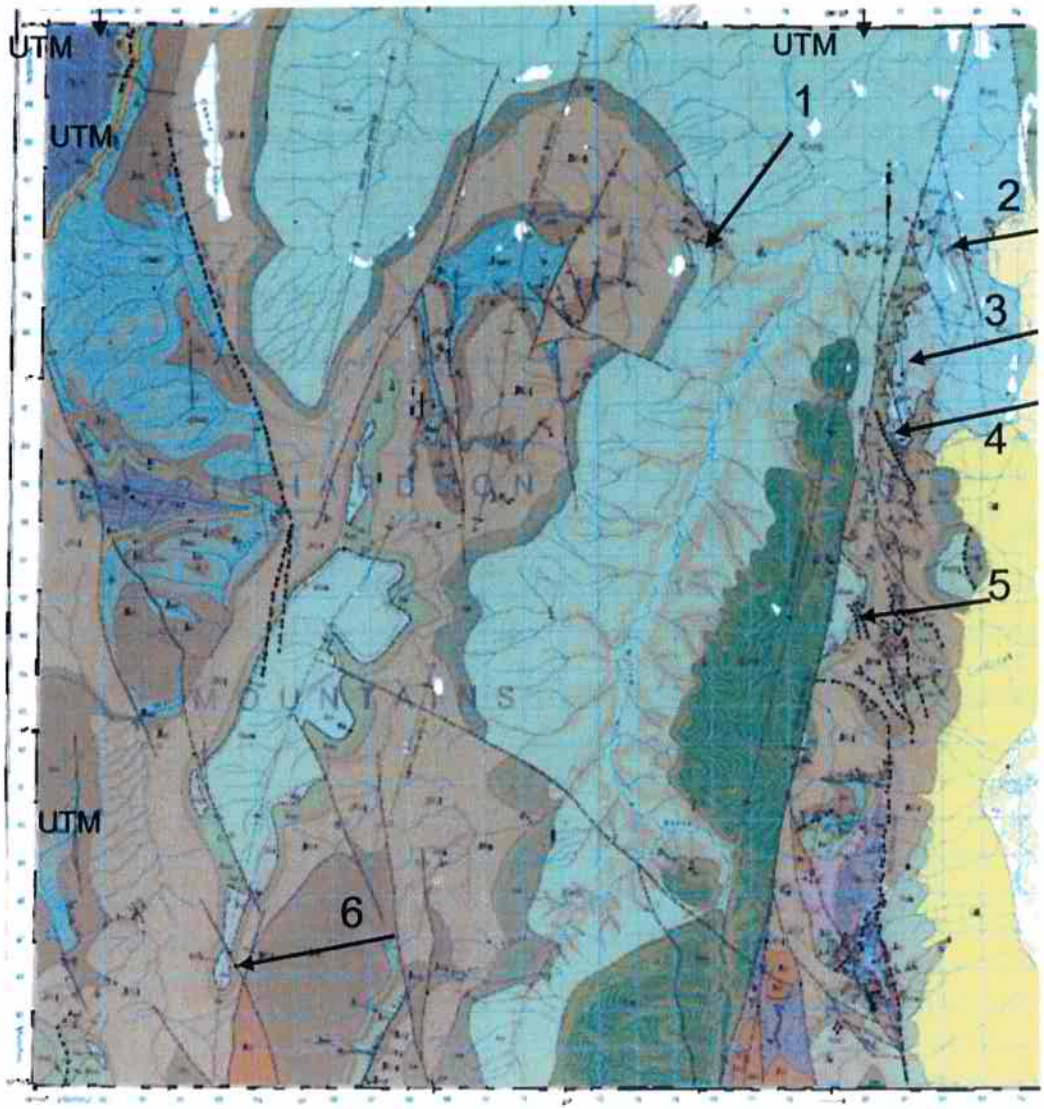

Figure 2 Modified from Lane (2005) Geological Survey of Canada Open File Map 4827. The Kamik Formation is mapped in the light blue, labeled KK, KKU, or KKL. The arrows refer to the outcrops examined. 1. Martin Creek 2. Grizzly Gorge (labeled Willow River on this map). 3. North flank of Mount Gifford 4. Mount Gifford 5. Husky Creek 6. Kamik Butte.

Figure 3. The lower white, swaley cross-stratified fine-grained sand interpreted as lower shoreface, marks the top of the McGuire Formation observed on Martin Creek. The black line follows the base of the Kamik Formation and marks a change to medium grained, trough cross-bedded amalgamated channel sands which disconformably overlie the McGuire. At this locality the lowest trough cross-bedded sands have some organic component which gives them a dark colour.

4. FIELD METHOD

The Kamik was looked at in detail for grain size, grain size variations, individual channel body dimensions, and the nature of contacts between channel bodies. Also of interest was the shale content, especially looking for lenses or interbeds of shale in the reservoir analogous sandstone layers.

5. OBSERVATIONS

5.1 HUSKY CREEK

The faulting in this area is complex as described in Report 3, Devon Canada submission (2005). This was deemed consistent with the larger scale context of its proximity to the strike-slip Donna River Fault system. For our purposes the stratigraphic section was exposed in one fault block (Figure 4). This was the most southerly and the most thin outcrop of the Kamik Formation examined. Only 3 m of coarse trough cross-bedded sandstone with common pebble lags (Figure 5) is preserved below the unconformity at the base of the Siku shale.

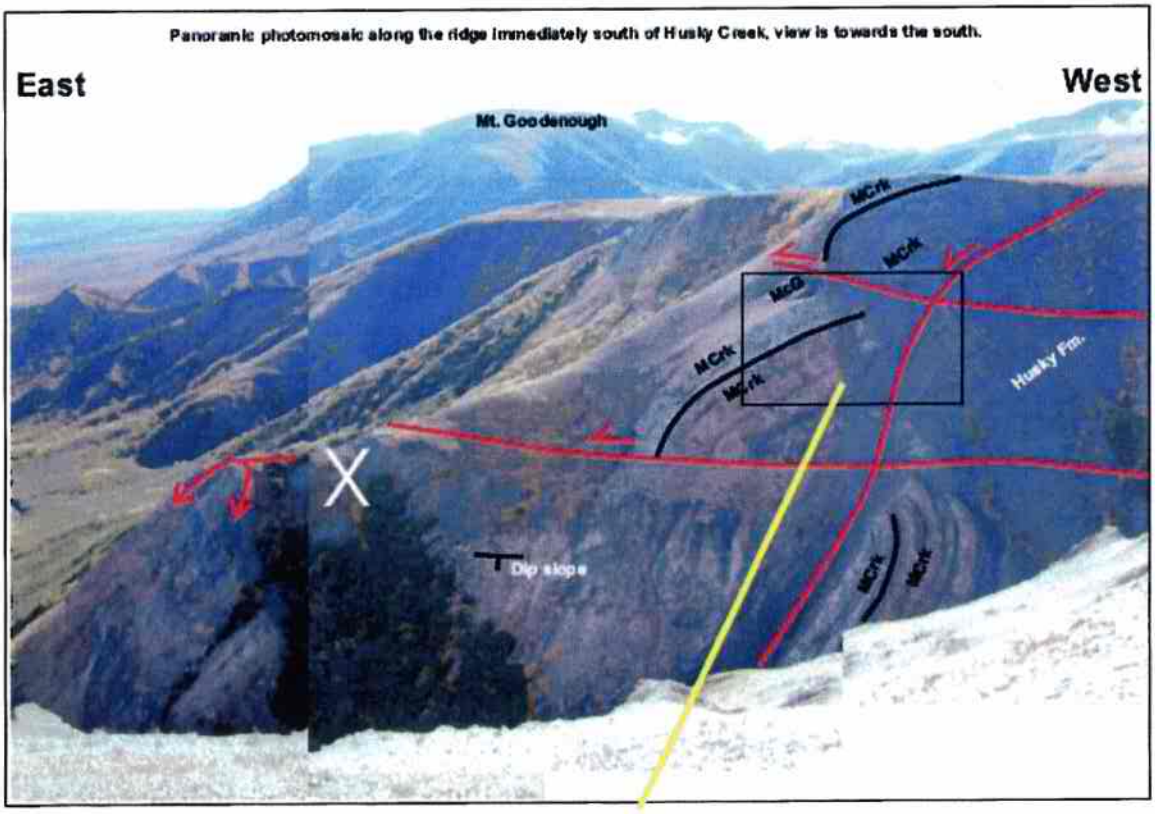

Figure 4 (Figure 2b from report 3, Devon Canada submission, 2005). The Kamik Formation at Husky Creek was measured in the boxed area where shales of the Mount Goodenough Formation are demonstrably present above the Kamik Formation. About 3 metres of Kamik sandstone (trough cross-bedded facies, Figure 5, is present at the top of the white sandstone labeled MCrk in the photograph.

Figure 5. Kamik sandstone and pebble conglomerate at Husky Creek. Photograph taken in boxed area shown in figure 4.

5.2 KAMIK BUTTE

This flat shoulder of a mountain on the east side of the upper reaches of Martin Creek was nicknamed Kamik Butte as the flat area is formed by the resistant 15 m thick basal Kamik sandstone. The location is east of Husky Creek. The Kamik Formation is medium to coarse sandstone with occasional very coarse laminae and basal lags. It is ubiquitously trough cross-bedded and no shale laminae were noted.

Figure 6. Trough cross-bedded medium to coarse sandstone with common very coarse to pebbly lags in the lower part of the channel. Photograph taken at "Kamik Butte".

Figure 7. Lower Kamik channel sand, "Kamik Butte". Individual channel sand bodies could be followed laterally for a minimum of 20-30 metres. The pogo stick is 1.5 metres long.

5.3 MOUNT GIFFORD

Only the basal Kamik is exposed in two fault blocks in the central part of Mount Gifford (Figure 7). It is a medium to coarse grained, trough cross-bedded amalgamated sandstone unit with a minimum 5 metre thickness. In the northern fault block (Figure 9) there is a minimum thickness of 50 metres of Kamik Formation. The outcrop consists of a series of exposed sandstone outcrops which are all typical medium to coarse, trough cross-bedded amalgamated sandstone units of 3-20 metres thickness. Between these sandstone units are covered intervals of indeterminate, but presumably finer grained sediments. This is consistent with log signatures from wells in the subsurface.

Based on report 3, Devon Canada submission (2005) the fault timing is not established. This allows the possibility that the thickness variation is due to original depositional or fault-controlled accommodation space. Coeval faulting and sedimentation is considered unlikely at Mount Gifford since the faults (Figure 7) exposed on the east side offset consistent thickness of Husky, Martin Creek and McGuire Formations making it unlikely that there were significant active faults here at the time of Kamik deposition.

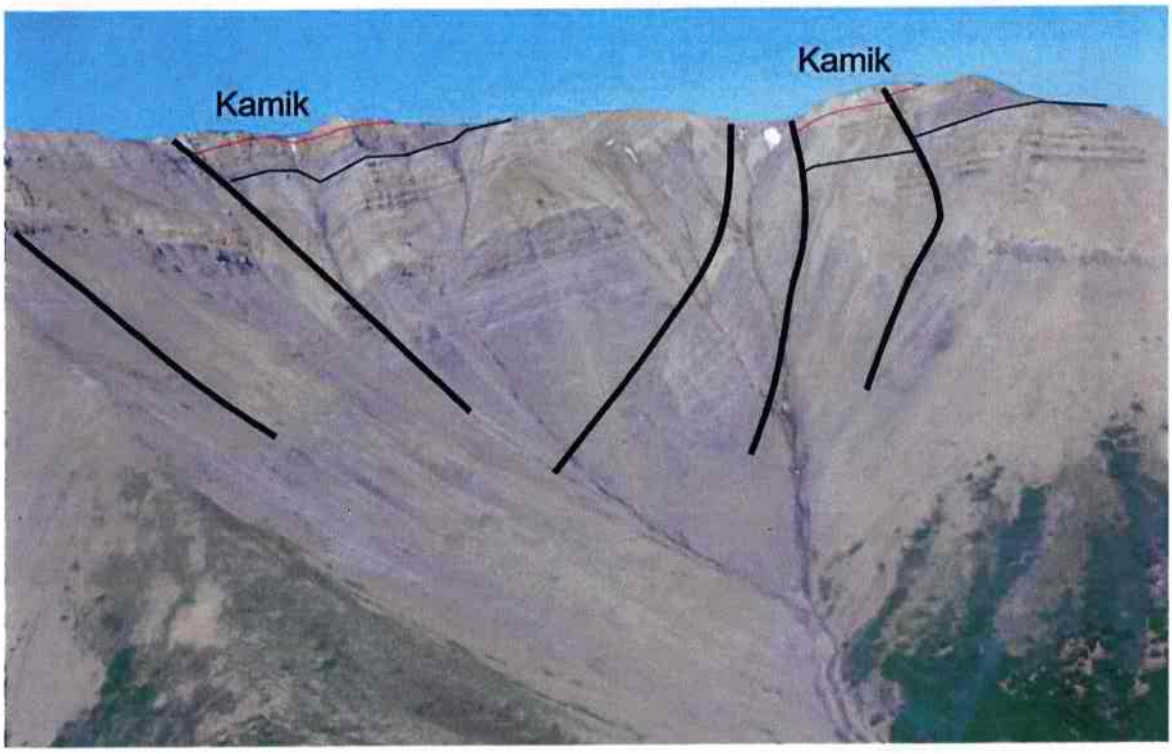

Figure 8. East side of Mount Gifford with fault traces outlined with bold lines, the base of the McGuire shale in thin black lines, and the base of the Kamik Formation in red lines. Given the proximity to the Donna River Fault and the presence of both apparent normal and reverse offsets, these faults are presumed to be strike-slip faults. One vertical outcrop face was observed with horizontal slickensides.

Figure 9. North fault block, Mount Gifford. Approximately 50 metres of Kamik Formation is exposed on the northeast slope of Mount Gifford comprised of thick amalgamated channel sandstones and covered intervals assumed to be finer grained deposits.

5.4 MARTIN CREEK

The base of the Kamik Formation at Martin Creek marks a change to medium grained, trough cross-bedded amalgamated channel sands which disconformably overlie the McGuire (Figures 3 and 10). At this locality the lowest trough cross-bedded sands have some organic component which gives them a dark colour. The basal sandstone is about 5 metres thick, while the entire Kamik Formation is 13 metres thick. As described in Figure 3, the Kamik disconformably overlies fine grained sandstone interpreted as part of the McGuire Formation. This unit is regionally present throughout the field area, consistently swaley cross-stratified and interpreted as deposited in a lower shoreface environment.

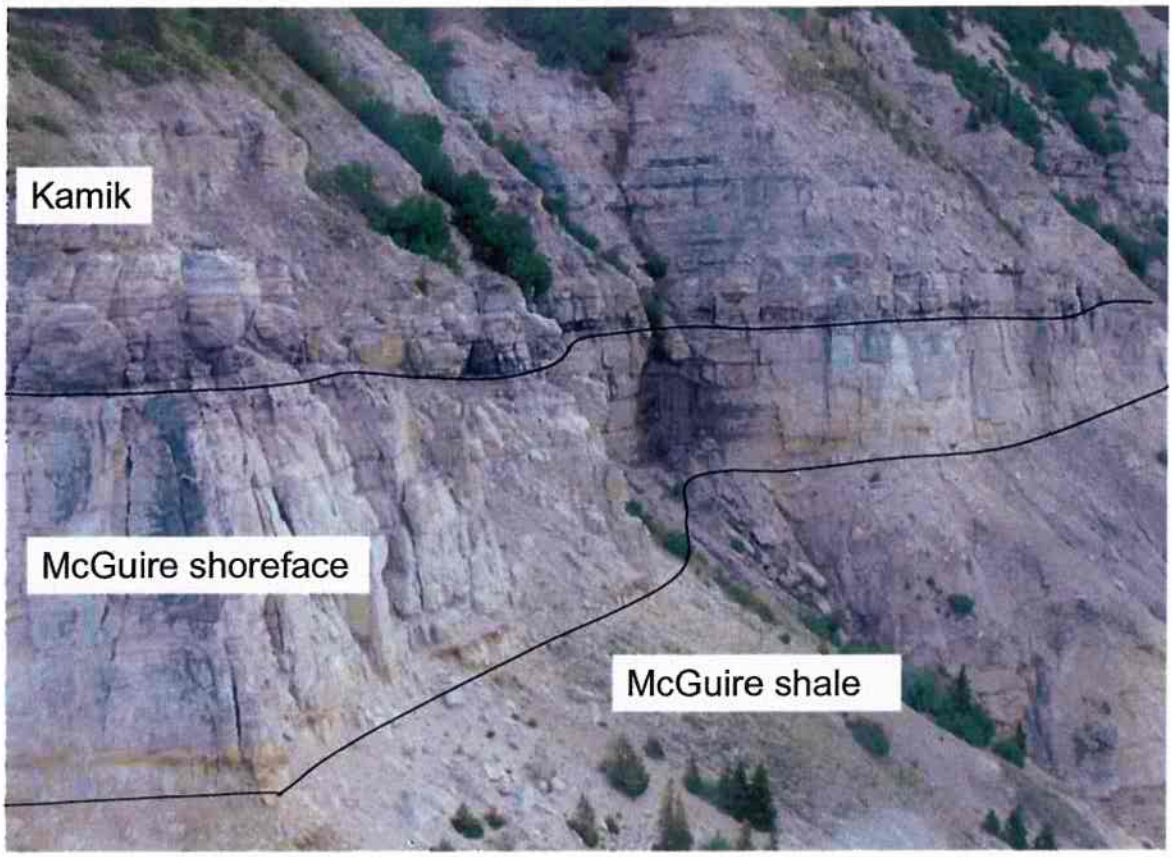

Figure 10. The Kamik and McGuire Formations on Martin Creek. A detailed view of the contact is shown in Figure 3.

5.5 GRIZZLY GORGE

At Grizzly Gorge there are almost 2 kilometres of continuous gently dipping outcrop along a canyon wall. An important observation was the systematic erosional beveling at the top of the Kamik Formation by an unconformity surface consistent with Dixon (1991).

The basal Kamik Formation was very consistent with the rest of the Aklavik Range Kamik sandstone observations. There was generally 4 metres of medium to coarse trough cross-bedded amalgamated channel. sandstone. The middle Kamik Formation was exposed in places as generally thin bedded deposits varying from mudstones to sandstones of cm to decimeter scale beds, with rare metre thick discontinuous channel sands. The thin sandstone beds had quite variable grain sizes ranging from fine to very coarse with no correlation to bed thickness. The sediments were bioturbated, similar to

observations in core. There is a rust-coloured weathering to the sandstone units in Grizzly Gorge (Figure 11).

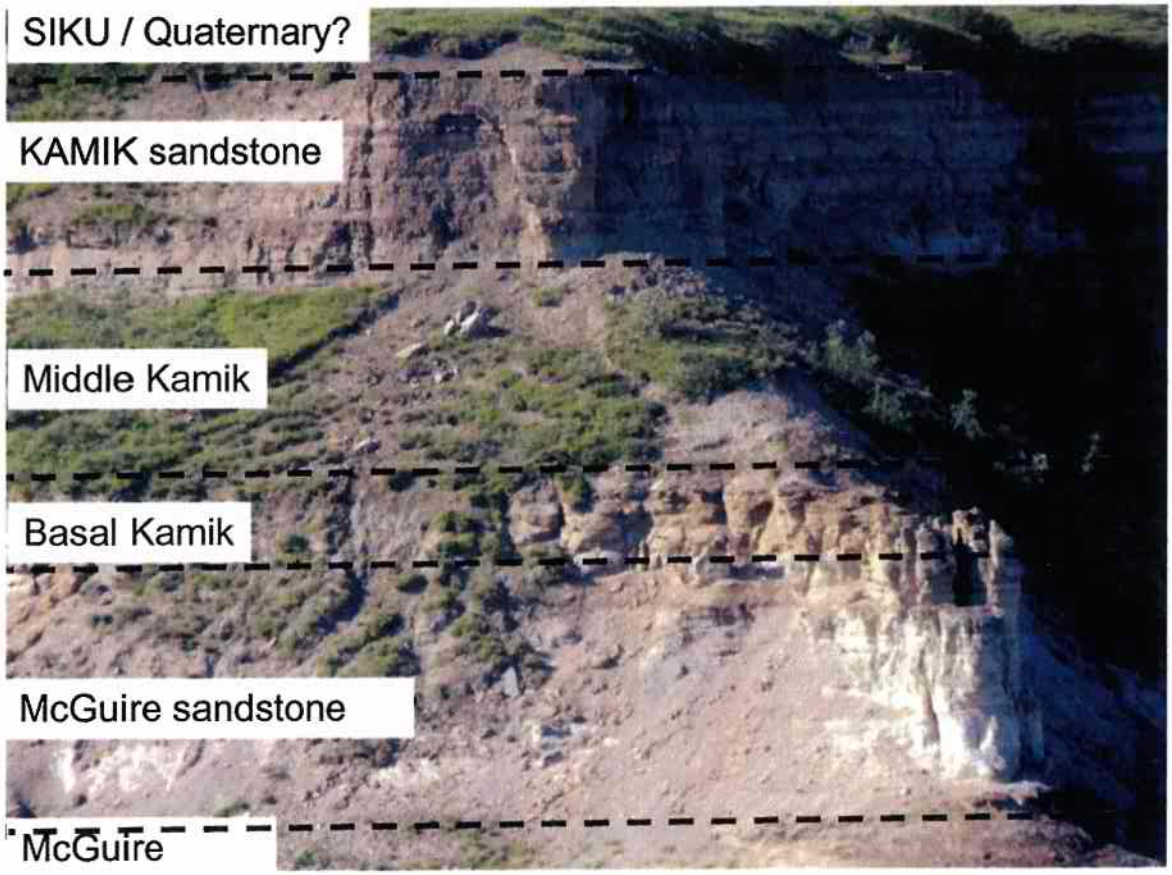

Figure 11. Stratigraphic overview of the canyon walls in Grizzly Gorge. The top contact was clearly an unconformity in parts of the canyon but some was obscured by present day erosion.

In the western parts of the canyon there is a 10 metre thick sandstone unit. It is a massively bedded fine to medium and medium grained sandstone with common to abundant large trace fossils of the Skolithos ichnofacies dominated by Diplocriterion and Skolithos. The trace fossils are highlighted by strong rust stain in the outcrop. This 10 m sandstone unit disappears to the eastern part of the canyon. The upper sandstone is inferred to have been erosionally removed during the Cretaceous before deposition of the Mount Goodenough Formation.

6. DISCUSSION & CONCLUSIONS

With regard to the reservoir sands, they were found to be consistent with core and log interpretation from the subsurface Tuk and Parson's Lake gas fields. The sandstone units of the Kamik Formation are amalgamated channel sands with negligible amounts of mud or shale. Core and outcrop grain sizes are comparable in the Kamik Formation; medium Upper to coarse Lower sand dominated with common lags and laminae of coarse Lower to granule or pebbles at the base of beds and trough cross-beds. The sandstone is trough and high-angle cross-bedded with occasional low angle cross-bedded and rippled units preserved at the top of these channel units. There is generally a basal 4 - 5 metre, up to 15 metre amalgamated channel sand present at the base of the Kamik. Within this unit in outcrop there were no shale or bioturbated muddy sands observed although there were some rip-up clasts present in some of the lower energy channels.

On the north flank of Mount Gifford there was a substantial thickness of Kamik Formation exposed. Similar to core and log based observations from the subsurface, the Kamik consists of a series of exposed sandstone outcrops which are all typical medium to coarse, trough cross-bedded amalgamated sandstone units of 3-20 metres thickness. Between these sandstone units are covered intervals of indeterminate, but presumably finer grained sediments.

7. REFERENCES

Devon Canada Corporation Final Report 2005, NEB Operations Identifier Numbers: 9337-D30-1E, 9337-D31.1E. Geological Fieldwork Results, North Richardson Mountains, Devon Canada Corporation, July 15-20, 2002 and September 2-10, 2003.

Dixon, J. 1991. The Neocomian Parsons Group, Northern Yukon and Adjacent Northwest Territories, Geological Survey of Canada Bulletin 406, 54 pp.

Lane, L. 2005. Geology, Aklavik Range (107B/04 and part of adjacent Beaverhouse Creek (107B/05), District of Mackenzie, Northwest Territories, Geological Survey of Canada Open File 4827, 1:50 000 scale map.

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