2018 YMEP # 18-038 FINAL REPORT

VICTORIA CREEK PLACER

FOR

Claims P509576 (Kristina 1) to P26233 (Peter 6)
Claims Owner: Michal Bidrman

Submitted By: Steve Harasimiuk

Whitehorse Mining District

NTS: 115I03P

Latitude N 62^0 05’ 16.9” Longitude 137^0 06’ 32.5”







TABLE OF CONTENTS

Section # 1 **INTRODUCTION – VICTORIA CREEK TARGET EVALUATION OBJECTIVE**

Section # 2 **WORK LOCATION ACCESS ROUTE**

Section # 3 **PROPERTY TENURE**

Section # 4 **HISTORICAL MINING EVIDENCE AT VICTORIA CREEK**

Section # 5 **PREVIOUS TESTING CAPABILITIES**

Section # 6 **2018 BUDGET**

Section # 7 **2018 VICTORIA CREEK TESTING PLAN**

Section # 8 **2016 GEOLOGIST SUMMARY REPORT – RECOMMENDATIONS FOR 2017/2018**

Section # 9 **GLOSSARY**

Section # 10 **APPENDIX**

SECTION # 1

INTRODUCTION

VICTORIA CREEK TARGET EVALUATION OBJECTIVE

Victoria Creek has several tributaries....each channel is locally referred to as Victoria Creek. The section that we tested was the upper right tributary, that collects water flow from several smaller creeks (Lexie, Eva, Ladybug), directly from the south drainage features of Victoria Mountain. This tributary feeds into the main Victoria Creek channel. The main channel originates from the east features if Victoria Mountain. Back Creek feeds into the main Victoria Creek channel downstream of our testing.

The work will be conducted within NTS mining claims map 115I03P. I hold an operating lease agreement for a block of 38 contiguous mining claims along upper Victoria Creek. The bottom claim number is P50199, the top claim is number P26237 (28 claims). There are also 10 claims along an upper right tributary named Eva Creek, claims number P12533 to P12542. A new class 4 water licence and Land Use Agreement for these claims was granted on May 18, 2018.

Reference: *Appendix Tab 11 & 24 – Claims Maps*
Appendix Tab 17 – Water Licence 17-085

The 1:80,000 claims map, included in this section, shows the location of Back Creek and the Victoria Creek channel where we conducted our tests. Both drainages have similar features. We wanted to confirm if the bedrock faults in Back Creek extend, north through to Victoria Creek. If the bedrock faults are similar to Back Creek, there may likely be similar gold accumulation in the deep (30m) gravel placers above the bedrock. Only testing will confirm that theory.

Previous reports, on the Mt Nansen Mining area, make reference to Victoria Creek as having the potential for deep placer gold. The area geology reports in subsequent sections in this proposal, make significant reference to Back Creek. Both Back Creek and Victoria Creek experienced the same glacial episodes and bedrock tectonics. During 2016 and 2017, testing at Victoria Creek was initiated through the support of YMEP funding through grant # 16-073 and # 17-060. This was the start of the confirmation that deep placers may be more extensively distributed in the area. Confirmation of deep placer gold would lead to increased placer mining development in the area.

The main objective of the 2018 testing program was to excavate and drill Victoria Creek in the three target areas and compare those lithography results with Back Creek. Back Creek has been

drilled and tested more extensively, which has resulted in successful commercial placer mining of its deep placer gravels. We need to continue with testing at Victoria Creek in 2019 to give us more insight to the mining potential as well as the bigger challenges to mining the resources.

WORK LOCATION ACCESS ROUTE

Victoria Creek is situated approximately 60 km west of the village of Carmacks along a government maintained secondary road. Carmacks is located north of Whitehorse via the paved Klondike Highway. The entire trip from Whitehorse to Victoria Creek takes approximately 4 hours by road. The Victoria Creek access is an additional 20 minutes by mining roads at the base of Mt. Victoria.

Reference: Appendix Tab 12 – Mt. Nansen Access Road

The first placer gold discovery in the Mount Nansen area was reportedly in 1899. Since that time, placer mining operations have been conducted on streams in the area, including Victoria Creek and some of its tributaries (Back and Eva creeks). The rich placer discoveries can be attributed to the hard rock potential of the area.

The abundance of hard rock mineralization both underlying and near Victoria Creek make it an excellent candidate for placer discovery.

REGIONAL TECTONICS, REGIONAL and PROPERTY GEOLOGY

The Victoria Creek property is located between the Tintina Fault, 120 km to the northeast, and the Denali-Shakwak Fault, 120 km to the southwest. Both faults are steeply dipping transcurrent structures that have seen hundreds of kilometres of dextral strike-slip offset. The property is located within the Yukon-Tanana Terrane (YTT) (Nelson and Colpron, 2007). The YTT is a metamorphosed continental arc that developed along the ancient Pacific margin of North America from Late Devonian to Permian.

In 1984, the Geological Survey of Canada published a geological map of the Carmacks area (NTS map sheet 115I) at 1:250,000 scale (Templeman-Kluit, 1984). Gordey and Makepeace (2003) later completed a Yukon-wide geological compilation, which updated the lithological unit names in the Victoria Creek area. Figure 2 illustrates geology as mapped by Templeman-Kluit and compiled by Gordey and Makepeace. The main lithological units are described in Table II.

Table II– Lithological units (*after Gordey and Makepeace, 2003*)

Map Suite	Age	Map Unit	Description
Prospector Mountain Suite	Late Cretaceous to Tertiary	LKdP	Coarsely crystalline gabbro and diorite.
Mount Nansen Formation	Middle Cretaceous	mKN	Massive aphyric or feldspar-phyric andesite to dacite flows, breccia and tuff; massive, heterolithic, quartz and feldspar-phyric, felsic lapilli tuff; flow-banded quartz-phyric rhyolite and quartz-feldspar porphyry plugs, dykes, sills and breccia.
Whitehorse Suite	Middle Cretaceous	mKyW	Hornblende syenite grading to granite or granodiorite.
Pelly Gneiss Suite	Devonian, Mississippian and older	DMgPW	Foliated medium grained, homogeneous biotite granite gneiss to biotite or hornblende granodiorite gneiss; massive to strongly foliated diorite to granodioritic gneiss; includes interfoliated amphibolite, quartz-mica schist and phyllite.

The northwest-trending Big Creek Fault lies approximately 10 km northeast of the property. This steeply dipping feature is poorly understood, but appears to have played an important role in localizing mineralization in the Mount Nansen Gold Camp and elsewhere in the district.

The Mount Nansen Mining Camp contains approximately 30 mineral occurrences of epithermal and porphyry origin and over 12 placer deposits. Vein hosted mineralization occurs throughout the camp and is generally found within northwest-trending structural zones. The Brown-McDade, Heustis and Webber veins are all examples of this type of mineralization. The Brown-McDade is a complex vein system that forms the contact between granodiorite to the north and schists and gneiss to the south. It contained pre-mining reserves and resources totally 600,000 tonnes at 6.1 g/t gold and 55 g/t silver, and between 1996 and 1997, it produced 16,000 oz

gold, 83,000 oz silver from 124,000 tonnes of ore. Both the Webber and Heustis veins are hosted in schists and gneiss. The Webber vein has an underground reserve of 85,000 tonnes at 9.4 g/t gold and 560 g/t silver, while the Heustis vein has an underground reserve of 123,800 tonnes at 14.1 g/t gold and 291 g/t silver (Hart and Langdon, 1997). Placer deposits are genetically related to these and other veins in the Mt. Nansen Gold Belt.

There are a number of other mineral deposits in the Dawson Range that are associated with intrusive activity, particularly late stage quartz-feldspar porphyry dykes. One example of this style of mineralization occurs at the Klaza property, which is located about five kilometres north of the Victoria Creek property.

At the Klaza property, soil geochemistry and excavator trenching lead to the discovery of a series of northwest (300º) trending gold-silver veins and breccia zones (Turner, 2011). Exploration programs in 2010 and 2011 comprised extensive excavator trenching, diamond drilling and helicopter-borne magnetic and radiometric surveys. Historical and recent work at the Klaza property has identified four mineralized zones (Klaza, BYG, BRX and HERC).

The Klaza Zone is the best explored of the zones. It has been cut in a number of excavator trenches and drill holes. Highlights from trenching include: 2.33 g/t gold and 34.9 g/t silver across 16.35 m (TR-10-09); 2.87 g/t gold and 42 g/t silver across 20.10 m (TR-10-10); and,

7.17 g/t gold and 16 g/t silver across 7.11 m (TR-11-26). Diamond drilling also intersected significant mineralization including: 2.29 g/t gold and 36 g/t silver over 19.75 m (DDH-10-03); 7.20 g/t gold and 260 g/t silver over 15.30 m (DDH-10-07); 1.04 g/t gold and 15 g/t silver over 33.30 m (DDH-10-10); 1.76 g/t gold and 26 g/t silver over 26.21 m (DDH-11-27); and 5.03 g/t gold and 14 g/t silver over 12.51 m (DDH-11-56).

Historical work on the Victoria Creek property suggests that gold occurs in three zones that range from four to thirty metres wide. These zones reportedly strike about 300° and dip between 60 and 65° to the west. This orientation is consistent with mineralization on the Klaza property and elsewhere in the Mount Nansen Mining Camp.

According to old reports, the core from these holes was logged by a number of different geologists, which may explain some inconsistencies where closely spaced holes are shown with different lithologies. Historical drill programs reported poor core recovery and assaying was only done for gold and silver. Based on the historical drill data it appears that mineralization is associated with both quartz-feldspar porphyry dykes and clay-rich alteration zones.

REFERENCES

Nelson, J.L. and Colpron, M.

2007 Tectonics and metallogeny of the Canadian and Alaskan Cordillera, 1.8 Ga to present; *in* Mineral Deposits of Canada: A Synthesis of Major Deposit Types, District Metallogeny, the Evolution of Geological Provinces, and Exploration Methods; W.D. Goodfellow (ed.), Mineral Deposit Division, Geological Association of Canada, Special Publication 5, p. 755-791. Available at: http://gsc.nrcan.gc.ca/mindep/synth_prov/cord/pdf/nelson_colpron_cordilleran_metallogeny.pdf

GEOGRAPHY OF THE MT. NANSEN/VICTORIA AREA

Mount Nansen and Victoria were formed when the ancient Kula Plate was subducting under North America during the Late Cretaceous period. This occurred approximately 80 Ma (1 Ma = 1 million years).

This upheaval brought heavy minerals to the earth's surface through fissures and veins. There have been many surface lode deposits discovered at Mt. Nansen including; Brown- McDade, Huestis, Webber and Flex some of which have been commercially mined.

Glacial events have been described in central Yukon including the Nansen, Klaza, Reid, and McConnell advances. Reid and McConnell glaciations subjected Mt. Nansen area to deposits and climatic influences of the ice sheets.

Prior to the onset of periodic Pleistocene glaciations, a long period of humid tropical weathering occurred in the Tertiary period. This left a thick mantle of highly weathered and eroded bedrock. The first and minimum of two pre-Reid ice advances had occurred at least 1 MA. This ice advance left ice scours on Mount Nansen and Victoria at an elevation of about 1372m (4500 ft) ASL. Mt Nansen elevation is 1827 m (5994 ft) ASL.

After de-glaciation and a lengthy ice free period, there was extensive weathering and a second pre-Reid glaciation occurred. As the Cordilleran ice sheet advanced from the south and merged with the pre-Reid glacier it deposited more glacial and glaciofluvial deposits.

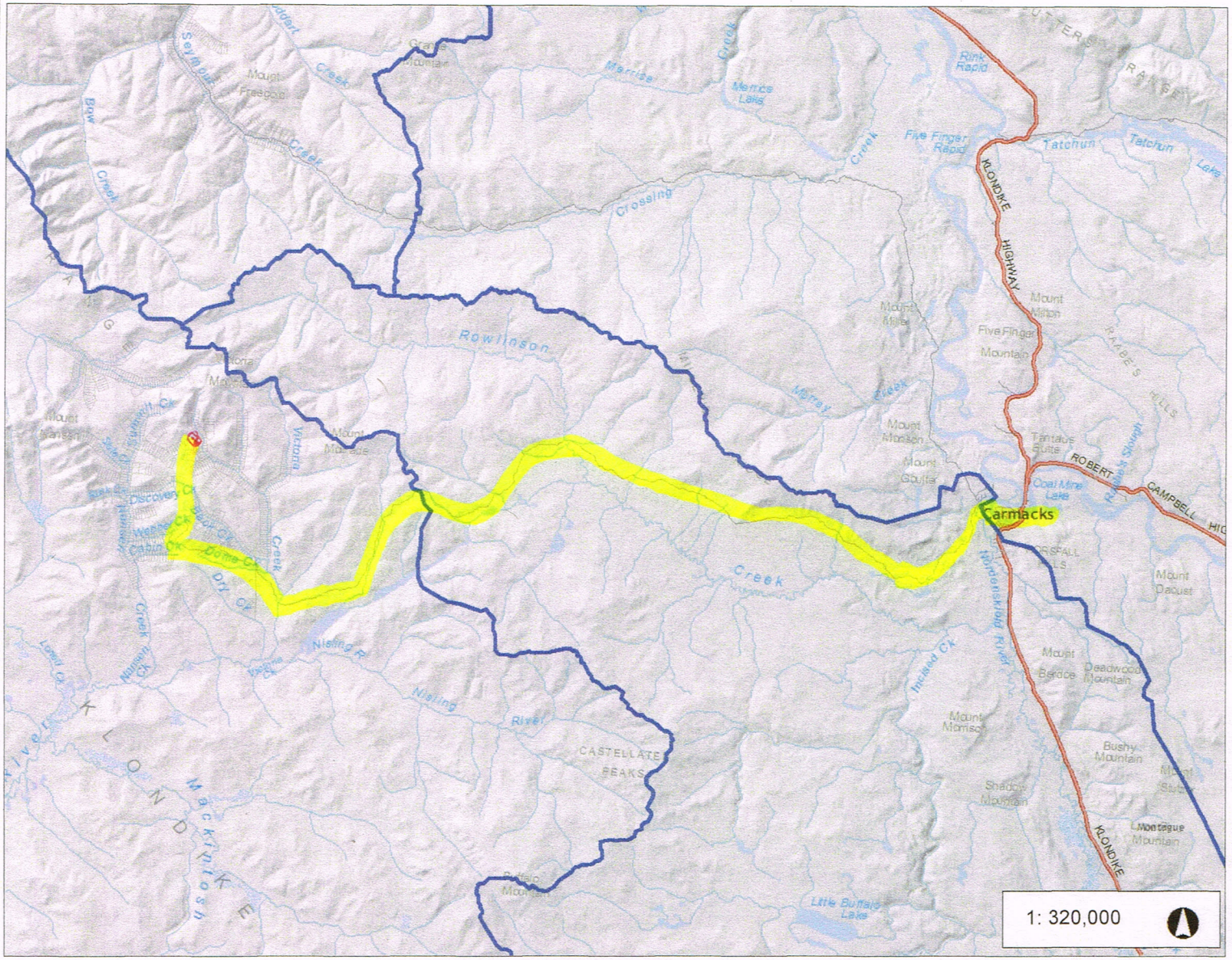
Nansen and Victoria Creek lay outside the limits of the late Wisconsin MacConnell and early Wisconsin region glaciations. They were however subjected to the deposits and water flow changes by these glacial episodes.

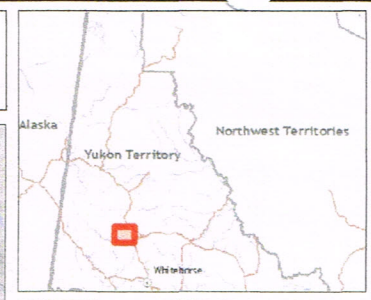
Reference: *Appendix Tab 13 – 1995 Yukon Placer Geology Report pg 6-7, 72-76, 96-99*
Appendix Tab 14 – Sedimentology of Placer Gravels Near Mt Nansen, LeBarge

YUKON PLACER SECRETARIAT

Mt. Nansen Access Road

Yukon
Energy, Mines and Resources





Legend

- Placer Watershed Boundaries
- Placer Claims (50K)
  - Active and Pending
  - Expired

1: 320,000

16.3 0 8.13 16.3 Kilometers

NAD_1983_Yukon_Albers
Produced from: Yukon Placer Watershed Atlas Date Printed: 06-Jan-2013

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION. The habitat suitability classifications presented here only apply to licenced placer mining operations, and ARE NOT RELEVANT TO ANY OTHER ACTIVITY in or near watercourses.

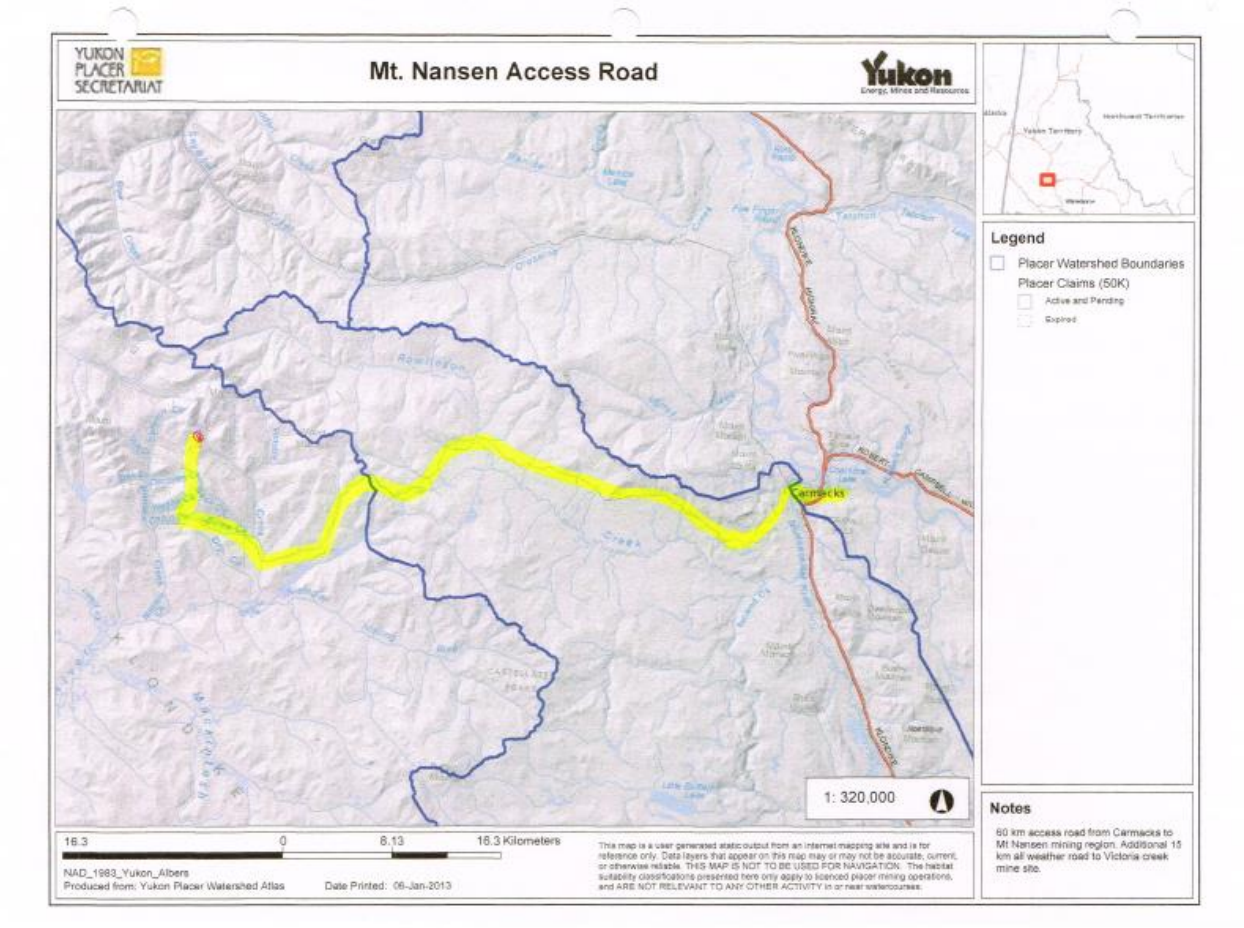
Notes

60 km access road from Carmacks to Mt Nansen mining region. Additional 15 km all weather road to Victoria creek mine site.

SECTION # 2

WORK LOCATION ACCESS ROUTE

Victoria Creek is situated approximately 50 km west of the village of Carmacks along a government maintained secondary road called Mt Nansen Road. Carmacks is located north of Whitehorse via the paved Klondike Highway. The entire trip from Whitehorse to Victoria Creek takes approximately 4 hours by road. Mt McDade is located up the Victoria Creek valley which is only accessible by an all terrain vehicle.



SECTION # 3

Claims Tenure

The testing work was conducted within NTS mining claims map 115I03P.

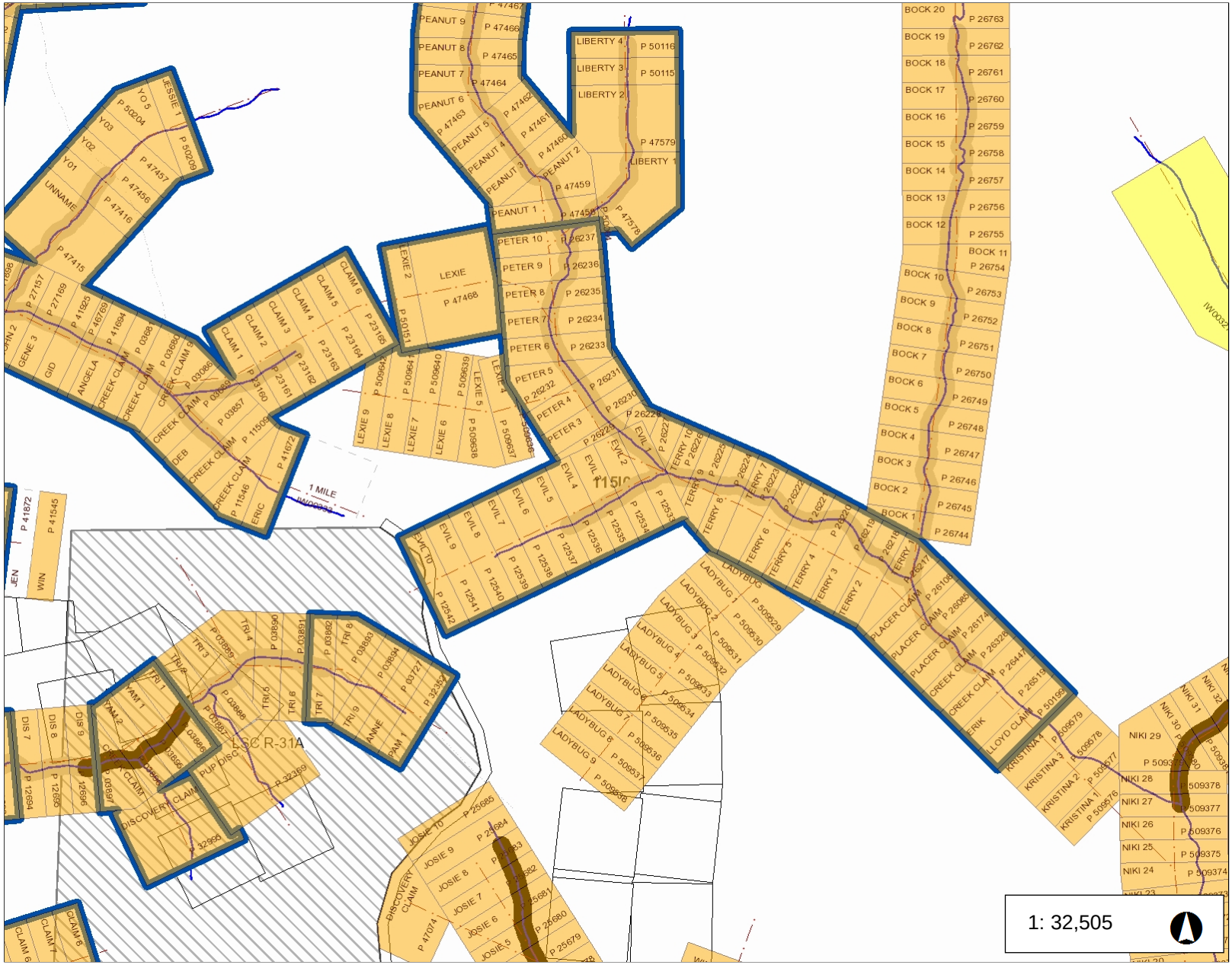
The claims are shown on the attached claims map, included in this section. The bottom claim number is P509576 (Kristina 1), the top claim is number P26237 (Peter 10). There are also 10 claims along an upper right tributary named Eva Creek, claims number P12533 (Evil 1) to P12542 (Evil 10). The contiguous block of claims are registered to Michal Bidrman.

The class 4 water licence # PM17-085, for the 38 claims and mine land use operating plan has been renewed by Steve Harasimiuk.

There is an operating lease agreement for this block of contiguous mining claims between Michal Bidrman and Steve Harasimiuk, ensuring full access to these claims to perform testing. Michal also participated in the testing work this season.

Victoria Creek claim map

Yukon
Energy, Mines and Resources


PEANUT 9
PEANUT 8
PEANUT 7
PEANUT 6
PEANUT 5
PEANUT 4
PEANUT 3
PEANUT 2
PEANUT 1
LIBERTY 4
LIBERTY 3
LIBERTY 2
LIBERTY 1
LEXIE
LEXIE 2
PETER 10
PETER 9
PETER 8
PETER 7
PETER 6
PETER 5
PETER 4
PETER 3
BOCK 20
BOCK 19
BOCK 18
BOCK 17
BOCK 16
BOCK 15
BOCK 14
BOCK 13
BOCK 12
BOCK 11
BOCK 10
BOCK 9
BOCK 8
BOCK 7
BOCK 6
BOCK 5
BOCK 4
BOCK 3
BOCK 2
BOCK 1
EVIL 10
EVIL 9
EVIL 8
EVIL 7
EVIL 6
EVIL 5
EVIL 4
EVIL 3
EVIL 2
EVIL 1
TERRY 10
TERRY 9
TERRY 8
TERRY 7
TERRY 6
TERRY 5
TERRY 4
TERRY 3
TERRY 2
PLACER CLAIM
CREEK CLAIM
LLOYD CLAIM
ERIK
KRISTINA 4
KRISTINA 3
KRISTINA 2
KRISTINA 1
LADYBUG 10
LADYBUG 9
LADYBUG 8
LADYBUG 7
LADYBUG 6
LADYBUG 5
LADYBUG 4
LADYBUG 3
LADYBUG 2
LADYBUG 1
JOSIE 10
JOSIE 9
JOSIE 8
JOSIE 7
JOSIE 6
JOSIE 5
DISCOVERY CLAIM
NIKI 32
NIKI 31
NIKI 30
NIKI 29
NIKI 28
NIKI 27
NIKI 26
NIKI 25
NIKI 24
LSC R-31A
1 MILE
1150
P 47578
P 47579
P 47468
P 47457
P 47456
P 47416
P 47415
P 47466
P 47465
P 47464
P 47463
P 47462
P 47461
P 47460
P 47459
P 47458
P 50116
P 50115
P 50151
P 50204
P 50209
P 41872
P 41545
P 32357
P 32369
P 32995
P 12684
P 12695
P 12696
P 25685
P 25684
P 25683
P 25682
P 25681
P 25680
P 25679
P 47074
P 26763
P 26762
P 26761
P 26760
P 26759
P 26758
P 26757
P 26756
P 26755
P 26754
P 26753
P 26752
P 26751
P 26750
P 26749
P 26748
P 26747
P 26746
P 26745
P 26744
P 12540
P 12541
P 12542
P 12538
P 12539
P 12536
P 12537
P 12534
P 12535
P 26226
P 26227
P 26228
P 26229
P 26230
P 26231
P 26232
P 26233
P 26234
P 26235
P 26236
P 26237
P 509640
P 509639
P 509638
P 509637
P 509636
P 509964
P 509963
P 509962
P 509961
P 509960
P 509959
P 509958
P 509957
P 509956
P 509955
P 509954
P 509953
P 509952
P 509951
P 509950
P 509949
P 509948
P 509947
P 509946
P 509945
P 509944
P 509943
P 509942
P 509941
P 509940
P 509939
P 509938
P 509937
P 509936
P 509935
P 509934
P 509933
P 509932
P 509931
P 509930
P 509929
P 509679
P 509678
P 509677
P 509576
P 509375
P 509374
P 509373
P 509372
P 509371
P 509370
P 509369
P 509368
P 509367
P 509366
P 509365
P 509364
P 509363
P 509362
P 509361
P 509360
P 509359
P 509358
P 509357
P 509356
P

SECTION # 4

HISTORICAL INFORMATION

The first placer gold discovery in the Mount Nansen area was reportedly in 1899. Since that time, placer mining operations have been conducted on streams in the area, including Victoria Creek and some of its tributaries (Back and Eva creeks). The rich placer discoveries can be attributed to the hard rock potential of the area.

The abundance of hard rock mineralization both underlying and near Victoria Creek make it an excellent candidate for placer discovery.

REGIONAL TECTONICS, REGIONAL and PROPERTY GEOLOGY

The Victoria Creek property is located between the Tintina Fault, 120 km to the northeast, and the Denali-Shakwak Fault, 120 km to the southwest. Both faults are steeply dipping transcurrent structures that have seen hundreds of kilometres of dextral strike-slip offset. The property is located within the Yukon-Tanana Terrane (YTT) (Nelson and Colpron, 2007). The YTT is a metamorphosed continental arc that developed along the ancient Pacific margin of North America from Late Devonian to Permian.

In 1984, the Geological Survey of Canada published a geological map of the Carmacks area (NTS map sheet 115I) at 1:250,000 scale (Templeman-Kluit, 1984). Gordey and Makepeace (2003) later completed a Yukon-wide geological compilation, which updated the lithological unit names in the Victoria Creek area. Figure 2 illustrates geology as mapped by Templeman-Kluit and compiled by Gordey and Makepeace. The main lithological units are described in Table II.

Table II– Lithological units (*after Gordey and Makepeace, 2003*)

Map Suite	Age	Map Unit	Description
Prospector Mountain Suite	Late Cretaceous to Tertiary	LKdP	Coarsely crystalline gabbro and diorite.
Mount Nansen Formation	Middle Cretaceous	mKN	Massive aphyric or feldspar-phyric andesite to dacite flows, breccia and tuff; massive, heterolithic, quartz and feldspar-phyric, felsic

			lapilli tuff; flow-banded quartz-phyric rhyolite and quartz-feldspar porphyry plugs, dykes, sills and breccia.
Whitehorse Suite	Middle Cretaceous	mKyW	Hornblende syenite grading to granite or granodiorite.
Pelly Gneiss Suite	Devonian, Mississippian and older	DMgPW	Foliated medium grained, homogeneous biotite granite gneiss to biotite or hornblende granodiorite gneiss; massive to strongly foliated diorite to granodioritic gneiss; includes interfoliated amphibolite, quartz-mica schist and phyllite.

The northwest-trending Big Creek Fault lies approximately 10 km northeast of the property. This steeply dipping feature is poorly understood, but appears to have played an important role in localizing mineralization in the Mount Nansen Gold Camp and elsewhere in the district.

The Mount Nansen Mining Camp contains approximately 30 mineral occurrences of epithermal and porphyry origin and over 12 placer deposits. Vein hosted mineralization occurs throughout the camp and is generally found within northwest-trending structural zones. The Brown-McDade, Heustis and Webber veins are all examples of this type of mineralization. The Brown-McDade is a complex vein system that forms the contact between granodiorite to the north and schists and gneiss to the south. It contained pre-mining reserves and resources totally 600,000 tonnes at 6.1 g/t gold and 55 g/t silver, and between 1996 and 1997, it produced 16,000 oz gold, 83,000 oz silver from 124,000 tonnes of ore. Both the Webber and Heustis veins are hosted in schists and gneiss. The Webber vein has an underground reserve of 85,000 tonnes at 9.4 g/t gold and 560 g/t silver, while the Heustis vein has an underground reserve of 123,800 tonnes at 14.1 g/t gold and 291 g/t silver (Hart and Langdon, 1997). Placer deposits are genetically related to these and other veins in the Mt. Nansen Gold Belt.

There are a number of other mineral deposits in the Dawson Range that are associated with intrusive activity, particularly late stage quartz-feldspar porphyry dykes. One example of this style of mineralization occurs at the Klaza property, which is located about five kilometres north of the Victoria Creek property.

At the Klaza property, soil geochemistry and excavator trenching lead to the discovery of a series of northwest (300º) trending gold-silver veins and breccia zones (Turner, 2011). Exploration programs in 2010 and 2011 comprised extensive excavator trenching, diamond

drilling and helicopter-borne magnetic and radiometric surveys. Historical and recent work at the Klaza property has identified four mineralized zones (Klaza, BYG, BRX and HERC).

The Klaza Zone is the best explored of the zones. It has been cut in a number of excavator trenches and drill holes. Highlights from trenching include: 2.33 g/t gold and 34.9 g/t silver across 16.35 m (TR-10-09); 2.87 g/t gold and 42 g/t silver across 20.10 m (TR-10-10); and,

7.17 g/t gold and 16 g/t silver across 7.11 m (TR-11-26). Diamond drilling also intersected significant mineralization including: 2.29 g/t gold and 36 g/t silver over 19.75 m (DDH-10-03); 7.20 g/t gold and 260 g/t silver over 15.30 m (DDH-10-07); 1.04 g/t gold and 15 g/t silver over 33.30 m (DDH-10-10); 1.76 g/t gold and 26 g/t silver over 26.21 m (DDH-11-27); and 5.03 g/t gold and 14 g/t silver over 12.51 m (DDH-11-56).

Historical work on the Victoria Creek property suggests that gold occurs in three zones that range from four to thirty metres wide. These zones reportedly strike about 300° and dip between 60 and 65° to the west. This orientation is consistent with mineralization on the Klaza property and elsewhere in the Mount Nansen Mining Camp.

According to old reports, the core from these holes was logged by a number of different geologists, which may explain some inconsistencies where closely spaced holes are shown with different lithologies. Historical drill programs reported poor core recovery and assaying was only done for gold and silver. Based on the historical drill data it appears that mineralization is associated with both quartz-feldspar porphyry dykes and clay-rich alteration zones.

Reference: Appendix Tab 15 – Mt. Nansen Property Mineral Report

GEOGRAPHY OF THE MT. NANSEN/VICTORIA AREA

Mount Nansen and Victoria were formed when the ancient Kula Plate was subducting under North America during the Late Cretaceous period. This occurred approximately 80 Ma (1 Ma = 1 million years).

This upheaval brought heavy minerals to the earth's surface through fissures and veins. There have been many surface lode deposits discovered at Mt. Nansen including; Brown- McDade, Huestis, Webber and Flex some of which have been commercially mined.

Glacial events have been described in central Yukon including the Nansen, Klaza, Reid, and McConnell advances. Reid and McConnell glaciations subjected Mt. Nansen area to deposits and climatic influences of the ice sheets.

Prior to the onset of periodic Pleistocene glaciations, a long period of humid tropical weathering occurred in the Tertiary period. This left a thick mantle of highly weathered and eroded bedrock. The first and minimum of two pre-Reid ice advances had occurred at least 1 MA. This ice advance left ice scours on Mount Nansen and Victoria at an elevation of about 1372m (4500 ft) ASL. Mt Nansen elevation is 1827 m (5994 ft) ASL.

After de-glaciation and a lengthy ice free period, there was extensive weathering and a second pre-Reid glaciation occurred. As the Cordilleran ice sheet advanced from the south and merged with the pre-Reid glacier it deposited more glacial and glaciofluvial deposits.

Nansen and Victoria Creek lay outside the limits of the late Wisconsin MacConnell and early Wisconsin region glaciations. They were however subjected to the deposits and water flow changes by these glacial episodes.

Reference: *Appendix Tab 13 – Mt. Nansen Area Placer Reports*
Appendix Tab 21 – Deep Placers of Mt. Nansen, Bond
Appendix Tab 28 – Early Pleistocene Glaciation in Mt. Nansen Area, Bond

MT. NANSEN AREA MINING HISTORY

Gold was first discovered in placer deposits in the Mt. Nansen area in 1899. Mr. Henry S. Back with Mr. H. Klein had found “good panning” on Nansen Creek. The first claim that was staked in the area was Discovery claim on Nansen Creek, which was staked on June 13, 1910. Mining began to take place in the area shortly thereafter and nearly all creeks in the area were at one time staked from end to end, although many were allowed to lapse.

During 1913 to 1914 two miners Mr. Miller and Mr. Shaw worked the South Fork of Nansen Creek near its mouth during the winter recovering 80 ounces of gold. They reportedly hoisted gravel through a vertical shaft a distance of 20 feet to bedrock and recovered approximately 4500 buckets of gravel (8pan/bucket), which would grade out at 0.29 oz/yd.

Nansen, Discovery, East Fork, South Fork, Weber, and Back Creek all recorded similar occurrences. In 1910 -14 the estimated total gold recovered was estimated at 310 to 440 raw ounces. The largest nugget recovered on Discovery Creek was reported to be one ounce. Additional government mining records noted that mining continued in the Nansen Creek district from 1934 to 1937 with some exceptionally good gold recoveries reported on Nansen and Victoria creeks in 1936. From 1914 to 1978 individual creek production records were not documented at the mine recorder's office.

MINING EVIDENCE AT VICTORIA CREEK

There were no government documented mining shafts in the claims at Victoria Creek. We did find evidence of early hand mining by locating a decayed wooden rocker box and a tin lined wooden sluice run. Through our own previous excavation efforts, we found that groundwater occurred within a permeable layer above the glacial till, approximately 10 - 30 feet below surface. This water table may have discouraged shaft mining Victoria Creek.

From documents that we were able to find in the government library, the miner that operated at Victoria Creek the longest was John Trout. John mined the claims until 2005. Then, Lloyd Wade took over the claims in 2006 and worked them intermittently until 2010. Upon reviewing the areas that all of the previous miners had worked (approximately 18 upper claims) they worked the shallow areas directly beneath the location of the present day creek. Our geophysical testing did show that Lloyd Wade may have discovered that the historical channel was 40m to the left of the present day channel. Lloyd did not reach bedrock but did leave a large unfinished excavation “cut,” along the left valley slope.

Reference: Appendix Tab 16 – Victoria Creek Placer Mining Reports

Section # 5

PREVIOUS TESTING CAPABILITIES

CAPABILITY/EXPERIENCE

I have prospected in the Mount Nansen area for 9 years (2010 - 2018) and mined/tested Victoria Creek for 7 years (2012 – 2018). A new 10 year water licence # PM17-085 for the 38 claims and mine land use operating plan had been approved on May 18, 2018 and is registered in my company name (Mammoth Mining Inc). In 2016, I obtained YMEP funding and initiated the most detailed testing and reporting on Victoria creek to-date. The testing team consisted of a geologist, driller, prospectors and miners. In 2017, our team implemented drilling strategies that yielded deeper auger drilling. The results were very encouraging. For 2018 season, we intend on mapping the deep placer layers and bedrock channels.

In the 2017 season, I had enlisted the support of Yukon prospector, Bernie Kreft. Bernie had agreed to provide his expertise to review our 2017 testing program and critique our progress, as required. Bernie was extremely busy in 2018, so we were not able to coordinate our schedules again.

Reference: Appendix Tab 17, Water Use Permit # PM17-085.

I have maintained a good working relationship with all government offices especially with the mining inspectors. All my inspection reports have been positive and I am in full compliance with my responsibilities regarding legislation, regulations, codes and practices. There were some minor observations that were identified and corrected immediately. I have included copies of my past mining inspection reports with this proposal.

Reference: Appendix Tab 18, Yukon Placer Mining Inspection Reports, 2012-2014, 4 pages

Personally, I have 40 years experience in oilfield, pipeline, power generation & distribution, mining, pulp & paper, and environmental restoration projects. I am a Registered Engineering Technologist with the Alberta Society of Engineering Technologists. As such, I follow the societies' strict code of conduct behavior policies. They include legal and ethical rules to follow. I have been a member in good standing for 37 years. I have successfully managed projects in NWT, BC, AB, and SK up to the $2B range.

I have been a self-employed contractor for 33 years and presently operate a gravel exploration company in Alberta. As such, the work is in full compliance with all aspects of government. I also provide consulting and project management services to several multi-national companies.

TECHNICAL SUPPORT

I was unable to hire geologist Levi Kalinski, during this summer exploration season, due to his busy work situation.

EQUIPMENT RESOURCES

Since 2011, I have mobilized a sufficient quantity of equipment into Victoria Creek and will be able to self-perform most of the testing activities.

The following equipment is available at Victoria Creek camp.

Camp - c/w trailers, bunkhouses, generators, power distribution, buried sewage facilities capable of housing 12 workers

6 sea-cans – c/w tools, spare parts, consumable items, electrical, dry storage, tarps, tents, etc

2 - storage trailers – c/w environmental spill and clean-up material, emergency response items

1 -“clean-up” shack – c/w sampling pails & bags, screening, classifying, crushing, gold clean-up, concentrating, melting, and weighing equipment

4 – ATVs c/w Argo, side-by-side, quads, tub trailers

1 – tracked drilling rig: Bombardier Muskeg auger rig (4” to 8” flights)

2 – excavators: Hitachi 400, Komatsu 400

1 – dozer: Cat D8G

3 – portable testing washplant c/w pump: 1 - reverse helix trommel, 1 – highbanker

1- UHF concentrating table

1– sieve screen sample shaker

3 – generators: 10 kw/hr, 7.5 kw/hr, 3.0kw

Misc support equipment: 4x4 truck, water pumps, hoses, fuel storage, spill clean-up kits

For the 2018 testing program, I self-transported a tracked drill rig capable of ODEX drilling (downhole hammer). During the 2017 winter, the hydraulic systems on the rig were rebuilt or replaced to control unnecessary leaks. The drilling penetration speed was remarkable.

We also brought up a larger test trommel to be used for ongoing annual testing. Photos of the new equipment are included in the photos section of the report.

2018 YMEP Target Evaluation – Victoria Creek

Field Worker Skills and Qualifications

The following people participated in the Victoria Creek Target Evaluation field work. Their specific and broad talents made the testing program a successful endeavor.

Steve Harasimiuk, prospector, miner and self-employed contractor. Steve is a Registered Engineering Technologist with over 40 years experience in industrial projects, such as; civil, mechanical, and environmental restoration. Steve owns and operates the equipment used for this testing program.

Michal Bidrman, is a seasoned mining expert and owner of the Victoria Creek Claims. Michal has mined in the Yukon for over 25 years. He has years of university training in Geology. He presently operates a consulting service to evaluate mines and equipment for clients. Mike enjoys putting his experience to use in the field by operating equipment, to advise on exploration results, and a develop a forward strategy plan.

Daniel Harrison, has been employed as a seasonal miner/prospector for 7 years. Dan can proficiently operate either 40t excavator and has the patience to scratch through the permafrost and rocks for hours. Daniel's attention to detail made him our logical choice to document and record our field data.

Laurie Harasimiuk, is a Yukon prospector that holds a prospecting lease and staked claims on other properties in the region. Laurie took her annual vacation from her job as a supervisor with the Government of Alberta, to oversee the 2018 Victoria Creek testing activity. Her ability to organize, co-ordinate, and document the testing activities was invaluable to ensure that field workers focussed on drilling and digging.

Spencer Coletti, is a young hard worker that has completed his formal heavy equipment operator training in Prince George, BC. Spencer has been operating various excavators for over a year now and has demonstrated his good skill and good work ethic at Victoria Creek. Spencer was running the excavator, as required, otherwise he was a "hands on" assistant in all aspects of this year's work plan.

In summary, these are the individuals involved in the field work activities for the 2018 Victoria Creek Target Evaluation project. All workers have participated in only YMEP activities at Victoria Creek, as there were no other mining activities at these claims this season.

For the 2018 season, we made four field work tours in Yukon. The work dates were; March 22-27, June 01-05, Aug 23-Sept 12, and Oct 5-10. The three later tours are entirely associated to the 2018 YMEP field exploration work.

All work time was recorded as a maximum of 10 hours per day, for a recorded person-day total of 90 days. Thanks to the team for their enthusiasm...and the long daylight hours...as we found ourselves working late many times.

Section # 6

Victoria Creek - 2018 Budget

Item **Expenses**

	Travel	Description	Quantity	Cost	Total
1	Daily Living Expenses	cost per person/per day	92	100	$9,200
2	Truck Kilometers	2500 km x $0.60/km	2500	0.6	$1,500
	Rental Truck	daily rental	8	144	$1,152
	Taxi	Airport to truck rental	3	15	$45
	Other				$0
	Sub-total Travel				$11,897

	Analysis/Assay Costs		Quantity	Cost	Total
3	Soil Samples	up to 30 soil samples	$30	22	$660
	Sub-total				$660

	Equipment Rentals/Supplies	Description	Quantity	Cost	Total
4	Cat D8K dozer/ripper	wet rate: $165.00 x .75	10	123.75	$1,238
	Komatsu 400EX excavator	120 hours x ($295.00 x .75)	120	221.25	$26,550
	Muskeg 6" Auger Drill	(15x50') x ($50.00/ft x .75)	750	37.5	$28,125
	Mobile B-80 ODEX/RC drill	6" DTH (30x30m) x ($30/m x .75)	900	22.5	$20,250
	Other				$0
	Sub-total Events				$76,163

	Salaries	Description	Quantity	Cost	Total
5	Steve Harasimiuk	Prospector	20	350	$7,000
	Michal Bidrman	Prospector	20	350	$7,000
	Levi Kalinski	Geologist	18	400	$7,200
	Laurie Harasimiuk	Labourer	20	275	$5,500
	Cindy Duchesne	Labourer	14	175	$2,450
	Ed Duchesne	Driller	10	350	$3,500
	Sub - total Salaries				$32,650

	Subcontracting Costs	Description	Quantity	Cost	Total
6	Line Cutting	services needed			$0
7	Geochemical Survey	services needed			$0
8	Geophysical Survey	services needed			$0
9	Trenching	services needed			$0
10	Drilling				$0
11	Reclamation				$0
12	Report Preparation	Geologist final report	5	400	$2,000
13	Mapping	Drone			$2,500
	Sub-total Services				$4,500

	Other Expenses	Description	Quantity	Cost	Total
	ATV's (3 quads, 1 Argo)	(3 x 18 days) = 54 days	54	40	$2,160
	Argo Tubs	(2 x 16 days) = 32 days	32	10	$320
	6kw gen	20 days x ($20 x .75)	20	15	$300
	3" & 2" pumps	20 days x ($15 x .75)	20	11.25	$225
	Sub-total Marketing/Communications				$3,005

	Supplies - Other	Description	Quantity	Cost	Total
	Propane	$1.00 x (2 x 100 lb)	200	1	$200
	Gasoline (quads, pumps)	$1.60 x 675 liters	674	1.6	$1,078
	Sub-total Supplies				$1,278

Total Expenses	**$130,153**

YMEP Expense Claim Form - Client Copy

Yukon
Energy, Mines and Resources

YMEP no:	**18-038**	*project name:*	**Victoria Creek Placer**	*applicant name:*	**Steve Harasimiuk**
expense claim no:	**01**	*program type:*	**placer**	*program module:*	**target evaluation**
date submitted:	**10-Dec-18**	*phone:*	**780-812-4525**	*email:*	**bossltd3000@gmail.com**
address:	**P.O. Box 6409, Bonnyville, Alberta T9N 2G9**				
start/end dates of fieldwork for this claim:	**1-Jun-18** *start*	**10-Oct-18** *end*		*no. of field days/this claim:*	**29**

eligible expenses item	*Please refer to rate guidelines. Provide photocopy of receipts.*	unit/days	rate	total
daily field expenses	no persons: 5	90	$100/day	$9,000.00
personnel	*Name (supply statement of qualifications)*			
	Steve Harasimiuk and Michal Bidrman	211 & 90 hrs	$35.00/hr	$10,535.00
	Daniel Harrison	230 hrs	$30.00/hr	$6,900.00
	Laurie Harasimiuk	150 hrs	$25.00/hr	$3,750.00
	Spencer Coletti	80 hrs	$25.00/hr	$2,000.00

equipment (rental)	private or commercial	unit/days	rate	total
1997 Komatsu PC-400LC6 excavator	private	30 hrs	$295.00 x .75	$6,637.50
1994 Hitachi EX-400 LC3 excavator	private	15 hrs	$295.00 x .75	$3,318.75
Bombardier Muskeg 6" auger rig	private	150' / 30 hrs	$50.00/ft x .75	$5,625.00
Norspan Mobile 80 8" ODEX crawler drill	private	250' / 40 hrs	$75.00/ft x .75	$14,062.50
2003 International winch & 40t trailer	private	24 hrs	$250 x .75	$4,536.00
2010 Dodge 1 ton crew truck	private	2260 km	$0.60/lm	$1,356.00
2001 Yamaha 700 Grizzly ATV	private	24 days	$40.00/day	$960.00
2000 Arctic Cat 500 ATV	private	21 days	$40.00/day	$840.00
1999 Arctic Cat 454 ATV	private	9 days	$40.00/day	$360.00
ATV tub trailer	private	7 days	$10.00/day	$70.00
2" water pump	private	21 days	$10.00/day	$210.00
other	*Please provide details.*			
Driving Force - truck rental June 1		4 days, 631 km		$840.32
Driving Force - truck rental Oct 6		3 days, 625 km		$677.88
BOSS ltd -billable hrs invoice Oct 31		$24,344.25		
Yukon diesel fuel receipts (incl in rates)		$6216.35		
			Total this claim:	$71,678.95

2018 YMEP Target Evaluation – Victoria Creek

Field Worker Skills and Qualifications

The following people participated in the Victoria Creek Target Evaluation field work. Their specific and broad talents made the testing program a successful endeavor.

Steve Harasimiuk, prospector, miner and self-employed contractor. Steve is a Registered Engineering Technologist with over 40 years experience in industrial projects, such as; civil, mechanical, and environmental restoration. Steve owns and operates the equipment used for this testing program.

Michal Bidrman, is a seasoned mining expert and owner of the Victoria Creek Claims. Michal has mined in the Yukon for over 25 years. He has years of university training in Geology. He presently operates a consulting service to evaluate mines and equipment for clients. Mike enjoys putting his experience to use in the field by operating equipment, to advise on exploration results, and a develop a forward strategy plan.

Daniel Harrison, has been employed as a seasonal miner/prospector for 7 years. Dan can proficiently operate either 40t excavator and has the patience to scratch through the permafrost and rocks for hours. Daniel's attention to detail made him our logical choice to document and record our field data.

Laurie Harasimiuk, is a Yukon prospector that holds a prospecting lease and staked claims on other properties in the region. Laurie took her annual vacation from her job as a supervisor with the Government of Alberta, to oversee the 2018 Victoria Creek testing activity. Her ability to organize, co-ordinate, and document the testing activities was invaluable to ensure that field workers focussed on drilling and digging.

Spencer Coletti, is a young hard worker that has completed his formal heavy equipment operator training in Prince George, BC. Spencer has been operating various excavators for over a year now and has demonstrated his good skill and good work ethic at Victoria Creek. Spencer was running the excavator, as required, otherwise he was a "hands on" assistant in all aspects of this year's work plan.

In summary, these are the individuals involved in the field work activities for the 2018 Victoria Creek Target Evaluation project. All workers have participated in only YMEP activities at Victoria Creek, as there were no other mining activities at these claims this season.

For the 2018 season, we made for four field work tours in Yukon. The work dates were; March 22-27, June 01-05, Aug 23-Sept 12, and Oct 5-10. The three later tours are entirely associated to the 2018 YMEP field exploration work.

All work time was recorded as a maximum of 10 hours per day, for a recorded person-day total of 90 days. Thanks to the team for their enthusiasm...and the long daylight hours...as we found ourselves working late many times.

Third Party Rates - January 5, 2017

Equipment

Excavator (tracked) 200 &

Equipment #	Year	Make - Model - Capacity - Description and Accessories	Fluctuation	Hourly Rates Wet	Mob/ Demob	Dry	Standby
Carmacks							
T Moon Construction (11808 Yukon Inc)	2	2012 Link Belt - 210 - - - Bucket with Thumb	Yes	$250.00	$185.00	$230.00	$162.50
	3	2013 Link Belt - 250 - - - Bucket with Thumb	Yes	$250.00	$185.00	$230.00	$162.50
	4	2006 Link Belt - - 2901K - - Bucket with Thumb	Yes	$250.00	$185.00	$230.00	$162.50
Carey On Construction	2	-- Komatsu - 270 CC - 28 ton - - Clean Up Bucket, Thumb, Digging Bucket	Yes	$260.00	$200.00	$250.00	$169.00
Castle Rock Ent (14899 Yukon Inc)	67	2008 Linkbelt - LX330 - 39' Reach - - Hydraulic Thumb, Digging Bucket 42", Clean Up Bucket 72"	No	$265.00	$268.00	$265.00	$265.00
	69	2008 Hitachi - ZX350LC-3 - 39' Reach - - Clean Up Bucket 72", Ripper, Digging Bucket 36", Digging Bucket 42"	No	$270.00	$370.00	$270.00	$270.00
Boreal Engineering Ltd	18	2008 Caterpillar - 330D LC - 36 tonne - - Clean Out Bucket, Ripper, Hydraulic Thumb, Digging Bucket	Yes	$275.00	$250.00	$250.00	$178.75
Castle Rock Ent (14899 Yukon Inc)	52	2014 CAT - 336EL - 36 ton - - Quick Change, Hydraulic Thumb, Ripper, Digging Bucket, Clean Up Bucket	No	$275.00	$370.00	$275.00	$275.00
Norcope Ent Ltd	4	-- Linkbelt - 460 - 46 Ton - - Bucket x 2	No	$275.00	$285.00	$0.00	$275.00
	5	-- Cat - 345 - 45 Ton - - Bucket x 2, Ripper	No	$275.00	$285.00	$0.00	$275.00
	17	-- Cat - 336 - 36 Ton - 4 Available. Hammer & Packer - add $20 per hour - Digging Bucket, Packer, Angle Blade, Hammer, Clean Up Bucket, Ripper	No	$275.00	$285.00	$0.00	$275.00
16142 Yukon Inc. (KPI Northern)	52	-- EX400 - - 2 available - Hydraulic Thumb, Rock Bucket, Frost Bucket, Digging Bucket, Clean Up Bucket	Yes	$295.00	$500.00	$0.00	$191.75
P S Sidhu Trucking Ltd (Whse)	8	-- Link Belt - 330 LC - 3 yard - 6 available - Clean Up Bucket, Hydraulic Thumb, Digging Bucket	No	$295.00	$300.00	$0.00	$295.00
Castle Rock Ent (14899 Yukon Inc)	26	2008 Hitachi - ZX350LC-3 - 39' Reach - - Trimble GPS Auto Grade, Ripper, Digging Bucket 36", Digging Bucket 42", Clean Up Bucket 72"	No	$310.00	$370.00	$310.00	$310.00
P S Sidhu Trucking Ltd (Whse)	9	-- Hitachi - 2 x 350 LC - 3 yard - 2 available - Clean Up Bucket, Digging Bucket, Hydraulic Thumb	No	$310.00	$300.00	$0.00	$310.00
Castle Rock Ent (14899 Yukon Inc)	70	2014 CAT - 336EL - 36 ton - - Trimble GPS Auto Grade, Hydraulic Thumb, Ripper, Digging Bucket, Clean Up Bucket, Quick Change	No	$315.00	$370.00	$315.00	$315.00
16142 Yukon Inc. (KPI Northern)	1	-- JD - 450C - - 2 Available - Trench Bucket, Clean Up Bucket	Yes	$325.00	$500.00	$0.00	$211.25
Arctic Backhoe Services Ltd.	21	-- Case - 9040 - 2 Yd - - Clean Up Bucket, Pilot Vehicle, Hydraulic Hammer	Yes	$325.00	$285.00	$0.00	$211.25
Cobalt Construction Inc.	23	2008 Hitachi - 450HC - - 2 Available - Digging Bucket, Ripper, Clean Up Bucket	No	$350.00	$300.00	$0.00	$350.00
James Magun Contracting	6	-- Hitachi - 450 - - - Clean Up Bucket, Digging Bucket	No	$350.00	$350.00	$0.00	$350.00
P S Sidhu Trucking Ltd (Whse)	10	-- Link Belt - 460 LX - 3.5 yard - 2 available - Clean Up Bucket, Hydraulic Thumb, Digging Bucket	No	$425.00	$425.00	$0.00	$425.00
Dawson							
Van Bibber Trucking	7	-- Linkbelt - 210xp2 - 210 - - Clean Up Bucket, Thumb	No	$15.00	$170.00	$140.00	$15.00
McCabe Creek Farm	4	-- CAT - - 320 - - Digging Bucket 48", Clean Up Bucket 60"	Yes	$165.00	$205.00	$145.00	$107.25
Berdoe Enterprises	15	-- John Deere - 230 LC - 30 Ft. Reach - - Clean Up Bucket, Pilot Vehicle, Rock Hammer (Pick), Hydraulic Thumb, Ripper, Digging Bucket	No	$175.00	$275.00	$170.00	$175.00
Deadman Creek Enterprises Inc (Whitehorse)	6	-- Volvo - EC210 - 44,000 lbs - - Digging Bucket, Hydraulic Thumb, Brush Rake, Promac Brush Head, Clean Up Bucket	Yes	$175.00	$20.00	$0.00	$113.75
Graceland Construction	6	-- Caterpillar - 320CL - - - Clean Up Bucket, Digging Bucket	Yes	$175.00	$150.00	$165.00	$113.75
Norcope Ent Ltd	6	-- CAT - 320 CL & 240 XL - 20 Ton & 24 Ton - Hammer $45 extra/hr,	No	$175.00	$175.00	$0.00	$175.00

Third Party Rates - January 5, 2017

Trucks

Tractor/Winch Truck

Equipment #	Year	Make - Model - Capacity - Description and Accessories	Fluctuation	Hourly Rates Wet	Mob/ Demob	Dry	Standby
Carcross							
James Magun Contracting 5	--	- - - Deck truck \ towing - Winch	No	$150.00	$150.00	$0.00	$150.00
Yukon Equipment Services Ltd. 15	--	Kenworth - T800 - 63,500 kg - Tandem Axle Trucks. 2 Available	No	$150.00	$300.00	$150.00	$150.00
Glacier Water Service 9	1986	Freightliner - - 3 Axle - Van option 9500.00/mo - no pump on tanker trailer - 2000 Trail Mobile 48' Hi-Boy Trailer, Fifth Wheel, Rear Spreader Bar, 2004 Advance Tanker Trailer 7000 Gal, 2001 Vanguard converted to office trailer	No	$190.00	$145.00	$175.00	$190.00
Carey On Construction 6	--	Ford - 9000 LTL - 10 ton - - Cross Gates	Yes	$200.00	$200.00	$210.00	$130.00
7	--	Ford - 9000 LTL - 10 ton - - Clams, Belly Dump	Yes	$200.00	$200.00	$210.00	$130.00
Yukon Equipment Services Ltd. 8	--	Kenworth - T800 - 50 ton - - Hydraulic Neck, Scissor Neck, Lo-Boy	No	$200.00	$400.00	$200.00	$200.00
T Moon Construction (11808 Yukon Inc) 11	--	Freightliner & Kenworth - FLD 120/ T800 - - 2 Available, Freightliner with Winch - Low Bed Trailor, End Dump, High Boy	Yes	$220.00	$185.00	$190.00	$143.00
P S Sidhu Trucking Ltd (Whse) 21	--	Kenworth - T800 - 30 ton - 4 available, Scissor neck - Winch, Kenworth Tractor	No	$225.00	$225.00	$0.00	$225.00
Boreal Engineering Ltd 12	2007	Kenworth - T800 - 40 ton winch - - Tandem or Tri Axle Scissor Neck	Yes	$250.00	$250.00	$240.00	$162.50
13	1988	Kenworth - T800 - 30ton winch - - Tandem or Tri Axle Scissor Neck	Yes	$250.00	$250.00	$240.00	$162.50
Carmacks							
James Magun Contracting 5	--	- - - Deck truck \ towing - Winch	No	$150.00	$150.00	$0.00	$150.00
Yukon Equipment Services Ltd. 15	--	Kenworth - T800 - 63,500 kg - Tandem Axle Trucks. 2 Available	No	$160.00	$300.00	$160.00	$160.00
Dunrite Trucking (Sand & Gravel) 1	--	Kenworrth - T800 - -	Yes	$180.00	$100.00	$140.00	$117.00
Glacier Water Service 9	1986	Freightliner - - 3 Axle - Van option 9500.00/mo - no pump on tanker trailer - 2000 Trail Mobile 48' Hi-Boy Trailer, Fifth Wheel, Rear Spreader Bar, 2004 Advance Tanker Trailer 7000 Gal, 2001 Vanguard converted to office trailer	No	$190.00	$145.00	$175.00	$190.00
Carey On Construction 6	--	Ford - 9000 LTL - 10 ton - - Cross Gates	Yes	$200.00	$200.00	$210.00	$130.00
7	--	Ford - 9000 LTL - 10 ton - - Clams, Belly Dump	Yes	$200.00	$200.00	$210.00	$130.00
Yukon Equipment Services Ltd. 8	--	Kenworth - T800 - 50 ton - - Hydraulic Neck, Scissor Neck, Lo-Boy	No	$200.00	$400.00	$200.00	$200.00
T Moon Construction (11808 Yukon Inc) 11	--	Freightliner & Kenworth - FLD 120/ T800 - - 2 Available, Freightliner with Winch - Low Bed Trailor, End Dump, High Boy	Yes	$220.00	$185.00	$190.00	$143.00
P S Sidhu Trucking Ltd (Whse) 21	--	Kenworth - T800 - 30 ton - 4 available, Scissor neck - Winch, Kenworth Tractor	No	$225.00	$225.00	$0.00	$225.00
Boreal Engineering Ltd 12	2007	Kenworth - T800 - 40 ton winch - - Tandem or Tri Axle Scissor Neck	Yes	$250.00	$250.00	$240.00	$162.50
13	1988	Kenworth - T800 - 30ton winch - - Tandem or Tri Axle Scissor Neck	Yes	$250.00	$250.00	$240.00	$162.50
Dawson							
James Magun Contracting 5	--	- - - Deck truck \ towing - Winch	No	$150.00	$150.00	$0.00	$150.00
Yukon Equipment Services Ltd. 15	--	Kenworth - T800 - 63,500 kg - Tandem Axle Trucks. 2 Available	No	$165.00	$300.00	$165.00	$165.00
Carey On Construction 6	--	Ford - 9000 LTL - 10 ton - - Cross Gates	Yes	$200.00	$200.00	$210.00	$130.00
7	--	Ford - 9000 LTL - 10 ton - - Clams, Belly Dump	Yes	$200.00	$200.00	$210.00	$130.00
Yukon Equipment Services Ltd. 8	--	Kenworth - T800 - 50 ton - - Hydraulic Neck, Scissor Neck, Lo-Boy	No	$200.00	$400.00	$200.00	$200.00
Glacier Water Service 9	1986	Freightliner - - 3 Axle - Van option 9500.00/mo - no pump on tanker trailer - 2000 Trail Mobile 48' Hi-Boy Trailer, Fifth Wheel, Rear Spreader	No	$205.00	$145.00	$190.00	$205.00

Bonnyville Oilfield Service & Supply Ltd.
Box 6409, Bonnyville, Alberta T9N 2G9
Phone 780-812-3000 Fax 780-812-3002

INVOICE

P.O. Box 6409
Bonnyville Alberta T9N 2G9
Phone (780) 812-3000 Fax (780) 812-3002

DATE: October 31, 2018
INVOICE # 181012

FOR: **YMEP # 18-038**
Victoria Creek
Chargeable Hours

BILL TO:
Steve Harasimiuk
Box 343
Ardmore, Alberta, T0A 0B0

	HOURS	RATE	AMOUNT
Chargeable Daily Work Hours (10 hours/day)			
Steve Harasimiuk (290 total hrs - 79 hrs operating equipment (40 hrs ODEX rig, 24 hrs winch truck, 15 hrs excavator))	211.00	35.00	7,385.00
Michal Bidrman (100 total hours - 10 hrs operating excavator)	90.00	35.00	3,150.00
Daniel Harrison (260 hrs total - 30 hrs operating auger drill)	230.00	30.00	6,900.00
Laurie Harasimiuk (150 hours)	150.00	25.00	3,750.00
Spencer Coletti (100 hours - 20 hrs operating excavator)	80.00	25.00	2,000.00

SUBTOTAL	$	23,185.00
TAX RATE		5.00%
SALES TAX		1,159.25
OTHER		
TOTAL	$	24,344.25

WCB # 3835050

GST # 887781474RT

Make all checks payable to: **Bonnyville Oilfield Service & Supply Ltd**.

DRIVING FORCE
Vehicle Rentals | Sales | Leasing

The Driving Force Inc.
213 Range Road
Whitehorse, YT Y1A 3E5
(867) 456-2277
Fax: (866) 973-8501
Toll Free: (800) 661-0445
www.drivingforce.ca

Branch 23 Invoice No. 1489317
Reservation No. 01482655

Vehicle No. **00150668**
Description 2018 Ford Super Duty F-350 SRW XLT XLT 4WD Crew Cab 8' Box
VIN 1FT8W3BT6JEB61984
License No. RGJ17 Colour White

Date and Time Out Jun01/18 07:58
Date and Time In Jun05/18 08:00

Return to Whitehorse

Renter

Harasimiuk, Steven
PO Box 343
Ardmore, AB T0A 0B0

(780) 812-4525

Destination: carmacks

Kms Out	594
Kms In	1,625
Kms Driven	1,031
Kms Allowed	400
Km Rate Over Allowed	$0.30
Kms Charged	631

Rental Charges

Kms	631.0 @ $0.30	$189.30
Days	4 @ $150.00	$600.00

This vehicle shall not be driven, operated or used by anyone not specifically named in this agreement or in violation of any terms of this agreement.

Please initial here [ ]

DECLARATION OF INSURANCE

Public Liability and Property Damage	Renter	[ ]	DF	[X]
Physical Damage including comprehensive	Renter	[X]	DF	[ ]

Other Charges
Vehicle License Fee $11.00

IMPORTANT MESSAGES

Purchasing Loss Damage Waiver (LDW)

By signing below, the renter accepts LDW at the rate per day or part thereof as recorded in the section entitled "Loss Damage Waiver Fees." By the renter accepting LDW, the renter is responsible to pay the amount of the deductible listed below PER OCCURENCE and DF agrees to waive the renter's financial responsibility for damage to the vehicle. However, if the renter has violated any of the terms and conditions of this rental agreement, the renter is responsible for all loss or damage to the vehicle and/or loss or damage to DF.

Renter's Signature:

X **DECLINED**

Loss Deductible

Initial

Declining Loss Damage Waiver (LDW)

By signing below, the renter is declining LDW and agrees to pay DF for all loss or damage to the vehicle, HOWEVER INCURRED, (regardless of fault).

FULL VALUE

Renter's Signature:

X

Billing Information

Rental Charges	$789.30
LDW	$0.00
Other Charges	$11.00
GST # R102214632 (5%)	$40.02
Total Charges	$840.32
Deposit taken	$800.00
Paid	$40.32

Payment Information

Jun01/18 VS	4500XXXXXXXX7927	$800.00
Jun05/18 VS	4500XXXXXXXX7927	$40.32

I am authorized as the Renter, or by the person named as the Renter, to enter into this contract, and I acknowledge that I have read and understood and agree to be bound by the Terms and Conditions set forth on the front and back of this Agreement.
Renter authorizes DF to use unsigned credit voucher(s) to process payments (as defined in Section 7 on the reverse of this form) against the credit card provided at the time of rental.

Renter's Signature **ON FILE**

Driving Force _____

DRIVING FORCE
Vehicle Rentals | Sales | Leasing

40 YEARS

The Driving Force Inc.
213 Range Road
Whitehorse, YT Y1A 3E5
(867) 456-2277
Fax: (866) 973-8501
Toll Free: (800) 661-0445
www.drivingforce.ca

Branch 23 Invoice No.1579262
Reservation No. 01579261

Vehicle No. **00148555**
Description 2018 GMC Sierra 3500HD SLE 4WD Crew Cab 167.7in SLE
VIN 1GT42WCY5JF223438
License No. RGH41 Colour White

Date and Time Out Oct06/18 13:13
Date and Time In Oct09/18 12:04

Return to Whitehorse

Renter

Harasimiuk, Steven
PO Box 343
Ardmore, AB T0A 0B0

(780) 812-4525

Destination: Local

Kms Out	11,493
Kms In	12,118
Kms Driven	625
Kms Allowed	300
Km Rate Over Allowed	$0.30
Kms Charged	325

Rental Charges

Kms	325.0 @ $0.30	$97.50
Days	3 @ $179.95	$539.85

This vehicle shall not be driven, operated or used by anyone not specifically named in this agreement or in violation of any terms of this agreement.

Please initial here ☐

DECLARATION OF INSURANCE

Public Liability and Property Damage	Renter	☐	DF	X
Physical Damage including comprehensive	Renter	X	DF	☐

Other Charges
Vehicle License Fee $8.25

IMPORTANT MESSAGES

Purchasing Loss Damage Waiver (LDW)

By signing below, the renter accepts LDW at the rate per day or part thereof as recorded in the section entitled "Loss Damage Waiver Fees." By the renter accepting LDW, the renter is responsible to pay the amount of the deductible listed below PER OCCURENCE and DF agrees to waive the renter's financial responsibility for damage to the vehicle. However, if the renter has violated any of the terms and conditions of this rental agreement, the renter is responsible for all loss or damage to the vehicle and/or loss or damage to DF.

Renter's Signature:

X **DECLINED**

Loss Deductible

Initial

Declining Loss Damage Waiver (LDW)

By signing below, the renter is declining LDW and agrees to pay DF for all loss or damage to the vehicle, HOWEVER INCURRED, (regardless of fault).

FULL VALUE

Renter's Signature:

X

Billing Information

Rental Charges	$637.35
LDW	$0.00
Other Charges	$8.25
GST # R102214632 (5%)	$32.28
Total Charges	$677.88
Deposit taken	$800.00
Refunded	- $122.12

Payment Information

Oct06/18 VS	4500XXXXXXXX7927	$800.00
Oct09/18 VS	4500XXXXXXXX7927	- $122.12

I am authorized as the Renter, or by the person named as the Renter, to enter into this contract, and I acknowledge that I have read and understood and agree to be bound by the Terms and Conditions set forth on the front and back of this Agreement.
Renter authorizes DF to use unsigned credit voucher(s) to process payments (as defined in Section 7 on the reverse of this form) against the credit card provided at the time of rental.

Renter's Signature **ON FILE**

Driving Force _____

el Yukon
317
aska Highway
tehorse, YT
A 6E4

)-11-18 01:21 PM Trans# 16416

LE

D: 7874619
D: B7874619 REF#:36
tch #: 105 SEQ: 105001001036
/11/18 13:21:32
PR CODE: 184835
TERAC/CHEQUING
**********3087C

OUNT 700.00$

00 APPROVED 184835 001

terac
D: A0000002771010
R: 0280008000
I: F800

ank You
ease Come Again

STOMER COPY

Fuel Yukon
91317
Alaska Highway
Whitehorse, YT
Y1A 6E4
Tel 867-667-4427
Fax 1-888-828-5330
GST 837187582

SALE RECEIPT # 16416
Customer: Cash Sale
Cashier: Ariel (R2/T1/S1)
11-Sep-2018 at 01:21 PM

Quantity	Reg Price	Price	Amount
IESEL - DIESEL Pump-8			
519.287L		$1.348/L	$700.00I
ub Total			700.00
otal			700.00
ST (5.0%) included in $700.00			33.33
nterac			700.00
otal Tendered			700.00

Thank You For Shopping With Us
Please Come Again !!!

CAMPGROUND SERVICE
14 ADELA TRAIL, BOX 826
WATSON LAKE YT

CARD **********7927
CARD TYPE VISA
DATE 2018/08/25
TIME 0322 10:45:17
RECEIPT NUMBER
C84103541-001-323-004-0

PURCHASE
TOTAL

$293.55

Visa Credit
A0000000031010
EA02D80CCED114BA
0080008000-E800
F46D2AEB3617BD69
0080008000-F800

APPROVED
AUTH# 054851 01-0?
THANK YOU

CARDHOLDER COPY

NT - RETAIN THIS
R YOUR RECORDS

CAMPGROUND SERVICES
Campground Services
Watson Lake, Yukon
Box 826
(826) 589-7448
GST#: 130789556

DIESEL	$300.03
Dollar Discount	$-6.48
Subtotal	$293.55
Pre-Tax Subtotal:	$293.55
Amount Due:	$293.55
Visa	$293.55
Change:	$0.00

Item Count 1

8/25/2018 9:45:58 AM
103 #134761 1 MF

Your cashier today: Mike

Thank You For Calling
PLEASE COME AGAIN
RETOURNEE SVP

uel Yukon
1317
laska Highw
hitehorse, Y
1A 6E4

ct-09-18 04:05 PM Trans# 20347

ALE

D: 7874619
D: B7874619 REF#:45
tch #: 133 SEQ: 133001001045
/09/18 16:05:14
PR CODE: 05438I
SA
**********7927C **/**

OUNT 370.31$

00 APPROVED 05438I 001

sa Credit
D: A0000000031010
R: 0080008000
I: F800

ank You
ease Come Again

STOMER COPY

Fuel Yukon
91317
Alaska Highway
Whitehorse, YT
Y1A 6E4
Tel 867-667-4427
Fax 1-888-828-5330
GST 837187582

SALE RECEIPT # 20347
Customer: Cash Sale
Cashier: Cassie (R2/T1/S1)
09-Oct-2018 at 04:05 PM

Quantity	Reg Price	Price	Amount
IESEL - DIESEL Pump-7			
267.760L		$1.383/L	$370.31I
ub Total			370.31
otal			370.31
ST (5.0%) included in $370.31			17.63
redit Card			370.31
otal Tendered			370.31

Thank You For Shopping With Us
Please Come Again !!!

btenez des récompen

TRANSACTION RECOR
RELEVE DE
TRANSACTION

MOBIL
@ #1730
2226 - 2ND AVENUE
WHITEHORSE, NT Y1A 1

TRANSACTION RECORD

MOBIL

2018-10-09 10:39:46

TRANS #: 045254
Station#: 00324242
GST #: R733514327

PUMP 8
DIESL $133.45
98.196L AT $1.359/L

GST INCLUDED $ 6.35
TOTAL : CAD$133.45

Type: PURCHASE
VISA
C **********7927
INVOICE NO: YAAB0368
AUTH: 06575I-F

Visa Credit
A0000000031010
0080008000
F800

01 Approved - Th

Fuel Yukon
91634 Alaska Hwy
Whitehorse, Yukon Y1A1A3

Tel: 867-633-3322

Inv#: 16595
Trans: Pre-Auth
Completion
**********7927
/ C
Visa Credit
AID: A0000000031010
Seq#: 132001001005
Terminal ID: ACYEPC02
Auth No: 00576I
ACI/ISO: 001/00
Date: 08/25/2018
Time: 6:40:21 PM
TVR 0080008000
TSI F800
APPROVED

Pump # : 4-Diesel
Vol : 370.920 L
Price/L: $1.348
Net Amt: $500.00
Date: 08/25/18
Time: 6:49:27 PM

Fuel Includes:
GST(5%): $23.81
Total : $23.81

THANK YOU
GST: 837187582

Fuel Yukon
91634 Alaska Hwy
Whitehorse, Yukon Y1A1A3

Tel: 867-633-3322

Inv#: 16596
Trans: Pre-Auth
Completion
**********7927
/ C
Visa Credit
AID: A0000000031010
Seq#: 132001001007
Terminal ID: ACYEPC02
Auth No: 03600I
ACI/ISO: 001/00
Date: 08/25/2018
Time: 6:54:56 PM
TVR 0080008000
TSI F800
APPROVED

Pump # : 3-Diesel
Vol : 255.890 L
Price/L: $1.348
Net Amt: $344.94
Date: 08/25/18
Time: 7:01:32 PM

Fuel Includes:
GST(5%): $16.43
Total : $16.43

THANK YOU
GST: 837187582

Fuel Yukon
91634 Alaska Hwy
Whitehorse, Yukon Y1

Tel: 867-633-3322

Inv#: 16597
Trans: Pre-Auth
Completion
**********7927
/ C
Visa Credit
AID: A0000000031010
Seq#: 132001001009
Terminal ID: ACYEPC02
Auth No: 01295I
ACI/ISO: 001/00
Date: 08/25/2018
Time: 7:20:45 PM
TVR 0080008000
TSI F800
APPROVED

Pump # : 3-Diesel
Vol : 370.920 L
Price/L: $1.348
Net Amt: $500.00
Date: 08/25/18
Time: 7:28:06 PM

Fuel Includes:
GST(5%): $23.81
Total : $23.81

THANK YOU
GST: 837187582

Fuel Yukon
91634 Alaska Hwy
Whitehorse, Yukon Y1A1A

Tel: 867-633-3322

Inv#: 16598
Trans: Pre-Auth
Completion
**********7927
/ C
Visa Credit
AID: A0000000031010
Seq#: 132001001007
Terminal ID: ACYEPC01
Auth No: 00555I
ACI/ISO: 001/00
Date: 08/25/2018
Time: 7:30:21 PM
TVR 0080008000
TSI F800
APPROVED

Pump # : 1-Diesel
Vol : 370.920 L
Price/L: $1.348
Net Amt: $500.00
Date: 08/25/18
Time: 7:37:52 PM

Fuel Includes:
GST(5%): $23.81
Total : $23.81

THANK YOU
GST: 837187582

Fuel Yukon
91634 Alaska Hwy
Whitehorse, Yukon Y1A1A3

Tel: 867-633-3322

Inv#: 16599
Trans: Pre-Auth
Completion
**********7927
/ C
Visa Credit
AID: A0000000031010
Seq#: 132001001009
Terminal ID: ACYEPC01
Auth No: 00458I
ACI/ISO: 001/00
Date: 08/25/2018
Time: 7:40:18 PM
TVR 0080008000
TSI F800
APPROVED

Pump # : 1-Diesel
Vol : 257.060 L
Price/L: $1.348
Net Amt: $346.52
Date: 08/25/18
Time: 7:45:25 PM

Fuel Includes:
GST(5%): $16.50
Total : $16.50

THANK YOU
GST: 837187582

TAKHINI GAS
0 NORTH KLONDIKE HWY MILE
WHITEHORSE, YT

Term ID: 56709972

Purchase

xxxxxxxxxxx7935

VISA Entry Method: C

Total: $ 525.17

2018/09/01 16:06:05

Seq #: 001-359134-0

Appr Code: 08114I

Resp Code: 01/027

Visa Credit
A0000000031010
4B D1 19 D0 53 5E 00 7C
00 80 00 80 00
F8 00
90 F2 14 E7 8F 42 D4 06

APPROVED
Thank You

Customer Copy

- IMPORTANT -
retain this copy for your records

TAKHINI GAS
0 NORTH KLONDIKE HWY MILE
WHITEHORSE, YT

Term ID: 56709972

Purchase

xxxxxxxxxxx7927

VISA Entry Method: C

Total: $ 122.02

2018/08/27 13:59:43

Seq #: 001-354060-0

Appr Code: 08288I

Resp Code: 01/027

Visa Credit
A0000000031010
CD A1 22 56 9C AA E9 92
00 80 00 80 00
F8 00
26 52 B2 22 F7 D4 E6 5B

APPROVED
Thank You

Customer Copy

- IMPORTANT -
retain this copy for your records

Fuel Yukon
01317
Alaska Highway
Whitehorse, YT
Y1A 6E4

ug-25-18 06:13 PM Trans# 13774

SALE

ID: 7874619
ID: B7874619 REF#:58
Batch #: 88 SEQ: 088001001058
08/25/18 18:13:08
APPR CODE: 09183I
VISA
**********7927C **/**

AMOUNT 257.50$

00 APPROVED 09183I 001

Visa Credit
AID: A0000000031010
TVR: 0080008000
TSI: F800

Thank You
Please Come Again

CUSTOMER COPY

Transaction #: 0015012

Pump: 3 DIESEL
Hose 1

Method of Payment: Cash

Volume 396.164 Litres

@ Price $1.329 / Litre

Total $526.17

Tax [5.000%] = $26.01

Time: 16:20
Date: 07/01/2018

***** Thank You *****

Transaction #: 0014392

Pump: 3 DIESEL
Hose 1

Method of Payment: Cash

Volume 91.816 Litres

@ Price $1.329 / Litre

Total $122.02

Tax [5.000%] = $5.81

Time: 14:13
Date: 06/27/2018

***** Thank You *****

Fuel Yukon
91317
Alaska Highway
Whitehorse, YT
Y1A 6E4
Tel 867-667-4427
Fax 1-888-828-5330
GST 837187582

SALE RECEIPT # 13774
Customer: Cash Sale
Cashier: Manager (R2/T1/S1)
25-Aug-2018 at 06:13 PM

Quantity	Reg Price	Price	Amount
DIESEL - DIESEL Pump-8			
191.022L		$1.348/L	$257.50I
Sub Total			257.50
Total			257.50
GST (5.0%) included in $257.50			12.26
Credit Card			257.50
Total Tendered			257.50

Thank You For Shopping With Us
Please Come Again !!!

Transaction #: 0014391

Pump: 2 UNL REG
Hose 1

Method of Payment: Cash

Volume 128.456 Litres

@ Price $1.449 / Litre

Total $186.13

Tax [5.000%] = $8.86

Time: 14:01
Date: 08/27/2018

Terry Cave

***** Thank You *****

Transaction #: 0014390

Pump: 3 DIESEL
Hose 1

Method of Payment: Cash

Volume 451.504 Litres

@ Price $1.329 / Litre

Total $600.05

Tax [5.000%] = $28.57

Red Tank

Time: 14:02
Date: 08/27/2018

***** Thank You *****

TAKHINI GAS
0 NORTH KLONDIKE HWY MILE
WHITEHORSE, YT

Term ID: 56948664

Purchase

35

VISA Entry Method

Total: $ 786.18

2018/08/27 13:51:58

Seq #: 001-405001-0

Appr Code 04732I

Resp Code: 01/027

Visa Credit
A0000000031010
6B CB 07 E4 66 26 0F C1
00 80 00 80 00
F8 00
B8 6E 96 43 1A CC 08 08

APPROVED
Thank You

Customer Copy

- IMPORTANT -
retain this copy for your records

Fas Gas Plus
Fas Gas Kopper King
91888 B Alaska Hwy
Whitehorse YT
Y1A5B7
8676682422
GST/HST:102875317
PST:

DATE: 2018/08/27 TIME: 13:11:18
SITE ID: 50228

PURCHASE

FUEL	QUANTITY	PRICE/L	AMOUNT
DIESEL	35.451L	$1.409/L	49.95#

TOTAL $49.95

FUEL TAXES ON 35.451L OF FUEL
GST 5.00% INCLUDED 2.38
TOTAL FUEL TAXES $2.38

TOTAL TAXES $2.38

= TAXES INCLUDED

VISA ENTRY METHOD: H
**********7927
2018/08/27 13:14:53
REF#: M2878233 SEQ #:001-055060-0
AUTH#: 03583I RESP CODE: 01/027
RECEIPT#: 00009612 BATCH#: 055
Visa Credit
A0000000031010
750796740528F147
0000000000
750796740528F147
0000

APPROVED - THANK YOU

- IMPORTANT -
RETAIN THIS COPY FOR YOUR RECORDS

CUSTOMER COPY

SECTION # 7

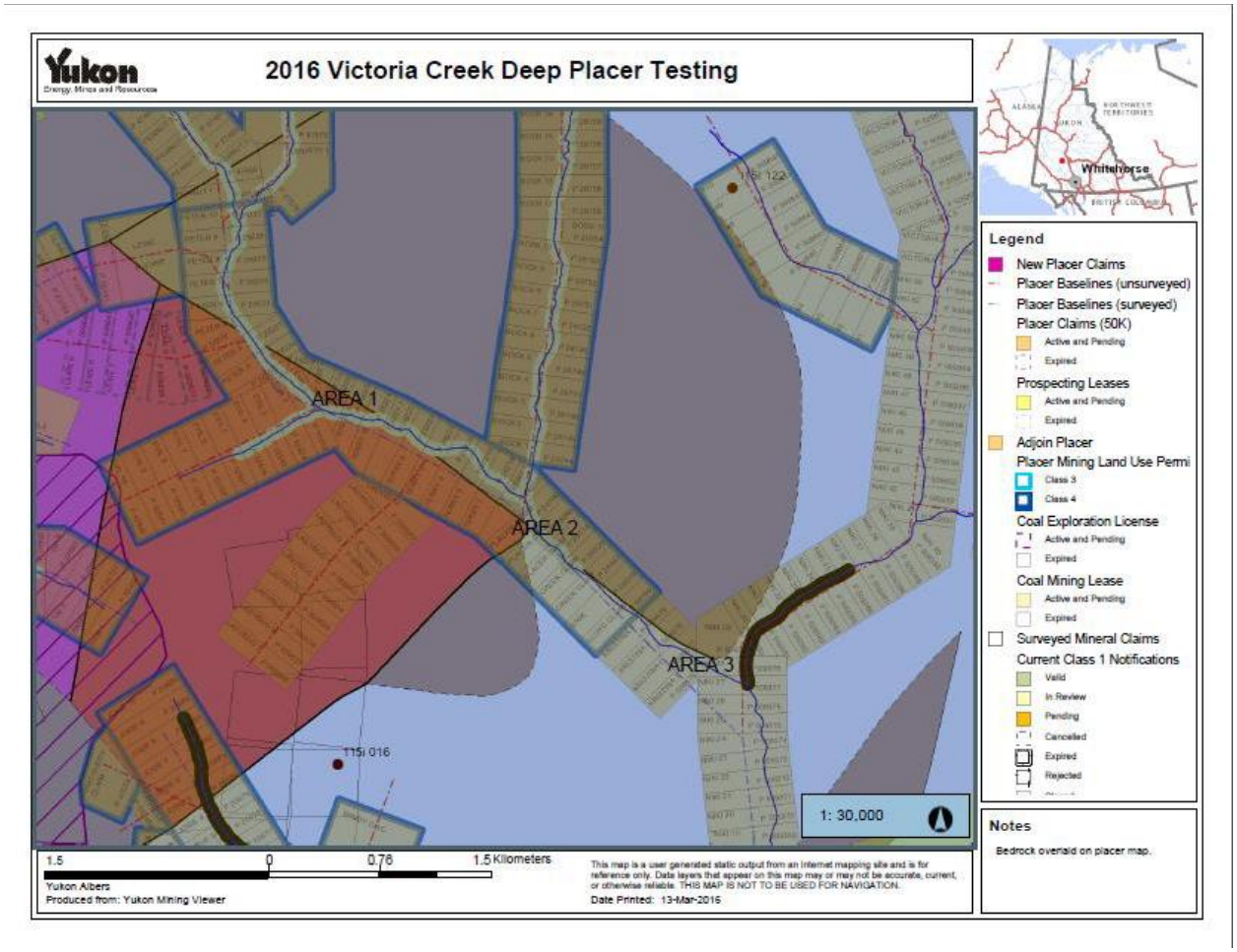
2018 VICTORIA CREEK TESTING

2018 TESTING TARGET AREAS

TEST AREAS

Three primary focus areas were identified for the 2018 target exploration work. All three have been correlated to geological plates that intersect each other and/or are undefined. Our primary purpose for our target evaluation is to confirm any economic quantities of placer gold and to confirm the lithography data.

The three areas were the key locations to explore for deep placer gravels, as we have previously performed work stripping and exposing the late Pleistocene and Pleistocene layers.



Area # 1 – Above and below the conflux of Eva Creek and upper right tributary of Victoria Creek at claim #s P26224 to P26231.

Area # 2 - Below the conflux of three channels; left & right channel of an upper Victoria Creek tributary and Ladybug Creek. Located where there is a narrowing of the valley, and the bedrock profile changes. This location is where we have done most of our exploration/test mining.

Area # 3 – Located at the lowest claim # P509576, up to P509579. This is where the upper right Victoria Creek tributary enters the main Victoria Creek channel.

The focus areas we have selected to drill and dig, are located above bedrock faults. At Victoria Creek there is a direct relationship with lode and placer gold. The pacer gold recovered on the test area can be a dark brass color that resembles wire or can be a polished circular nugget shape. The dark dull colored "vein" gold is likely originated locally, where-as the circular "nugget" style pieces were transported by stream or glacial movement.

Reference: *Appendix Tab 22 – Yukon Exploration and Geology, Placer-Lode Gold at Nansen*
Appendix Tab 23 – Placer-Lode Gold Relationships in the Nansen District

PREVIOUS TESTING IN AREA # 1

Test area # 1 is an area that had been mined for the past 50 plus years. We initially believed that the previous miners had mining this area down to the bedrock. It was considered to have been "mined out" until we began re-testing the area in 2015. We wanted to confirm the depth of the bedrock and map its' elevation profile. So, in 2015 our testing confirmed an undisturbed gravel material layer below a layer of fractured boulders, mistaken as bedrock.

According to the previous bedrock mapping, the Mount Nansen and Whitehorse suite bedrock fault line is in Area # 1, very near to our 2015 trench.

In 2016, we started our testing program with two geophysical 2D bedrock profile lines that crossed the bedrock fault at Area # 1. Our drilling program followed the two profiles as well as test pit excavations with continuous sampling as we progressed.

Our 2018 goal for Area # 1 was to excavate the layer of large rocks & boulders and drill/dig into the gravel below the clay/boulder layer and find the real bedrock layer. The intention was to map the bedrock profile of this area and sample for gold in each drill hole or test pit. Considerable effort was invested in 2016 to excavate test pits. Encountering permafrost, we allowed excavations to thaw out naturally.

We encountered all the usual challenges...permafrost, water channels, side slopes. Drilling and digging into the areas identified by geophysical profiles as being potential fault lines or tertiary drainage channels yielded no significant test results. The majority of testing centered within area # 1, where the valley is at its narrowest width, at that location.

2018 TESTING PLAN IN AREA # 1

We believe that the Mount Nansen and Whitehorse suite bedrock fault line is in area # 1 very near to our trench. In 2017, we have left most of the excavations open and in 2018 we want to dig these pits deeper.

We have a good personal relationship with the quartz claim holders below Victoria Creek. We have contacted them regarding our testing program and they have given us approval to drill into bedrock for reference samples.

Reference: Appendix Tab 24 - Arctic Geophysical 2012 Victoria Creek report # 1, pg 7-16
Appendix Tab 25 - Area # 1 Proposed Exploration Maps, 2 pages

AREA # 2 TARGET EVALUATION

PREVIOUS TESTING IN AREA # 2

A geophysical profile of the target area was conducted in 2011. The upper gravel layers have been stripped off down to the Pleistocene level. The “cut” is directly above the bedrock channel target, identified in the report.

Reference: Appendix Tab 26 - Arctic Geophysical 2011 Victoria Creek Report, pg 6-12

Test area # 2 is downstream of the conflux of a left and right tributary to an upper Victoria Creek channel. It is within claims P50100 and P26108. At claim P26106 the clay layer extends ~10 (33’) below surface and is ~16m (52’) thick. The clay layer is void of any gold. Below this clay layer we encountered gravel cobbles with gold traces.

Our attempts to drill down to bedrock and confirm the overall depth of bedrock to be ~23 m (75 ft) from surface of the main mining cut, did not work with our drill rig. Despite using several styles of carbide drill bits we could not penetrate to the depth we needed to reach a gravel sample.

With the test pit results we encountered in area # 1, we checked area # 2 for the similar results and found some promising shallow gravels along the far right bank of the valley. We did locate a gravel seam that had some gold quantities, but ran out of time to properly evaluate it.

2017 TESTING PLAN IN AREA # 2

Several of the test drill and pit along the right bank in area # 2 contained promising gold samples. Those test pits along the far right of the valley against a bedrock outcrop, contained a lot of frozen muck. We left these pits open for them to thaw naturally so that we can come back to dig them deeper in 2018. We did encounter gravel and silt layers but did not get to the bedrock on any of these test pits.

AREA # 3 TARGET EVALUATION

PREVIOUS TESTING IN AREA # 3

Target Area # 3 is located at claim # P509577. A geophysical profile of the claim was conducted in 2014. Auger sample drilling was performed down to 6m (20') in 2014. Some encouraging results were encountered so a third party drill rig was contracted to obtain independent information. The contract drill rig was only able to drill one hole before encountering mechanical problems. His results were good, but one hole is not a representative sample quantity.

Reference: Appendix Tab 27 - Excerpts from Arctic Geophysical 2014 Report, 2 pages

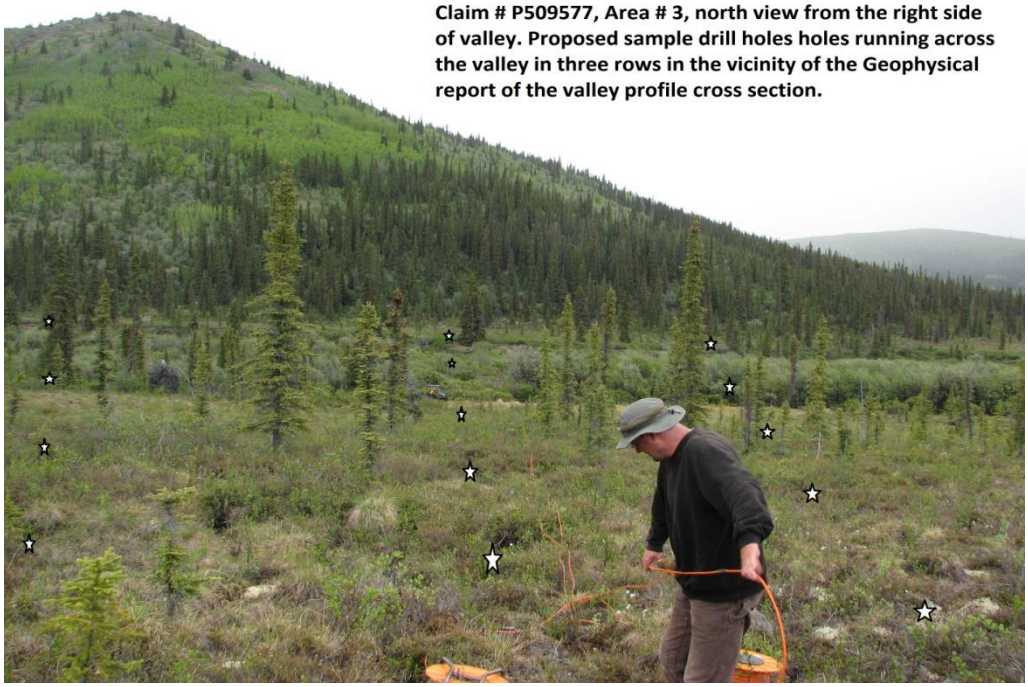
Ironically, the bedrock layer on this lower claim is closer to the surface that claims that are further upstream. The bedrock maps of this area indicate a corner of the Whitehorse Suite entering this area, dominated by the Mount Nansen bedrock.

Late in the 2016 season, we excavated a large benched test pit in the location of a drill hole dug in 2015. We did not reach the depth of the drill hole and encountered no economic gold samples. Further digging will be easier in 2018, once more permafrost thaws the gravel excavation.

2018 TESTING PLAN IN AREA # 3

Ironically, the bedrock layer on this lower claim is closer to the surface that claims that are further upstream. The bedrock maps of this area indicate a corner of the Whitehorse Suite entering this area, dominated by the Mount Nansen bedrock.

We want to drill this area down to bedrock to confirm our geophysical report and confirm any viable quantities of gold. We intend on drill sampling in a three row grid pattern. All sample locations will be GPS surveyed and staked. The initial drill holes will be selectively chosen based on accessibility. Subsequent drill holes will establish any trends from the initial holes that yielded the best results. For 2018, evaluation of this area will be based on results from up to 40 drill holes and 18 test pits. We will perform our work based on the most probable location of the ancient Tertiary channel theorized from the geophysical report by Arctic Geophysical. We will continue with drilling as many holes as possible until the financing for the testing program.



Claim # P509577, Area # 3, north view from the right side of valley. Proposed sample drill holes holes running across the valley in three rows in the vicinity of the Geophysical report of the valley profile cross section.



Claim # P509577, Area # 3. Sample drill holes to be spaced apart equally, in three rows, accross the valley and staggered from each other to provide a representative cross section of the test area, in the vicinity of the Geophysical bedrock profile data.

PROPOSAL SUMMARY

The goal for the 2018 season will be to locate and explore the bedrock faults, in the lower locations of Victoria Creek, to determine if the area contains economic quantities of gold. The focus will be in area # 2 and # 3, because the test results from 2016. We encountered permafrost is all drill holes and test pits confirming the area had not been disturbed by human activity.

In general, we made significant progress evaluating the property but only revealed a partial understanding of the subsurface dynamics of this watershed. We did not intersect any defined gold bearing channels but did encounter some tests that need further sampling in their vicinity to track the sediment flow behavior.

Generally, all test results were sub-economic and most sample results were void of gold in the upper test area # 1. No gold nuggets or gold that could be picked up by tweezers was found. Only small specs and flecks that clung to the bottom of a pan, were found.

Before we finished our testing in the 2017 season, we also searched area # 2 and # 3. To our delight there were several good results along the right bank of the valley at area # 2 within a shallow gravel seam. At area # 3, we started a large excavation above a drill hole sampled several years ago. We did not get to the 20 ft drill depth, to be able to confirm the economic drill sample.

SUMMARY and RECOMMENDATIONS

In our 2017 season, our auger rig managed to penetrate 20m depth, then encounter large boulders. At that depth the weight of the auger string/rig was equalized by the hole friction. The hole penetration rate essentially stopped at that depth. We succeeded in obtaining test results, but as soon as we began grinding on a boulder with the carbide bits, there was no progress. So, we were forced to retrieve our auger samples and start a new hole. We lost valuable time trying to penetrate boulders, only to reach another boulder and repeat the process. Some sample holes did successfully reached bedrock but hey were off to the side of the main channel and yielded poor results.

Our 2018 plan was to penetrate the boulder level with our ODEX drill rig. Based on our geophysical information there are several potential channels to test. Our target drilling depth was 40m. The drill is a track mounted drill with an onboard air compressor package (250 psi/1100cfm) that will percussion drill with a DTH carbide button bit. This rig is considerably more powerful than the auger rig. The rigs penetration rate exceeded my expectations.

We did not use any mud additives to the drill circulation, as there was plenty of ground water for lubrication and cooling the drill bit. The initial permafrost gravel layer was easily drilled within 2 minutes. Each drill stem is 3m long. We added a second drill stem and part way down our circulation (return mixture of air/cuttings from the drill bit) slowed down. We varied the air pressure/flow and stroked the drill string but the lost circulation did not improve. We attributed the “hole flow loss” to thawed water channels in the permafrost. When we reached 10m our air loss downhole prevented the drill cuttings from being flushed to the surface. This caused the drill stem to plug off and we would have to retrieve our drill stem and start a new hole.

At 10m depth we maintained 200 psi pressure and walked radially from the rig to determine if the air was reaching the surface. We discovered air “hissing” in the gravel overburden as far away as 100m from the drill hole. This is a huge learning for us as the permafrost appears to be riddled with flowing water channels. This explains why the deeper we dug our mining “cut” we encountered more water that what was flowing in the surface creek. Also, that the diversion of groundwater did not impact the water flow in the creek.

Back to our drill “circulation loss” dilemma. We could have tried using foam (or other coagulants) to seal off the permeable layers, to prevent the air loss. I am personally opposed to the introduction of chemicals into the ecosystem. I believe we can solve the air loss problem with a mechanical solution. Foam and other drilling chemicals are used more in the diamond (core) drilling industry where you have solid bedrock to drill your hole into. In the situation at Victoria Creek there are stratigraphy layers of clay and gravel. These gravel layers are as small as 300mm. You can hear and feel the gravel whenever it is being drilled. Each of the gravel layers, we encountered while drilling, appear to have flowing groundwater.

We tried a few experiments with the ground water. We would run the rig air for a precise time (down hole). Then we would shut off the rig entirely and listen to see how long it would take the air to escape from the various vent holes. There would be an initial depressurization, followed by a steady air flow at surface from ground leaks (as groundwater filled in the voids). This was done at each gravel layer encountered. This was confirmed that between layers of permafrost, there are voids (channels) containing ground water. The volume of water is significant. The deeper we drilled the results indicating voids was consistent, however more difficult to substantiate because there was so much air leakage.

There was nothing to gain by retrieving more soil samples from the upper gravel/clay layers that contain no economic gold, So, we put a transition on the new rig to convert it to drill with augers. We were hoping the weight and speed would be an advantage. However, the new rig is designed with threaded drill stem connections that spin together. The augers rely on a hex

shaft to slide onto a hexagonal bell end. Any slight misalignment, of the augers, required sledge hammers and pry bars to make a connection. No speed advantage as a result.

Without much drilling success, we re-entered some previous test pits and dug out the thawed material for soil samples against the frozen material. All soil test sample were run through the equipment we have at site. Results were sub-economic levels.

Both rigs were hauled from Victoria Creek, for the off-season repairs. The ODEX rig will be retrofitted with a “closed circulation” (dual walled) drill system. This retrofit will cost approximately $40k for materials only. This reverse circulation system will alleviate the air loss issues we were encountering.

We are still committed to continue to explore Victoria Creek. For all the effort we put into 2018, it did not yield the desired results.

We hope to return next year and continue our testing. A big thank you from our team to the Yukon Government for supporting the YMEP funding.

Sampling Report
On The
Victoria Creek Project

Work Period August 2st to August 14th, 2016

Located In
Dawson Range Region
On
NTS Mining Claim Map 115I03P
62°5’40” Latitude, -137°9’10” Longitude

Prepared by
Adam Roque

September 2, 2016

Contents

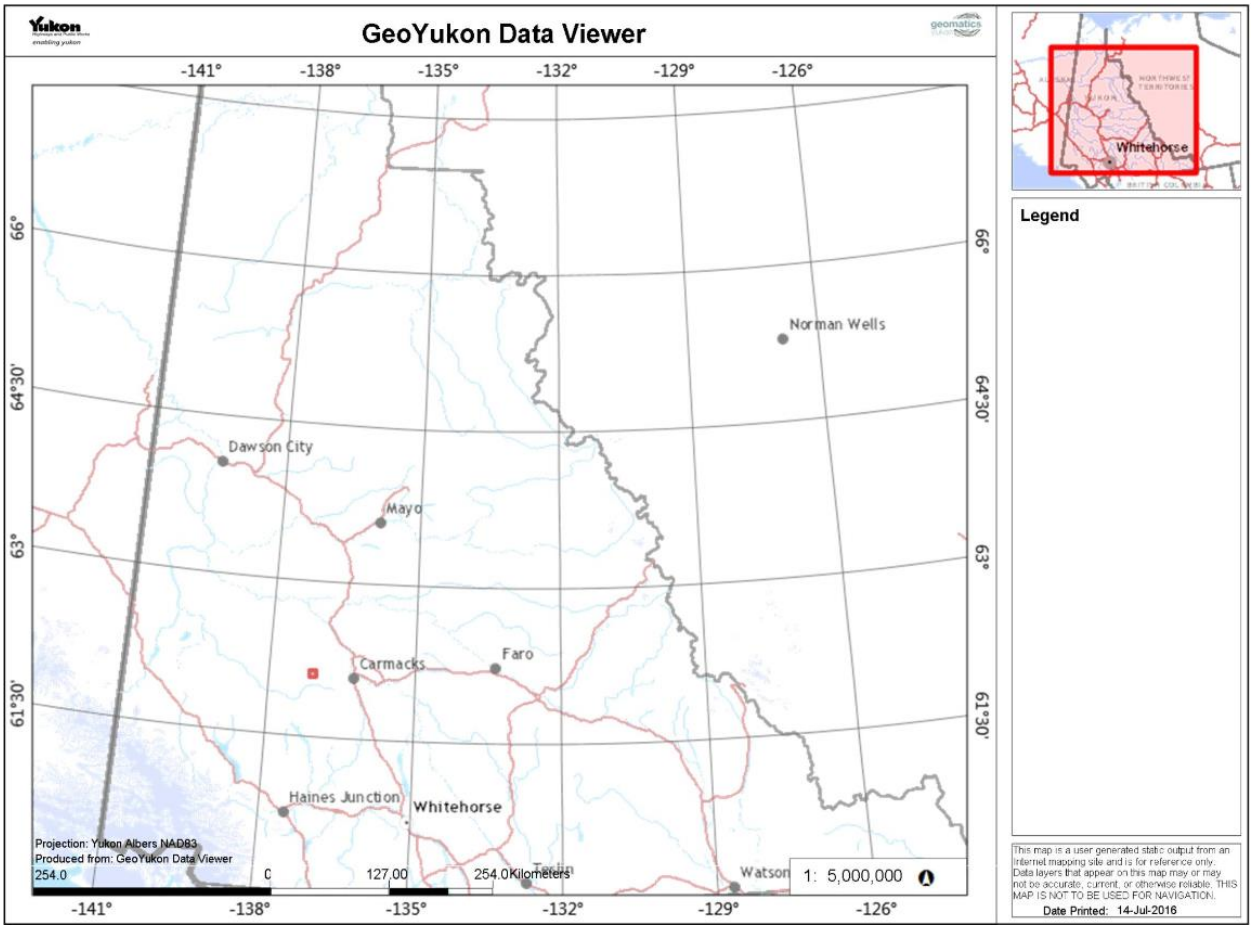
Introduction 2
Location & Access 2
Physiography 4
Bedrock Geology 5
Claim Area Division and Surface Evaluation 6
Previous Work History in Victoria Creek 8
Method of Sampling/Analyzing 9
Exploration Summary 9
Conclusions 16
Recommendations 17
Appendix A: Claims list 18
Appendix B: Exploration Area Outline 19
Appendix C: Exploration Area Outline (Continued) 20
Appendix D: Pit and Drill hole Map 22
Statement of Qualifications 23
References 24

Introduction

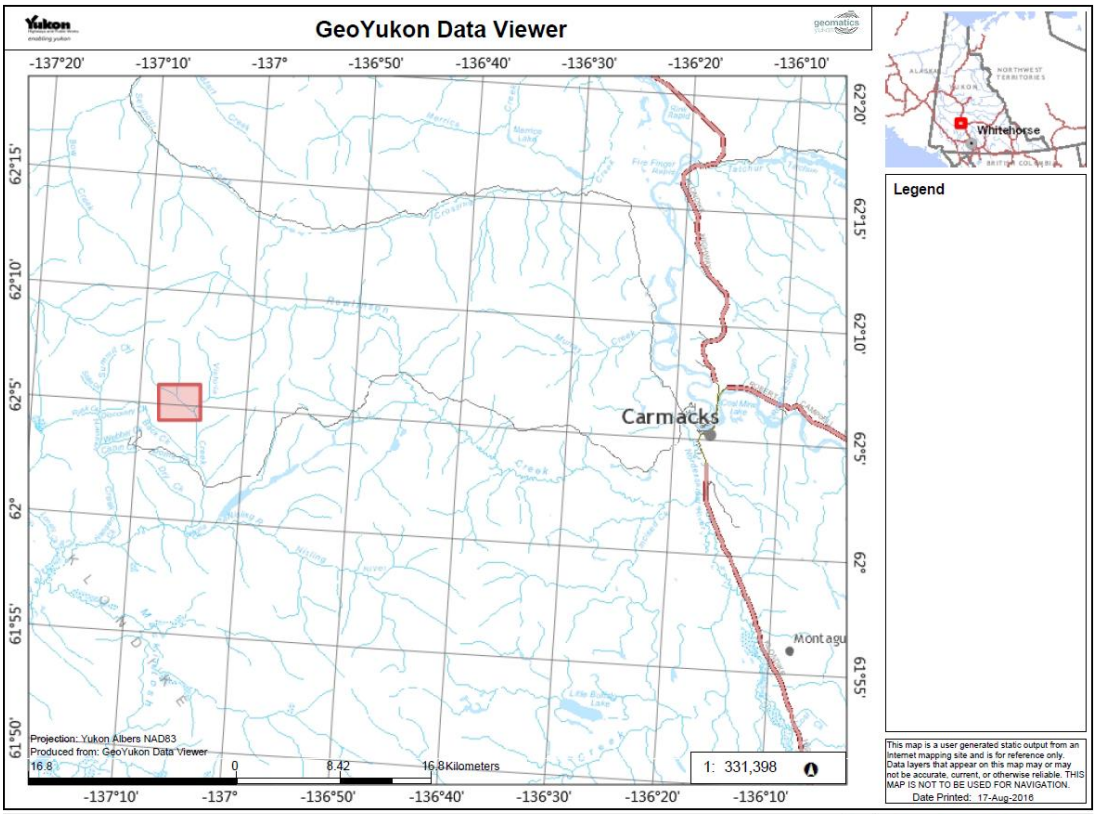
This report describes prospecting and trenching work performed on Victoria Creek, Mount Nansen, Yukon by Adam Roque (G.I.T.) of Subsurface Exploration Consulting Inc. and the seasonal staff of Bonnyville Oilfield Service and Supply between August 2nd and August 14th, 2016. Work was conducted within NTS mining claims map 115I03P within 38 blocks of contiguous mining claims along upper Victoria Creek. These claims range from claim numbers: P 26237 (Top) to P 50199 (Bottom). Geophysical profiling of the area was conducted in order to identify the potential of deep placer gravels overlying bedrock. The primary purpose of this exploration program was to target and evaluate any economic quantities of placer gold and to confirm depths of bedrock as interpreted from Geophysical data. The use of "we", "us", or "our" in this report refers to the exploration team consisting of Adam Roque (G.I.T.) of Subsurface Exploration Consulting Inc. and the seasonal staff of Bonnyville Oilfield Service and Supply.

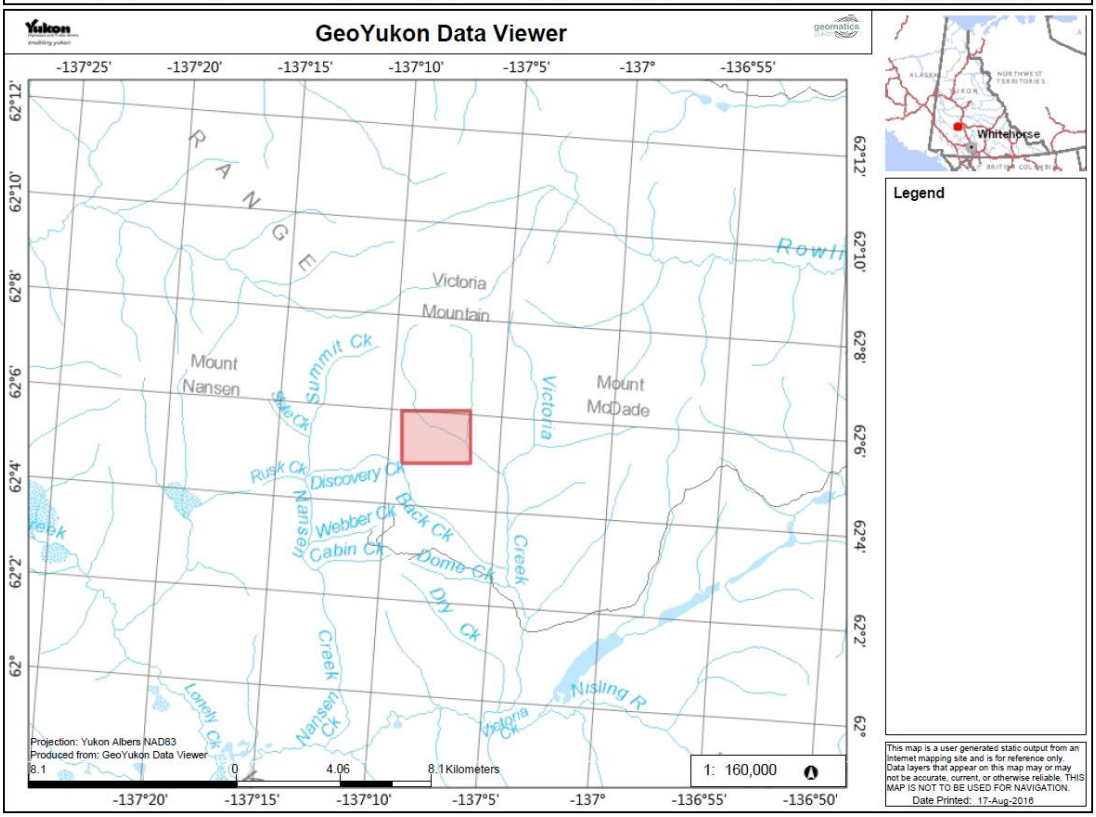
Location & Access

The region of interest is located in south-central Yukon (Map 1), approximately 60 kilometers west of the village of Carmacks. The work site is accessible by vehicle from Carmacks through mining roads at the base of Mt. Victoria

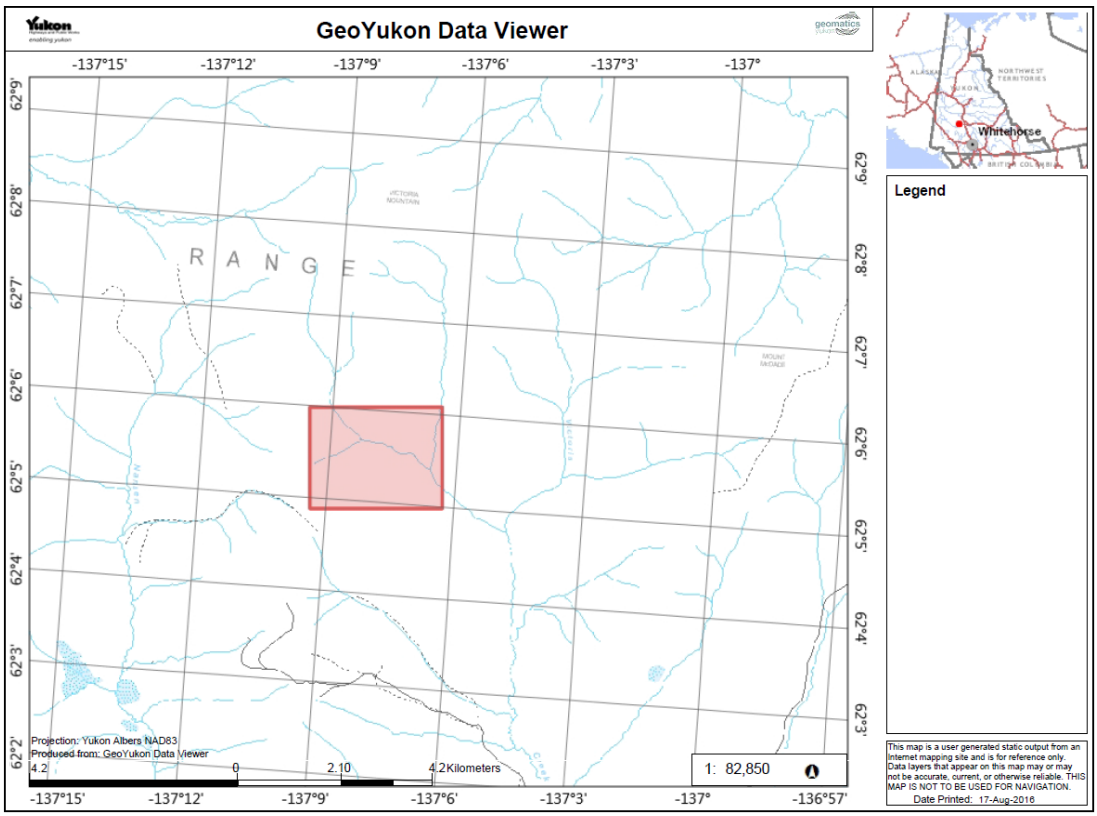


Map 1. Yukon Map





Map 2. Regional map (Top) and Map 3. Regional Map Zoomed in (Bottom)



Map 4. Region of interest map

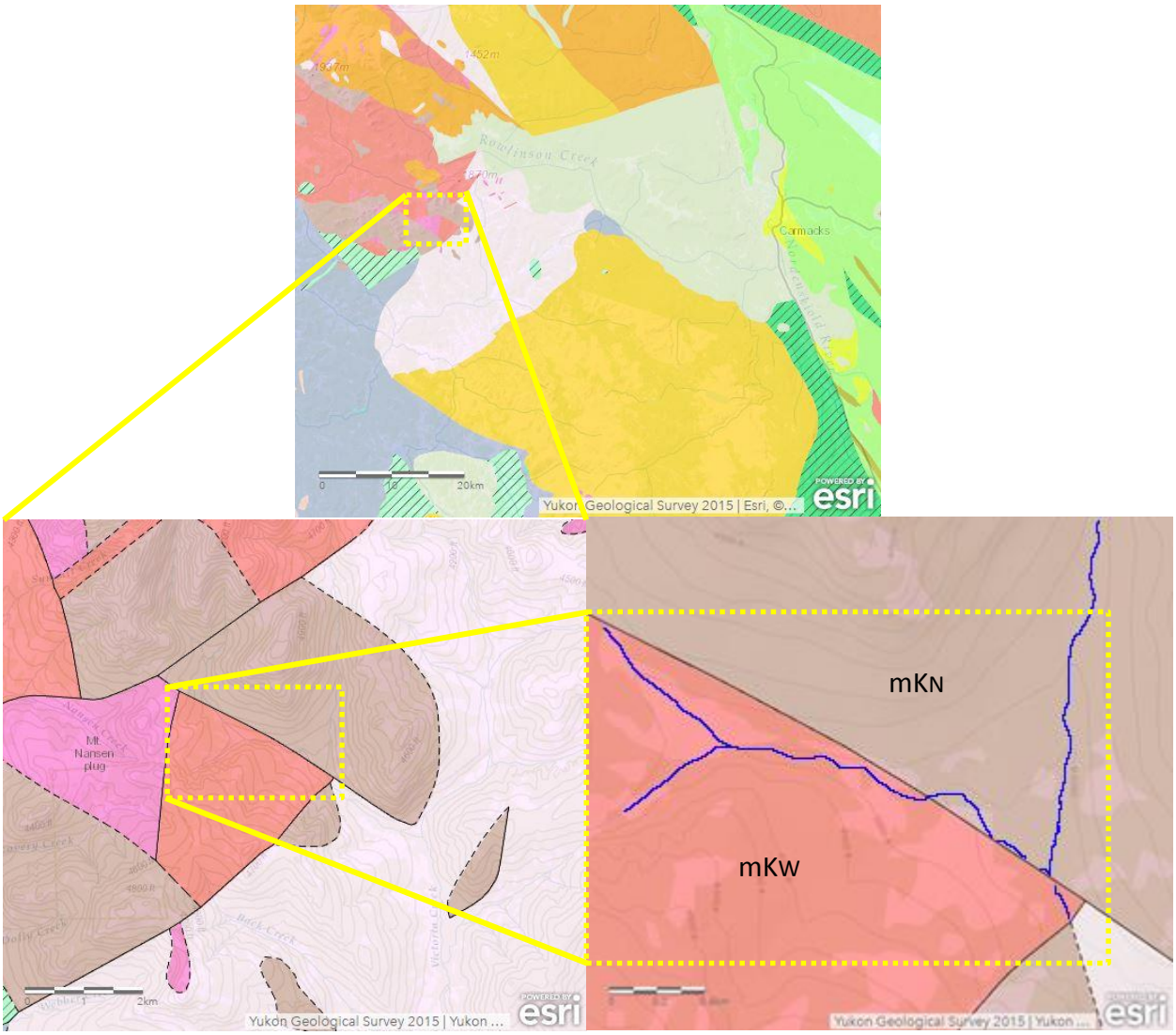
Physiography

The Physiographic Map of the Canadian Cordillera (Matthews, 1986) (as cited in Jackson, 2000) suggests that the area of study lies within the “Yukon Plateaus” consisting of isolated peaks in the Dawson Range region which rise up to 1820m along with rolling uplands with broad summits and ridges that are generally below 1500m above sea level. Some upland surfaces may have only experienced local developing alpine glaciation or have been unaffected by glaciation completely.

Bedrock Geology

The Yukon bedrock geology map (Colpron, Israel, Murphy, Pigage, and Moynihan, 2016) suggests that the majority of surrounding bedrock in the area of study is likely from the Early Cretaceous Whitehorse Suite (Map 5) (pale red unit). Colpron et al. (2016) propose that this suite of rocks comprises of generally equigranular granitic rocks with several varieties ranging from felsic, intermediate, locally mafic, and rarely syenitic compositions. These rocks are typically grey and are medium to coarse-grained.

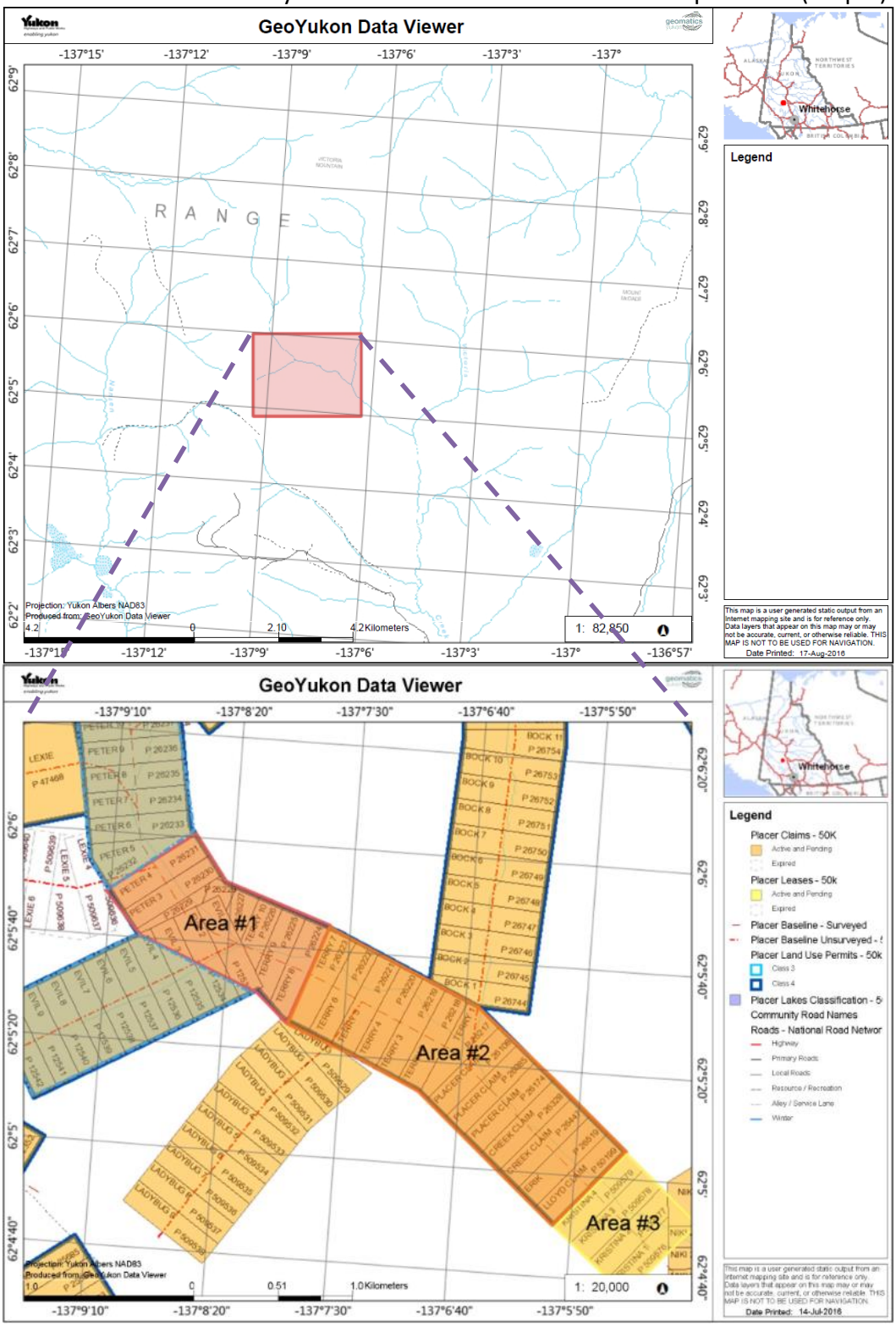
Further north of the study area and also part of Area #2 and Area #3, the pale brown unit is understood to be Lower Cretaceous in age and known as the Mount Nansen volcanics. This unit encompasses massive aphyric or feldspar-phyric andesite to dacite flows, tuff, flow-banded rhyolite, and quartz-feldspar porphyry plugs, dikes, sills and breccia (Colpron et al., 2016).



Map 5. Bedrock Geology maps of the Victoria Creek study area. Pale red areas represent the Early Cretaceous Whitehorse Suite (mKW); while, pale brown represents the Lower Cretaceous Mount Nansen Volcanics (mKN).

Claim Area Division and Surface Evaluation

Claims in the area of study were divided into three areas for exploration (Map 6):



Map 6. Claims and area division map

Area #1:

Claim Name	Claim Number
PETER 4	P 26231
PETER 3	P 26230
	P 26229
	P 26228
	P 26227
TERRY 10	P 26226
TERRY 9	P 26225
TERRY 8	P 26224

Area #1 consists of the junction between the upper Victoria Creek and the lower Eva Creek. Most of the material in this area appears to have been previously worked along the banks of the Creeks. Two Geophysical Surveys were taken in this area using 2D resistivity to create a profile interpretation.

Area #2:

Claim Name	Claim Number
TERRY 7	P 26223
TERRY 6	P 26222
TERRY 5	P 26221
TERRY 4	P 26220
TERRY 3	P 26219
TERRY 2	P 26218
TERRY 1	P 26217
PLACER CLAIM	P 26108
PLACER CLAIM	P 26085
PLACER CLAIM	P 26174
CREEK CLAIM	P 26328
CREEK CLAIM	P 26447
ERIK	P 26519
LLOYD CLAIM	P 50199

Area #2 contains most of the previous testing and mining efforts of Victoria Creek Mining. Placer Claims P 26085 and P 26108 have large amounts of material pushed towards the banks as previous mining operations took place in this area.

Area #3:

Claim Name	Claim Number
KRISTINA 4	P 509579
KRISTINA 3	P 509578
KRISTINA 2	P 509577
KRISTINA 1	P 509576

Area #3 is mainly virgin forests/vegetation. Pathways for vehicles and equipment seem limited as some portions of the ground are soft and/or muddy. Our team reached the end of our exploration season before we were able to do any exploration and testing.

Previous Work History in Victoria Creek

Although early mining within Victoria Creek has been observed from abandoned wooden rocker boxes and tin lined wooden sluice runs, there are no government documented mining shafts. Aside from the efforts of Bonnyville Oilfield Service and Supply, only shallow areas directly beneath the location of the current day creek are known to be worked from 2006 to 2010.

Method of Sampling

Samples were brought to surface by using either an excavator or 6" Auger drill. Their drilled/excavated depths were measured and sample material was typically collected every 5 feet into 5 gallon pails.

Method of Analyzing

Collected samples were brought back to a test wash shack in camp, were weighed, and evaluated for gold using a Goldenboy reverse helix test trommel. Concentrate samples were collected along with any Gold recovered from the test wash. Samples are held with Bonnyville Oilfield Service and Supply for future reference.

Exploration Summary

Work comprised of prospecting, mapping, auger drilling, and excavation of trenches/pits. Several bulk samples were taken from these test sites and evaluated through a Golden Boy Gold Rotary Separator to test their placer gold potential. The following is a summary of the work completed in each area:

<u>Area #1</u>:

Two Geophysical profile lines were taken by Artic Geophysics Inc. using 2D Resistivity in this area. These profiles provided potential depths of bedrock and gave us an idea of the most convenient spots to drill or excavate to reach it.

On Line 1 the bedrock surface was interpreted to be approximately 6 meters deep from an old settling pond at about 1200 meters elevation. Excavation of a pit revealed a resilient contact within 4 meters of digging (PIT-002). This pit soon flooded with water; therefore, a new pit was opened (PIT-003) in order to observe the stratigraphy of the sediments in the area (Figure 1). Unit A is mainly overburden/soil; Unit B is a massive diamicton; Unit C is a weakly laminated very fine sand to silt; Unit D is coarse to medium sand comprised of weathered bedrock; and lastly Unit E is the proposed bedrock.

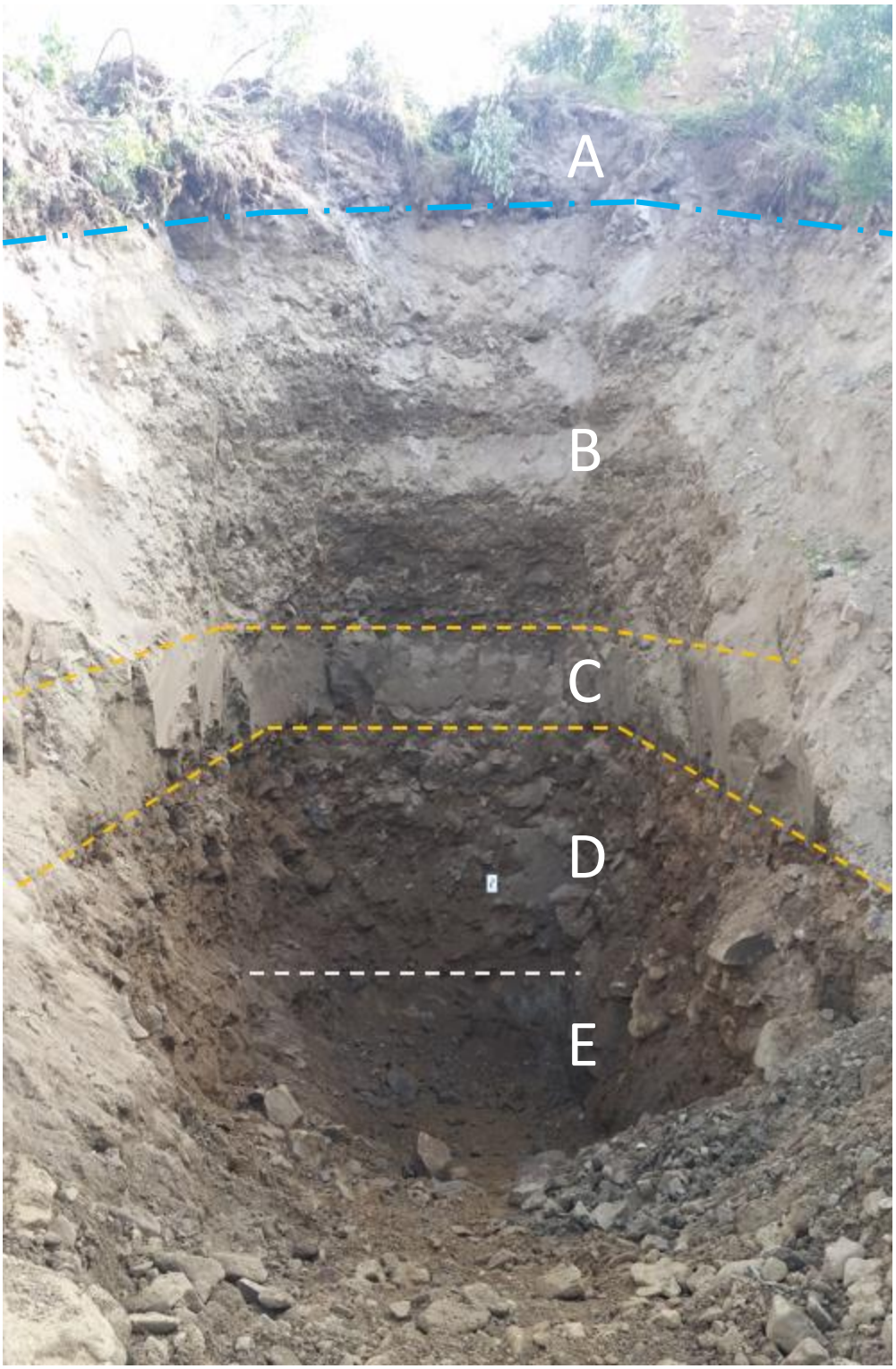


Figure 1. Sediment deposits in PIT-003. The white card in the photo is 150mm (image taken facing North)

Unit	Interpretation	Description	Thickness (m)
A	Overburden/Soil	Pale/light brown to brown, soil and very fine sand-silt, matrix-supported, poorly sorted, 30-40% subangular clasts, pebbles to boulders. Gradational lower contact.	~1
B	Massive Diamicton	Pale to Light brown, very fine sand to silt, unconsolidated, matrix-supported, poorly sorted, 30-40% clasts, mainly subangular to angular clasts, pebbles to boulders. Gradational upper contact and sharp lower contact. (Interpreted as Till)	~6
C	Weakly laminated sand/silts	Pale to Light brown, very fine sand to silt, weak laminations of darker sediment, matrix-supported, well sorted, minor to trace clasts. Upper and lower contacts are sharp.	0.8
D	Pre-glacial Weathered bedrock and paleo-channel deposits	Oxidized appearance, orange and light brown, coarse sand to silt, matrix-supported, poorly sorted, 30-40% clasts including large boulders, clasts appear subrounded to subangular, cobbles to boulders. Upper contact is sharp, lower contact appears sharp to gradational.	3
E	Bedrock (Whitehorse Suite)	Proposed bedrock boundary. Salt and pepper appearance. Generally medium grained equigranular biotite-hornblende granodiorite. Very competent rock.	N/A

Figure 2. Unit interpretations and descriptions of sediments in Area #1 PIT-003

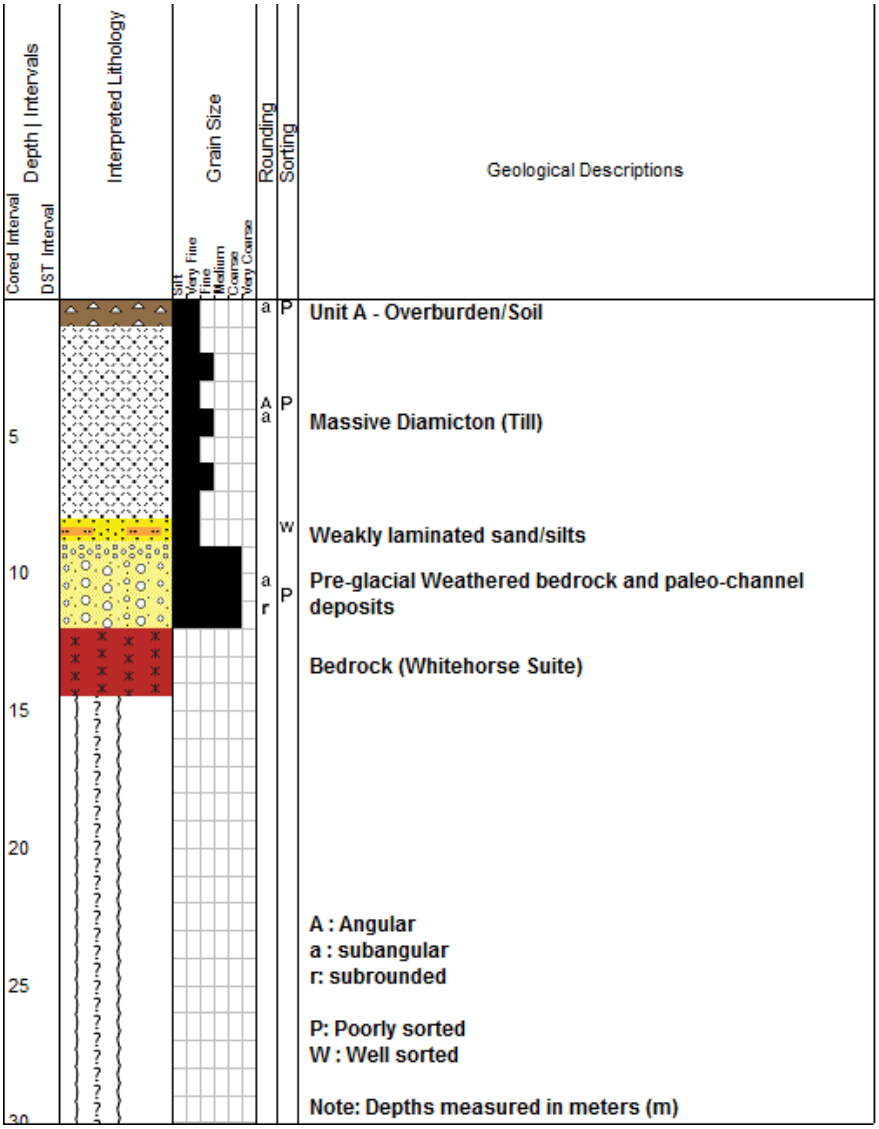


Figure 3. Idealized stratigraphic column of PIT-003. Bedrock depth understood to be around 1195 to 1200 meters elevation.

Our team attempted to replicate this pit onto Geophysical Line 2, but was unable to because of the muddy terrain and groundwater in the area.

We also did some testing on the North facing slope (south of the Creek in Area #1/South of PIT-003) and were able to find similar characteristics in PIT-022 (Figure 4). We did however not reach bedrock as groundwater flooded the pit. Further into the bank we wanted to do more testing, but were stopped due to the permafrost of the North-facing slope. PIT-014 to PIT-020 were left shallowly excavated to allow the permafrost to thaw.

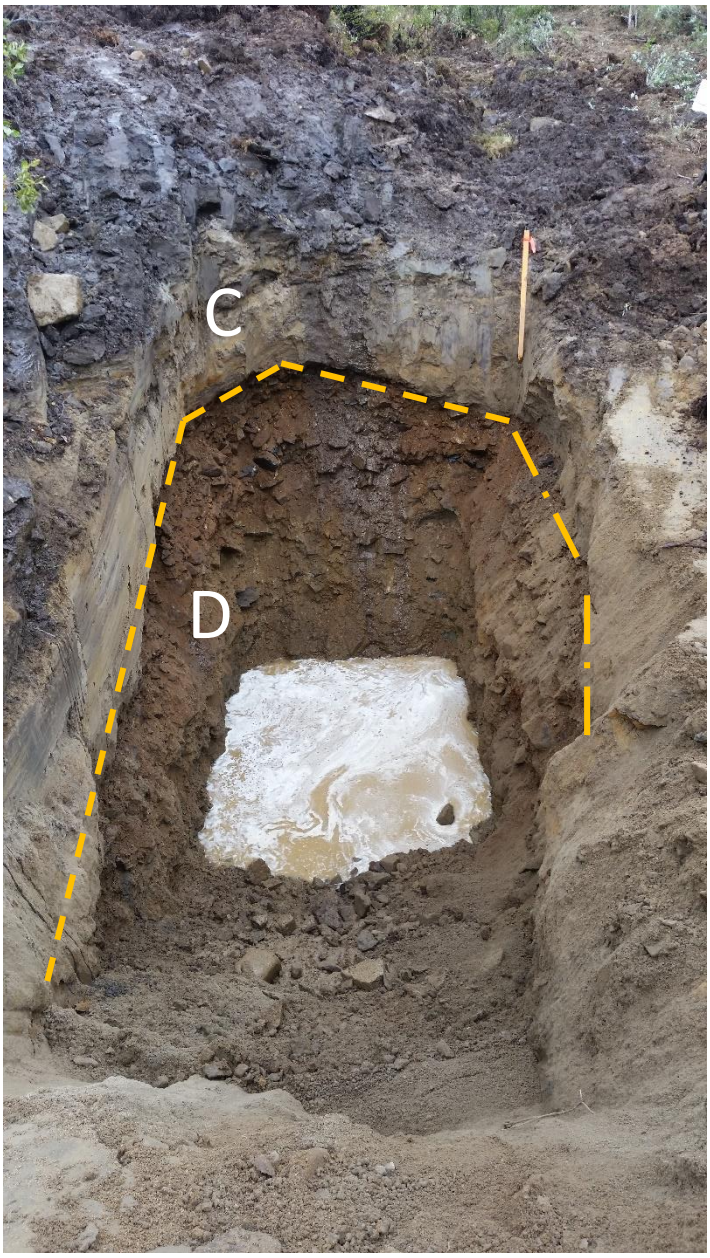






Figure 4. PIT-022 Sediments. PIT-022 flooding with groundwater (Left). Contact between proposed Unit C and Unit D (Top right) and possible varves in Unit C (Bottom right). Note: Wooden stake is approximately 1 meter in length and the white card 150mm.

Area #2:

A majority of testing was done on the south side of the creek, along the North facing slopes and afterward took place around the pre-existing pits which were created prior to the summer exploration season of August 2016.

PIT-023 and PIT-024 were excavated to verify the lateral continuity of Unit C and Unit D as seen in PIT-021. We were only able to excavate a few meters of material given that permafrost is present. These pits revealed thick beds of Pale teal to pale grey laminated silt and Pale brown to pale grey fine to very fine sands (Figure 5.).

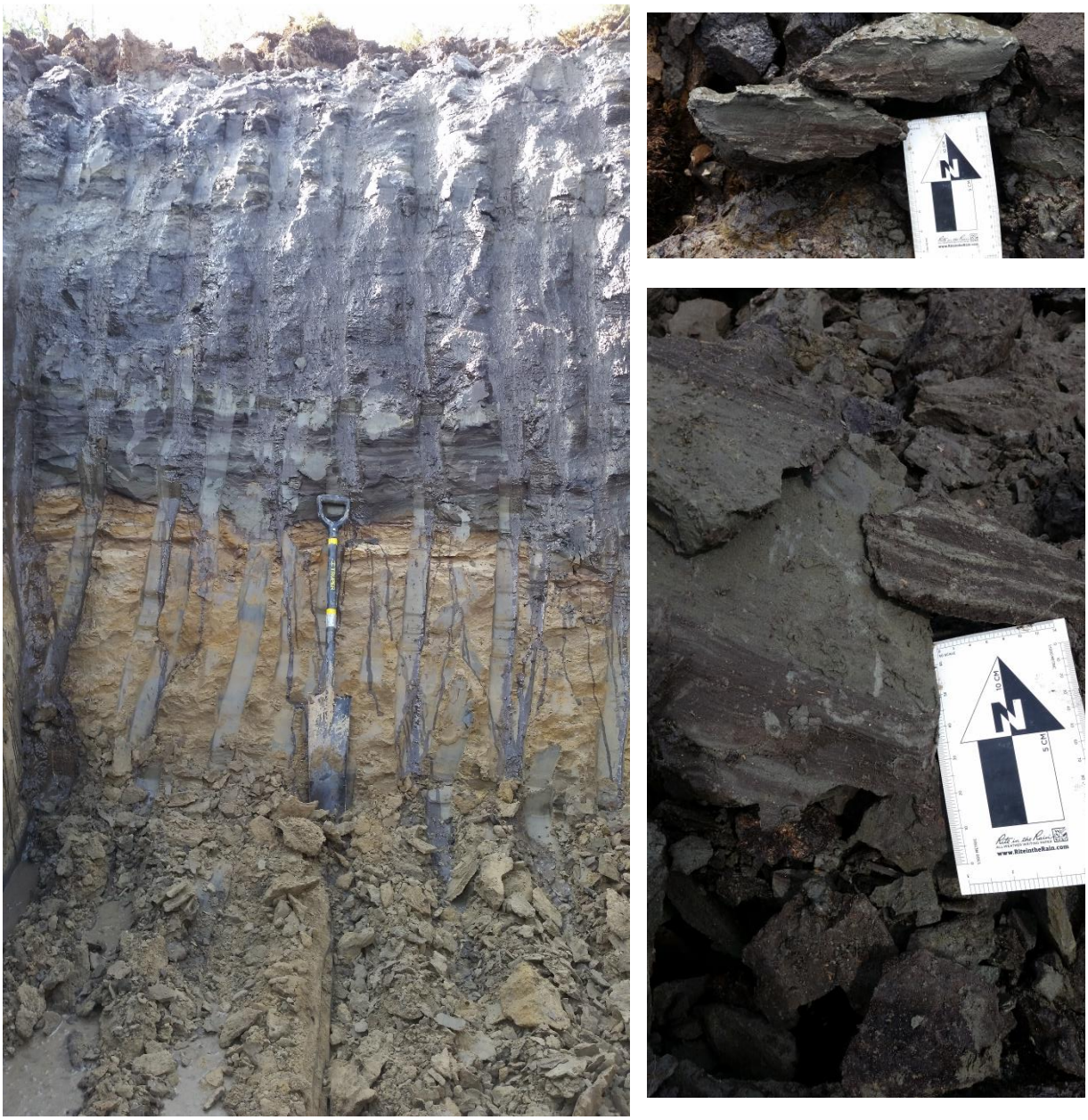


Figure 5. Bed of laminated silt underlain by fine to very fine sand (Left). Laminations in silt (Top and bottom right). The shovel is approximately 1.2 meters.

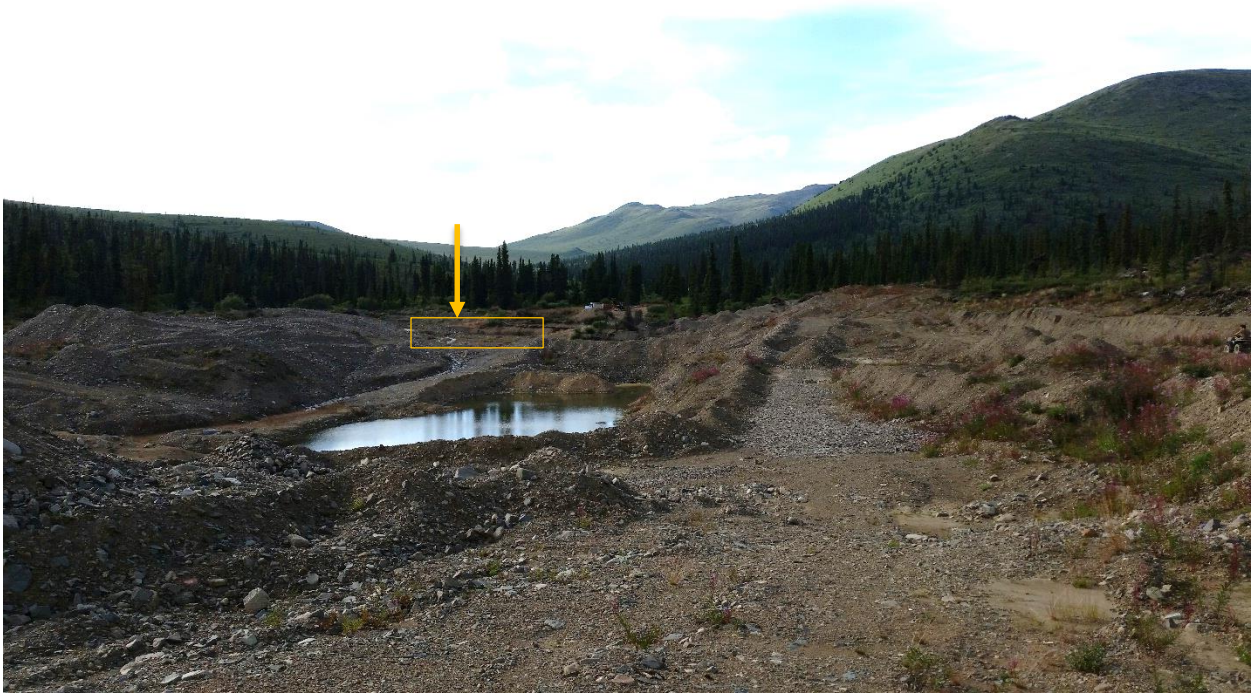


Figure 6. Mining work in Area #2 prior to the summer exploration season of August 2016. The orange outline represents the location of VC-010, PIT-026, and PIT-027. Image is facing North to Northwest.

Further Southeast in Area #2 testing took place near pre-existing pits that were used in Bonnyville Oilfield Service and Supply's past operations (Figure 6). This area comprised of Auger Drill VC-010 and PIT-026/PIT-027. Although significant test results were found in this area, groundwater limited our ability to make significant geological observations.

Area #3:

Area #3 is comprised mainly of virgin vegetation/forest. Access throughout Area #3 is limited and sections where there are pathways are soft and/or muddy. Our team was unable to do any testing or exploration work in Area #3 before the end of our exploration season.

Conclusions

For many years, the exploration of the Victoria creek area has been undocumented and explored at shallow depths. During this exploration season, we were able to do testing in Area #1 and Area #2 and evaluate their economic quantities of placer gold.

In Area #1, we were able to excavate a pit to better understand the lithologic stratigraphy of the area and verify the interpreted Geophysical profile. We were also able to expose pits subject to permafrost to be later excavated and tested in the future. In Area #2, we discovered thick beds of silt and sand which will also require further excavation to uncover their underlying sediments. Area #3 is left unexplored by our team and should be investigated in the future.

In conclusion, additional testing and excavation of exposed permafrost areas and areas with limited groundwater will be necessary to make new interpretations on the sediments, bedrock depths, and economic quantities of deep placer gold deposits. The efforts of Bonnyville Oilfield Service and Supply will provide documented data for future exploration programs and miners.

Recommendations

- Trenching, auger drilling, and bulk sampling methods is recommended to further determine pay zones of the Victoria Creek area.

- Continued prospecting and testing should be carried out during a drier season to minimize the constant issue of pits flooding.

- Exposure of North facing slopes during warmer seasons would allow permafrost to melt in areas of interest. Permafrost is an issue which delayed or ceased excavation during the testing period.

- New Geophysical Profiles may be useful in determining the depth to bedrock in Area #2 and Area #3. This may also be useful in verifying the extent of the above mentioned units and overall structure.

- Regular maintenance and refining of the A101-200 GOLDENBOY SEPARATOR. Verifying the quality and accuracy of results from samples is of paramount importance.
  I would suggest methods similar to those done in a laboratory setting which use:

A blank sample – a sample which does not contain the mineral being test for. This will test for any potential contamination coming from previous tests and in the testing equipment.

A standard sample – a sample containing a known amount of the mineral being tested for (or other dense mineral) which can reproduce the same results every test. This will assure the calibration of the test equipment or in personnel sample handling.

A field duplicate sample – Two samples taken from the same site and depth to test the consistency in the sampling procedure, for any contamination, and calibration of equipment. Note: This sample may not be as useful as there may be variance in precious metal samples due to the nugget effect.

Appendix A: Claims list

Claim name	Claim ID
	P 26228
	P 26229
PETER 3	P 26230
PETER 4	P 26231
PETER 5	P 26232
PETER 6	P 26233
PETER 7	P 26234
PETER 8	P 26235
PETER 9	P 26236
PETER 10	P 26237
TERRY 1	P 26217
TERRY 2	P 26218
TERRY 3	P 26219
TERRY 4	P 26220
TERRY 5	P 26221
TERRY 6	P 26222
TERRY 7	P 26223
TERRY 8	P 26224
TERRY 9	P 26225
TERRY 10	P 26226
	P 26227

PLACER CLAIM	P 26174
PLACER CLAIM	P 26085
PLACER CLAIM	P 26108
KRISTINA 1	P 509576
KRISTINA 2	P 509577
KRISTINA 3	P 509578
KRISTINA 4	P 509579

Claim name	Claim ID
EVIL 1	P 12533
EVIL 2	P 12534
EVIL 3	P 12535
EVIL 4	P 12536
EVIL 5	P 12537
EVIL 6	P 12538
EVIL 7	P 12539
EVIL 8	P 12540
EVIL 9	P 12541
EVIL 10	P 12542
LADYBUG	P 509529
LADYBUG 1	P 509530
LADYBUG 2	P 509531
LADYBUG 3	P 509532
LADYBUG 4	P 509533
LADYBUG 5	P 509534
LADYBUG 6	P 509535
LADYBUG 7	P 509536
LADYBUG 8	P 509537
LADYBUG 9	P 509538

CREEK CLAIM	P 26447
CREEK CLAIM	P 26328
ERIK	P 26519
LLOYD CLAIM	P 50199

Appendix B: Exploration Area Outline

Area #1

Claim Name	Claim Number
PETER 4	P 26231
PETER 3	P 26230
	P 26229
	P 26228
	P 26227
TERRY 10	P 26226
TERRY 9	P 26225
TERRY 8	P 26224

Area #2

Claim Name	Claim Number
TERRY 7	P 26223
TERRY 6	P 26222
TERRY 5	P 26221
TERRY 4	P 26220
TERRY 3	P 26219
TERRY 2	P 26218
TERRY 1	P 26217
PLACER CLAIM	P 26108
PLACER CLAIM	P 26085
PLACER CLAIM	P 26174
CREEK CLAIM	P 26328
CREEK CLAIM	P 26447
ERIK	P 26519
LLOYD CLAIM	P 50199

Area #3

Claim Name	Claim Number
KRISTINA 4	P 509579
KRISTINA 3	P 509578
KRISTINA 2	P 509577
KRISTINA 1	P 509576

Appendix C: Exploration Area Outline

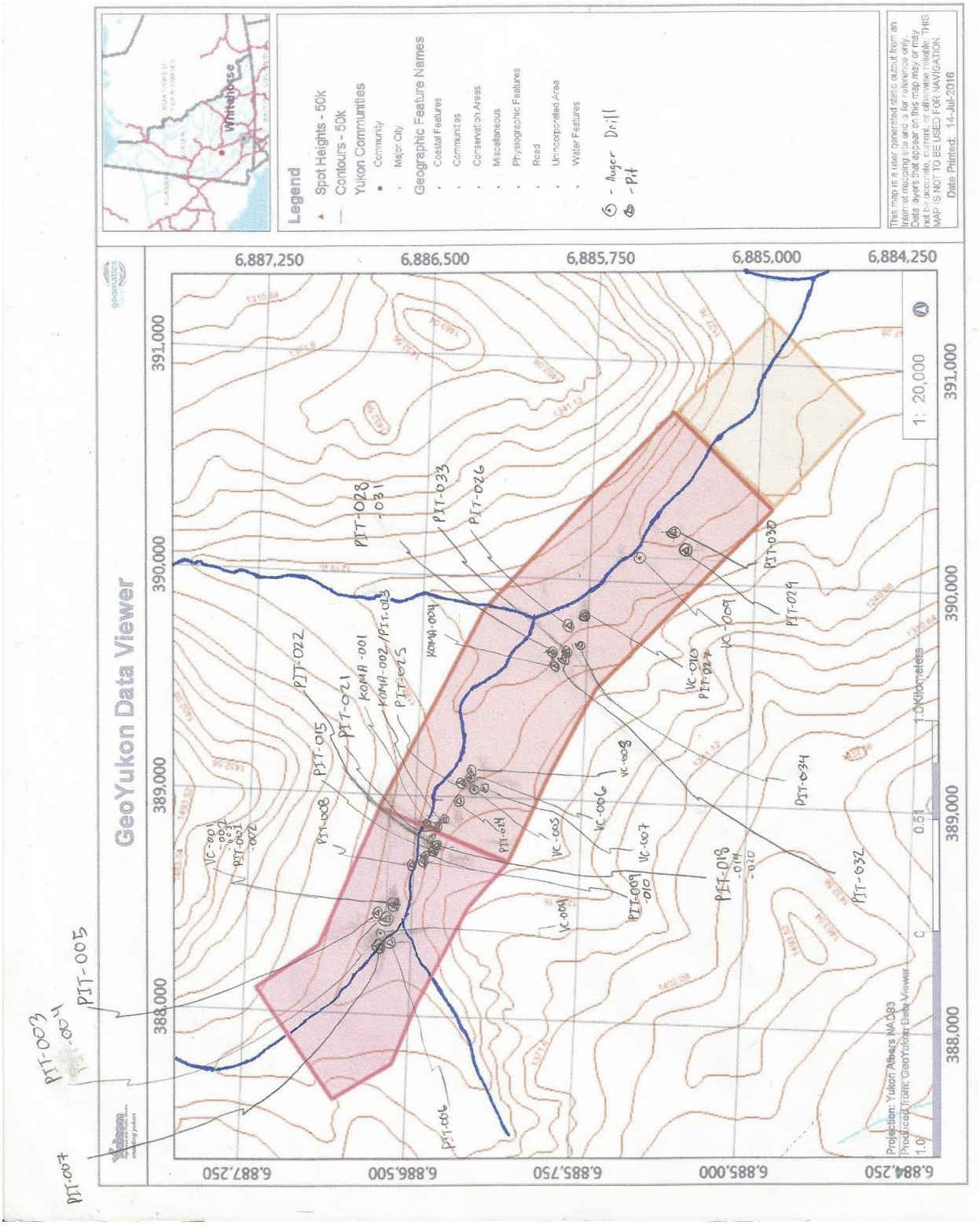
List of GPS Marks — Yukon Albers NAD83 Projection

Accuracy +/- (in meters)		UTM 8		Claim name	Claim ID	Elevation (m)
5m	VC- 001	388511	6886568	TERRY 10	P 26226	1208
5m	VC- 002	388511	6886568	TERRY 10	P 26226	1208
5m	VC- 003	388511	6886568	TERRY 10	P 26226	1208
4m	VC- 004	388386	6886644		P 26227	1212
5m	VC- 005	389071	6886213	TERRY 6	P 26222	1188
5m	VC- 006	389071	6886213	TERRY 6	P 26222	1181
3m	VC- 007	389073	6886218	TERRY 6	P 26222	1187
5m	VC- 008	389109	6886263	TERRY 5	P 26221	1178
4m	VC- 009	390109	6885521	CREEK CLAIM	P 26328	1133
6m	VC- 010	389838	6885777	PLACER CLAIM	P 26085	1138
5m	PIT- 001	388511	6886568	TERRY 10	P 26226	1208
5m	PIT- 002	388511	6886568	TERRY 10	P 26226	1209
4m	PIT- 003	388451	6886607		P 26227	1207
5m	PIT- 004	388448	6886613		P 26227	1210
5m	PIT- 005	388449	6886662	TERRY 10	P 26226	1210
4m	PIT- 006	388344	6886614		P 26227	1207
4m	PIT- 007	388298	6886637		P 26227	1215
4m	PIT- 008	Aband	Aband	TERRY 9	P 26225	
4m	PIT- 009	388707	6886464	TERRY 8	P 26224	1194
4m	PIT- 010	388714	6886459	TERRY 8	P 26224	1196
3m	PIT- 011	388695	6886459	TERRY 8	P 26224	1195
3m	PIT- 012	388721	6886452	TERRY 8	P 26224	1195
4m	PIT- 013	388732	6886445	TERRY 8	P 26224	1193
5m	PIT- 014	388742	6886442	TERRY 8	P 26224	1198
4m	PIT- 015	388754	6886431	TERRY 8	P 26224	1193
4m	PIT- 016	388762	6886427	TERRY 8	P 26224	1193
3m	PIT- 017	388775	6886423	TERRY 8	P 26224	1194
3m	PIT- 018	388784	6886420	TERRY 8	P 26224	1197
4m	PIT- 019	388790	6886417	TERRY 8	P 26224	1195
4m	PIT- 020	388799	6886415	TERRY 8	P 26224	1192
7m	PIT- 021	388870	6886419	TERRY 7	P 26223	1185
6m	PIT- 022	388795	6886427	TERRY 8	P 26224	1195
3m	PIT- 023	388900	6886375	TERRY 7	P 26223	1180
4m	PIT- 024	388994	6886308	TERRY 6	P 26222	1183

5m	PIT- 025	389079	6886290	TERRY 6	P 26222	1174
4m	PIT- 026	389801	6885830	PLACER CLAIM	P 26108	1141
6m	PIT- 027	389838	6885777	PLACER CLAIM	P 26085	1138
4m	PIT- 028	389670	6885911	TERRY 1	P 26217	1149
4m	PIT- 029	390175	6885320	CREEK CLAIM	P 26447	1128
4m	PIT- 030	390234	6885378	CREEK CLAIM	P 26447	1127
4m	PIT- 031	389660	6885881	TERRY 1	P 26217	1150
6m	PIT- 032	389647	6885849	TERRY 1	P 26217	1146
4m	PIT- 033	389681	6885837	PLACER CLAIM	P 26108	1147
3m	PIT- 034	389717	6885798	PLACER CLAIM	P 26108	1147

Accuracy +/- (in meters)		UTM 8		Claim name	Claim ID	Elevation (m)
5m	KOMA- 001	388893	6886468	TERRY 7	P 26223	188
5m	KOMA- 002	389075	6886208	TERRY 7	P 26223	1184
	KOMA- 003	Mark not taken				
4m	KOMA- 004	389621	6885887	TERRY 1	P 26217	1148
	KOMA- 005	Mark not taken				

Appendix D: Pit and Drill hole Map



Map of Pit and Drill Hole locations

Statement of Qualifications

I, Adam Roque, from Subsurface Exploration Consulting Inc. of Edmonton, Alberta, directed and participated in the exploration work described herein.

I am a graduate of the University of Alberta's Bachelor of Science with specialization in Geology, class of 2012.

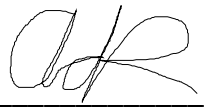
I have been involved in hard rock exploration programs in the Philippines and in Oil & Gas exploration programs in Saskatchewan and Alberta since 2013.

This report is based on fieldwork observations directed and completed by myself, and includes information from previous studies/work that has been made available to the public.

This report contains observations based on fieldwork completed during August 2016.

This report is based on fieldwork completed in the Victoria Creek area.

Respectfully submitted,



Adam Roque

September 2, 2016

Date

References

Colpron, M., Israel, S., Murphy, D., Pigage, L. and Moynihan, D., 2016. Yukon bedrock geology map. Yukon Geological Survey, Open File 2016-1, scale 1:1 000 000, map and legend.

Jackson, L.E., Jr. 2000. Quaternary geology of the Carmacks map area, Yukon Territory. Geological Survey of Canada, Bulletin 539.

Mathews, W.H. (1986): Physiographic Map of the Canadian Cordillera, Geological Survey of Canada, "A" Series Map 1701A, Scale 1:500,000.

SECTION # 9

GLOSSARY

Alluvial Transported and deposited by flowing water. Related to sediment deposits that were originally produced by flowing water.
Assay A laboratory test for mineral content
Bank yard The volume of material, pay dirt, equivalent to one cubic yard in situ (in place) that in its original undisturbed place in the ground. This volume does not include a swell factor or reduction in volume because of screening.
Bedrock Solid rock underlying placer gravels. In many cases the bedrock surface is weathered or decomposed and can be ripped or dozed
Bench A placer deposit in an ancient stream channel at an elevation above the present stream channel.

Black sand A magnetic black iron oxide, an important iron ore, is found with gold

Breccia A rock composed of angular fragments cemented together. Regions between the fragments are often hollow and contain tiny crystals.
Claim A piece of land in a gold productive area. Legally staked out and recorded the title with the gold commissioner of that area.
Classification Basically is screening. In placer mining terminology classification commonly refers to mechanical separation of the coarse material from pay dirt according to size. Classification may be used in the mining operation before pay dirt enters the wash plant or within the wash plant itself.
Cleanup Collecting concentrated placer material from the wash plant recovery devices for further concentration of gold particles.
Coarse Tailings Pebble and larger material discharged from a wash plant or classification. System.

Crystal A mineral's external form determined by its unique orderly arrangement of atoms. Crystals are solids, bounded by planes, which intersect at specific angles.

Cut/ Mine Pit The placer mining process in which pay dirt is excavated from the surface of gold bearing gravels to bedrock and beyond. The excavation itself, from which overburden and pay dirt have been removed; is called the cut or open cut.

Density The mass p.er unit volume of a substance in grams per cubic centimetre at 20^{0} C. Placer gold density is about 16 to 19 gm/cc compared to water, which has a density of one gm/cc. Related to specific gravity.

Deposit Any natural accumulation of a mineral caused by the action of wind or water.
Development The working of an ore deposit.
Discharge The rate of flow, or volume of water flowing by a point in a given period of time. Often expressed as cubic metres per second in metric, or cubic feet per second in English units. A common unit of discharge in placer mining is the Imperial Gallon per Minute (IGPM). One IGPM = 1.2 U.S. GPM. One Cubic foot per second (CFS) = 374 IGPM. 1 Cubic meter per second = 35.315 cfs = 7,812.14 Igpm 1000 Igpm = 0.128 m3/sec = 4.52 cfs.

Diorite Coarse-grained igneous rock of intermediate composed of approximately equal amounts of plagioclase feldspar and ferromagnesian minerals.

Element A substance that cannot be broken down to other substances by ordinary chemical methods.

End moraine A ridge of till piled up along the front edge of a glacier.

Erosion A natural wearing away of the earth's substance, e.g.; [rain, wind, water]

Erratic An ice-transported boulder that has not been derived from bedrock near its present site.

Esker A long, sinuous ridge of sediment deposited by glacial melt water.

Extrusive rock Igneous rock that has been exposed to surface.

Extrusive Molten rock that flowed onto the earth's surface where it cooled.

Faceted rock A rock fragment with one or more flat surfaces caused by erosive action.

Fault A fracture in the terrain along which opposing sides have moved.

Fineness Word used to describe the purity of gold, e.g.; [960 fine gold contains 960 parts gold and 40 parts other minerals- copper, silver, gold, etc]

Fissure A separation along a fracture or break in rock.
Fluvial deposit A sedimentary deposit left behind by a river.
Fracture A property of minerals used in their identification. Fracture is used to describe the surface appearance of a freshly broken mineral. Some terms used to describe a fracture are conchoidal, hackly, uneven and splintery. [Or the way a substance breaks where not controlled by cleavage]
Fracture zone Major line of weakness in the earth's crust that crosses the mid-oceanic ridge at approximately right angles.
Free gold Not combined with any other mineral, e.g.; [placer gold]
Galena A type of silver ore.
Glacier A sheet of ice formed by re-crystallized snow.
Grizzly An iron grating or long steel bars used to classify down material while being sluiced.
Ground moraine A blanket of till deposited by a glacier or released as glacier ice melted.
Hydrothermal veins A preexisting fracture within which minerals have been deposited and/or leeched out by hydrothermal action. Minerals commonly associated with hydrothermal veins include gold, pyrite, and galena.
Igneous rock Rocks that were formed by solidification from a molten state.
Lateral moraine A low ridge-like pile of till along the side of a glacier.
Lode A deposit of an ecomically important mineral contained within solid rock.
Malleable Metals that can be pounded and flattened without breaking.
Metamorphic faces Pressure and temperature stability fields for metamorphic rocks as determined by mineral assemblages.
Metamorphic rock A rock changed by the heat or tremendous pressure changing the rock into a structure, e.g.; [clay to slate].
Moraine A body of till either being carried on a glacier or behind after a glacier has receded.
Muck In placer mining means the frozen overburden on top of pay gravels made of fine silt, organic matter and ice.
Black muck is the term reserved for a unique kind of dark coloured muck in the Klondike.

Ore A natural mineral that can contain one or more precious metals, e.g.; [silver ore, gold ore, copper ore, etc]

Ore minerals Are minerals having commercial value.
Outcrop Refers to an exposed part of a mineral-bearing vein or deposit.

Overburden Any organic material or mineral soil lying on top of pay gravels that must be removed to create the cut.
Pay Dirt The gravels in an alluvial deposit which contain placer gold in economic amounts.

Placer A glacial, alluvial or marine deposit containing concentrations of tough and heavy minerals of all kinds.

Placer mine Surface mines in which valuable mineral grains are extracted from stream bar or beach deposits

Quartz May be the only familiar name among the most common minerals on the earth.

Quartzite A rock composed of sand-sized grains of quartz that have been welded together during metamorphism.

Receding glacier A glacier with a negative budget, which causes the glacier to grow smaller as its edges melt back.
Recessional moraine An end moraine built during the retreat of a glacier.
Rhyolite A fine-grained, igneous rock, which is largely made up of feldspar and quartz.

Sand Sediment composed of particles with a diameter of .062 to 2 mm.
Sandstone A sedimentary rock composed of tightly compacted grains of sand.
Schist A metamorphic rock, which can usually be split into thin flakes or slabs.
Seam Generally thin layer or vein containing concentrations of minerals.
Secondary deposit These are deposits where the minerals are found already removed from their original place of formation. That removal is usually accomplished by forces of nature, generally wind and water, and occasionally by natural chemical means.
Sediment Loose, solid particles that can originate by [1]-weathering and erosion of preexisting rocks; [2]-chemical precipitation from solution, usually in water; and [3]-secretion by organisms.
Sedimentary breccia A coarse- grained sedimentary rock composed of lithified rubble.
Sedimentary facies Significantly different rock types occupying laterally distinct parts of the same-layered rock unit.
Sedimentary A rock formed by the compacting and cementing of sediments and debris from other rocks and animals.
Sedimentary rock A rock formed by pressure, cementing or other means over time.
Shaft Holes sunk in the ground to reach bedrock.
Shale A type of fine, layered sedimentary rock formed from the deposition of silt, clay, and mud over time.
Sterling A standard alloy of silver, which is composed of 92.5 parts silver to 7.5 parts copper.
Subduction The sliding of the sea floor beneath a continent or island arc.
Tailings Generally waste rock from a mining operation.
Talus Rock and gravel deposited by the forces of nature at the base of a cliff or slope.
Tarnish The change in surface color of a mineral, usually due to exposure to air.
Troy weight A weighing system used for weighing precious metals.
Truncated spur Triangular facet where the lower end of a ridge has been eroded by glacial ice.
Vein A solid mass of minerals that can have significant length, width, and depth. A lode vein has length, depth, and thickness; it may also have a series of veins interconnected.

Specific Gravity

What is specific gravity? Specific gravity is simply the weight in grams of one cubic centimeter of a metal. The Specific Gravity Test is used to determine the amount of gold (in nuggets) that contain a mixture of gold and other materials. In this example of the specific gravity test, we are using a gold nugget mixed with quartz. Simply put, the formula is 3.1 x the weight in water, minus 1.9 x the weight in air:

Dry nugget weighs 96 grams x 1.9 = 182.4 "Wet" nugget weighs 74.5 grams x 3.1 = 230.95

- "Wet" = weight in water - Put a container with enough water to cover the nugget on a scale. Tare (zero) out the scale and hang the nugget by a string in the water.

Subtract the dry weight from the wet weight
230.95 - 182.4 = 48.55

Now we divide 48.55 by 31.1 to determine how much gold is in our nugget
48.55 / 31.1 = 1.56 ounces of gold

- 31.1 = This is the number of grams per ounce of gold

Original dry weight = 96 grams / 31.1 = 3.08 ounces.
Subtract the gold weight from the dry weight.
3.08 ounces - 1.56 ounces = 1.52 ounces.
Therefore what is left is 1.52 ounces of quartz.

The specific gravity for gold is 19.3.
The specific gravity for quartz is 2.65.
The ratio between gold and quartz is 7.28 X.

Here are specific gravity's and other properties of a few more metals:

Metal	Specific Gravity	Melting Point (ºF)	Melting Point (ºC)
Copper	8.96	1981	1083
Gold	19.32	1945	1063
Iron	7.87	2802	1539
Lead	11.34	621	327
Nickel	8.90	2651	1455
Palladium	12.00	2831	1555
Platinum	21.45	3224	1773
Silver	10.49	1761	961

Section # 10

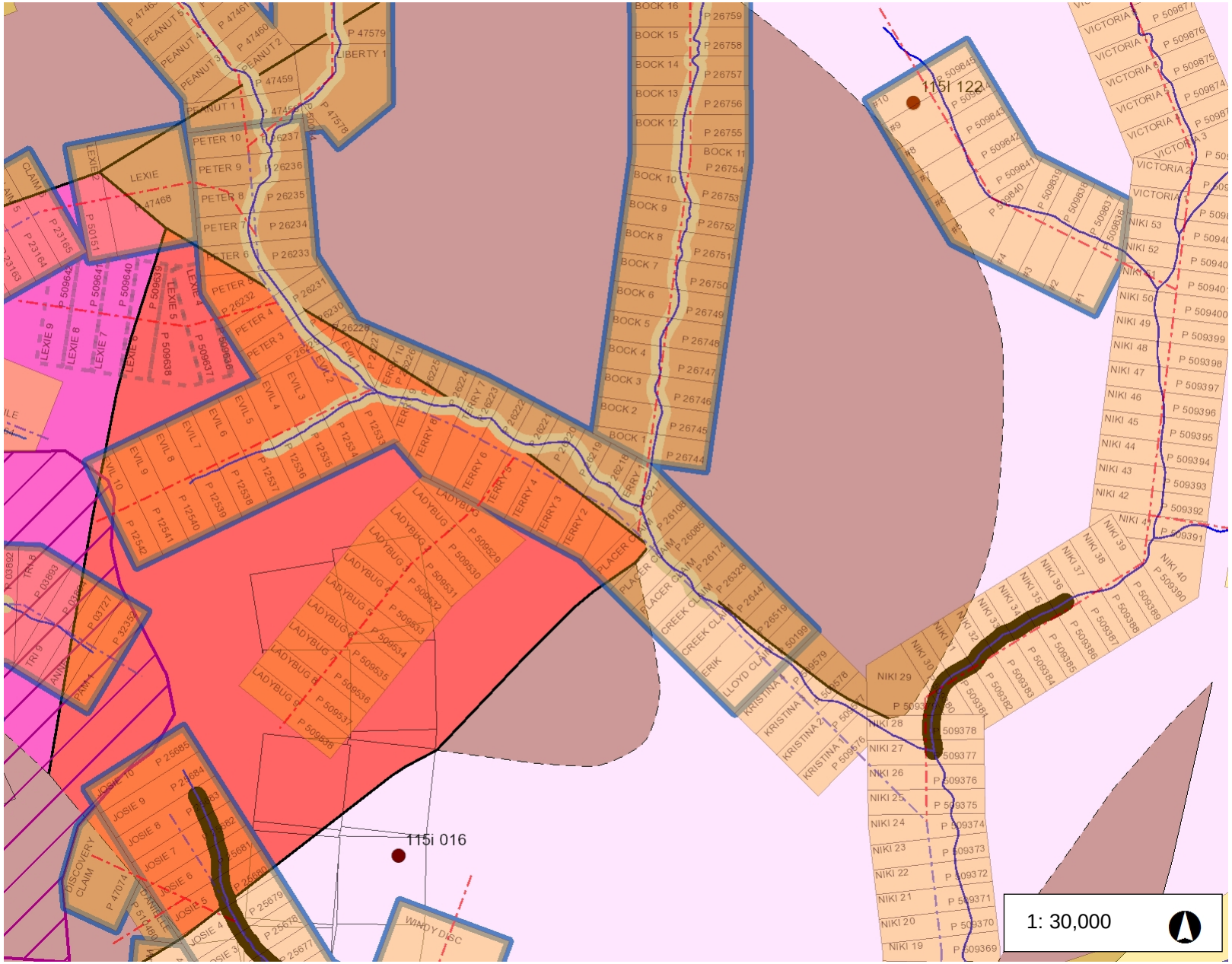
2018 APPENDIX

Tab #

11	**Claims Map**
12	**Mt. Nansen Access Road Map**
13	**Yukon 1995 Mt. Nansen Placer Report, pages 6-7, 72-76, 96-99**
14	**Sedimentology of Placer Gravels Near Mt Nansen, LeBarge 1995**
15	**Yukon Government 2008 – Mount Nansen Mineral Property Report, pages 63-65**
16	**Yukon Government Placer Mining Reports 1993-1994; pg 124-125, 2007-2009, pg 127, 131 & 2010-2014, pg 175, 185-186**
17	**Water Use Permit # PM06-524, Land Use # AP06524, 29 pages**
18	**Yukon Placer Mining Inspection Reports, 2012-2014, 4 pg**
19	**Sample Testing Method and Forms, 6 pages**
20	**Area # 1-3, Deep Placer Area Testing Maps, 7 pages**
21	**The Deep Placers of Mount Nansen, Jeff Bond 2014, 33 pages**
22	**Yukon Exploration and Geology 2015, pg 63-78**
23	**Placer-Lode Gold Relationships in the Nansen District, pg 1-24**
24	**Arctic Geophysical 2012 Victoria Creek report # 1, pg 7-16**
25	**Area # 1 Proposed Exploration Maps, 2 pages**
26	**Arctic Geophysical 2011 Victoria Creek Report, pg 6-12**
27	**Excerpts from Arctic Geophysical 2014 Report, 2 pages**
28	**Early Pleistocene Glaciation Mount Nansen Area, Bond, pg 111-129**
29	**2018 Work Photos**

Yukon
Energy, Mines and Resources

2016 Victoria Creek Deep Placer Testing





Legend

- New Placer Claims
- Placer Baselines (unsurveyed)
- Placer Baselines (surveyed)
- Placer Claims (50K)
  - Active and Pending
  - Expired
- Prospecting Leases
  - Active and Pending
  - Expired
- Adjoin Placer
- Placer Mining Land Use Permi
  - Class 3
  - Class 4
- Coal Exploration License
  - Active and Pending
  - Expired
- Coal Mining Lease
  - Active and Pending
  - Expired
- Surveyed Mineral Claims
- Current Class 1 Notifications
  - Valid
  - In Review
  - Pending
  - Cancelled
  - Expired
  - Rejected

Notes

Bedrock overlaid on placer map.

1.5 0 0.76 1.5 Kilometers

Yukon Albers

Produced from: Yukon Mining Viewer

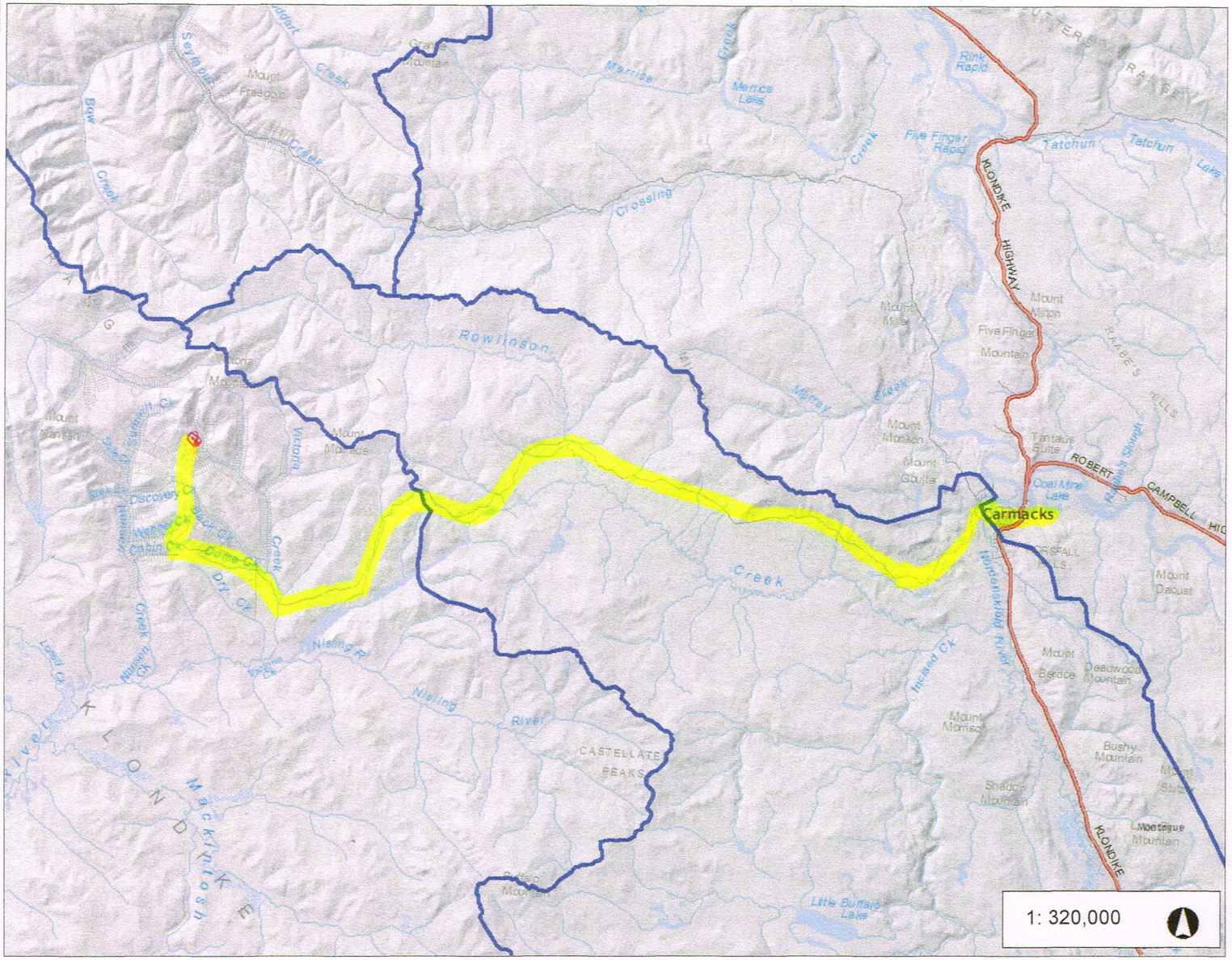
This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

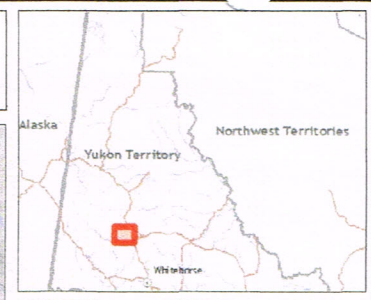
Date Printed: 13-Mar-2016

YUKON PLACER SECRETARIAT

Mt. Nansen Access Road

Yukon
Energy, Mines and Resources





Legend

- Placer Watershed Boundaries
- Placer Claims (50K)
  - Active and Pending
  - Expired

1: 320,000

16.3 0 8.13 16.3 Kilometers

NAD_1983_Yukon_Albers
Produced from: Yukon Placer Watershed Atlas Date Printed: 06-Jan-2013

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION. The habitat suitability classifications presented here only apply to licenced placer mining operations, and ARE NOT RELEVANT TO ANY OTHER ACTIVITY in or near watercourses.

Notes

60 km access road from Carmacks to Mt Nansen mining region. Additional 15 km all weather road to Victoria creek mine site.

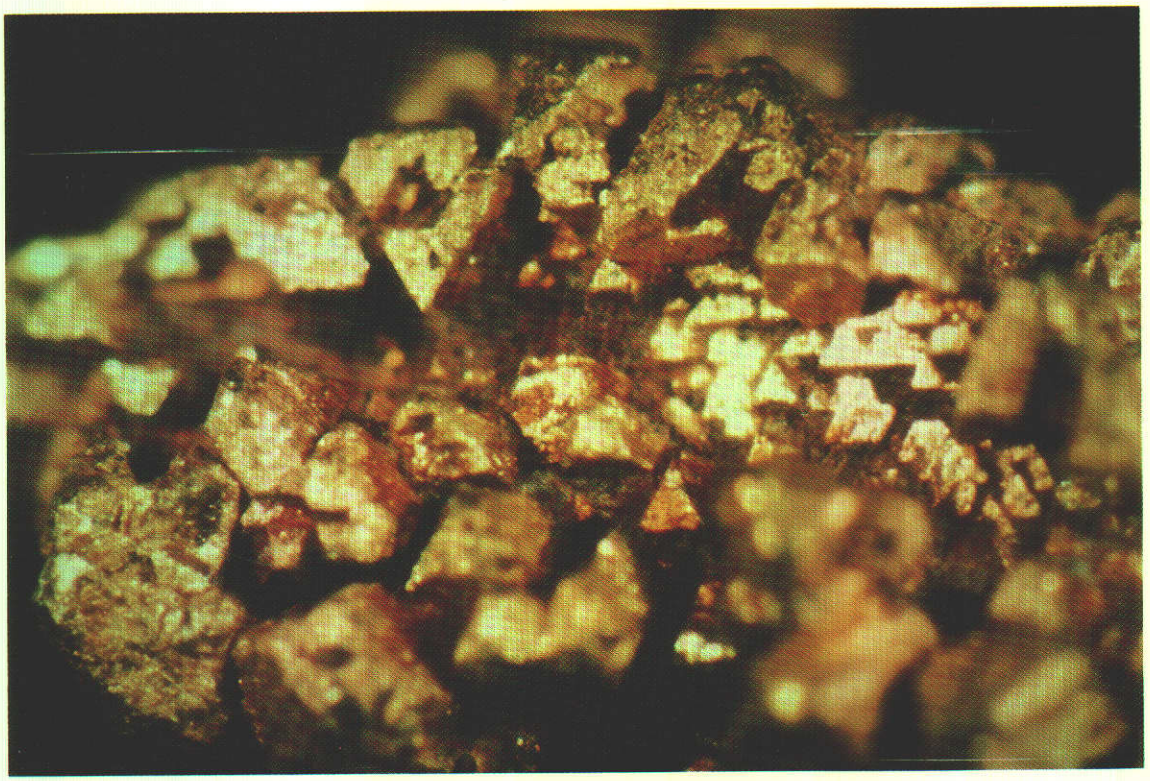
BULLETIN 4
(1)

Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

Exploration and Geological Services Division, Yukon Region

BULLETIN 4

SEDIMENTOLOGY OF PLACER GRAVELS NEAR MT. NANSEN CENTRAL YUKON TERRITORY



W.P. LeBarge

1995

Canada

12-4
1500

FACIES SCHEME

Introduction

The term "facies" has generally been used by various authors as the classification of a body of rock or sediment based on a unique set of characteristics that set it apart from other bodies of rock or sediment. Modern usage originated with de Raaf et al., (1965) who used "lithological, structural and organic aspects detectable in the field" to subdivide a group of formations into facies. Walker (1984) noted that this subdivision is essentially a classification procedure which depends on the objectives of the study as well as the time available and the abundance of physical and biological structures in the rocks. Middleton (1978) noted that although facies will ultimately be given an environmental interpretation, the facies definition must be quite objective and based on the total field aspect of the rocks themselves.

The facies scheme utilized in the study area was designed with the above in mind. It was revised throughout the field season and adjusted as new lithologies were encountered. The objectives of the study were constantly kept in mind so that the facies scheme would be neither too simplistic nor too complex to achieve the goals of the study in the amount of time available. Although several facies occurred in widely varying genetic settings, care was taken not to add environmental interpretation into the facies descriptions.

The main characteristics of each bed which were described in the field were: lithology (percent of gravel, sand, silt and clay), maximum grain size (based on ten largest clasts), clast angularity, sedimentary structures, clast support, sorting, contacts, and accessories. Gravel and sand units were described according to the modified Wentworth scale (Wentworth, 1922) and classified according to the AGI (American Geological Institute) classification scheme (Detrich et al., 1982). Table 6 summarizes the main aspects of each facies described.

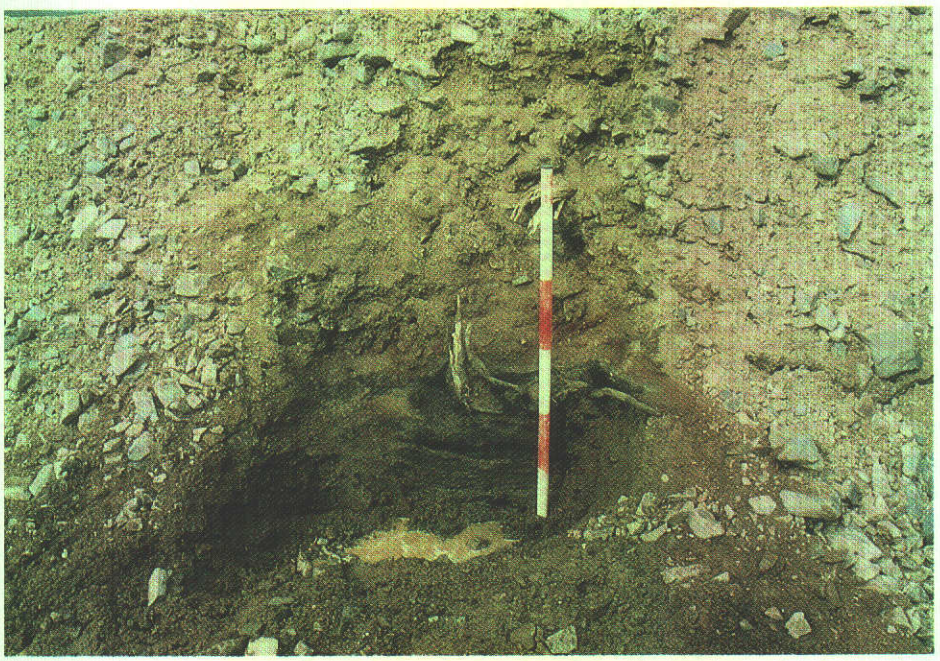


Figure 11 - Measured section K 1-3 shows one of several buried organic horizons (Facies 1) in the Klaza River locality. Note the stump in growth position, which has been radiocarbon dated at 4600a +/- 60 B.P.



Figure 12 - Facies 2, a convoluted, faulted tephra, lies beneath several feet of mud and fine sand at Eva Creek, measured section EVA 2-1. This unit is also exposed similarly in upper Discovery Creek. White River Ash caps the sequence near the present topographical surface.

General Facies Descriptions

Facies 1 - Organic

This facies (shown in Figure 11) includes recent and older organic material. Organic grade varies from present day and Holocene plant material to fibric peat material found lower in most sections. A total of 41 beds were encountered, comprising 15.24% of the total beds measured. The following sections contained Facies 1: LBAC 1-1, LBAC 2-2, UBAC 1-1, EFN 1-1, EFN 2-2, EFN 3-1, EFN 3-2, EFN 4-1, WEB 1-1, WEB 2-1, K 1-1, K 1-2, K 1-3, K 2-1, EVA 1-1, EVA 2-1, DIS 1-1, DIS 1-2, DIS 1-3, DIS 2-1, DIS 2-9, DIS 2-11, DIS 2-12, LDIS 1-1, VIC 1-1, VIC 1-2, VIC 1-3, NAN 1-1, DOL 1-1.

Facies 2 - Tephra

Two tephras are present. The most recent, found near the present day surface, is the White River Ash (Lerbekmo and Campbell, 1969; Lerbekmo et al., 1975). Its grain size is generally medium sand and it is overlain in most areas by only a few centimetres of organic material. The second tephra (Figure 12) is found associated with silts and fine sands within one metre of the present day surface. It is occasionally found in the same sections as the White River Ash. This ash has yet to be dated. A total of 18 beds were encountered, comprising 6.69% of total beds measured. The following sections contained Facies 2: LBAC 1-1, LBAC 2-2, EFN 1-1, EFN 2-2, WEB 2-1, K 2-1, 1-1, EVA 1-1, EVA 2-1, DIS 1-1, DIS 1-2, DIS 2-1, DIS 2-11, VIC 1-1, VIC 1-2, VIC 1-3.

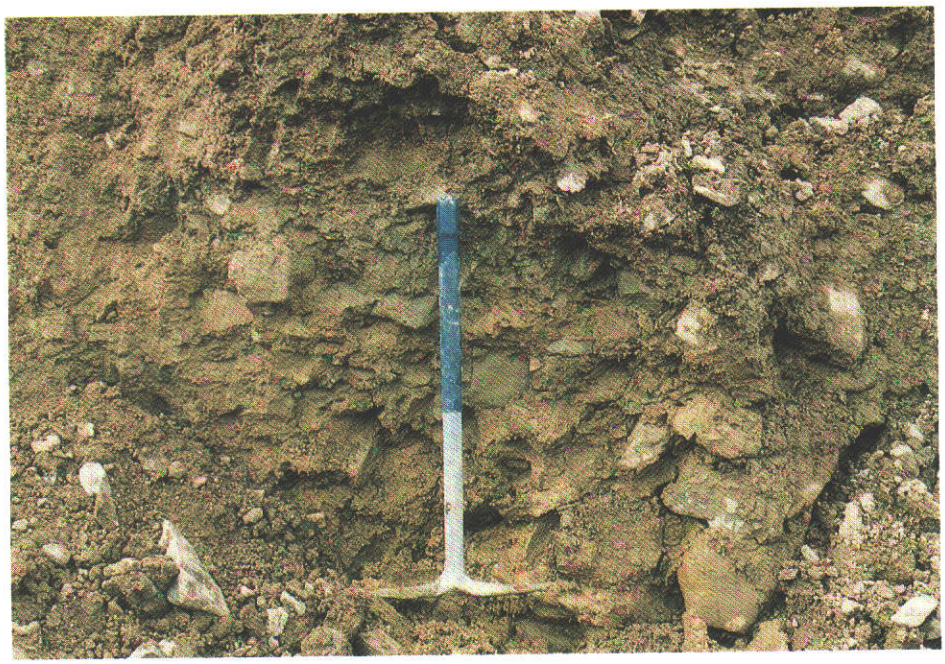


Figure 13 - Facies 3, disorganized cobble-boulder diamicton, occurs in the Klaza River locality, section K 2-1, unit A. Some placer gold has been mined from this unit. The pick is 65 cm long.

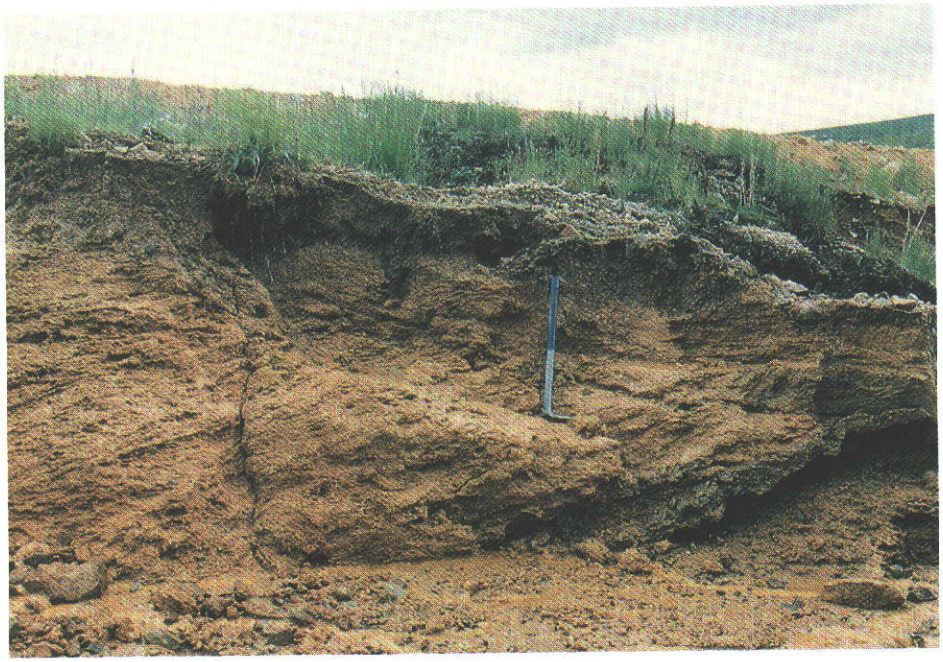


Figure 14 - An unusual stratified pebbly diamicton is overlain by colluvium on the East Fork of Nansen Creek. The unit is clay-rich, contains weathered granodiorite clasts and has strata that dip uphill.



Figure 15 - Cobbly diamicton of Facies 3 occurs on Nansen Creek, measured section NAN 1-1. This clay-rich unit contains numerous weathered clasts and significant placer gold concentrations.

Facies 3 - Diamicton

This unit varies from clast- to matrix-supported, is disorganized and contains pebble to boulder size clasts in a matrix of clay, silt, and sand. Some units are mud-dominated and some are sand-dominated. It is very poorly sorted, and clasts are angular to subrounded. In many sections this facies is gold-bearing and is mined as the pay unit (Figures 13 and 15). A total of 19 beds were encountered, comprising 7.06% of total beds measured. The following sections contained Facies 3: EFN 3-1, EFN 3-2, WEB 1-1, K 2-1, NAN 1-1, UBAC 1-1.

Facies 4 - Massive and stratified silt and clay

This unit is composed of disorganized and massive to stratified silt and clay, with varying amounts of other minor components including sand and tephra (Figure 16). Pebbles and cobbles comprise less than 25%. A total of 14 beds were encountered, comprising 5.20% of total beds measured. The following sections contained Facies 4: K 1-1, K 1-2, K 1-3, K 2-1, EVA 1-1, EVA 2-1, DIS 1-1, DIS 1-2, DIS 2-1, DIS 2-11, LDIS 1-1.



Figure 16 - Stratified silt and clay of Facies 4 overlies disorganized pebble-cobble gravel of Facies 9 at Eva Creek section EVA 1-1, and is in turn overlain by White River Ash. Traces of an older tephra are mixed with the silt and clay.

Facies 5 - Massive and disorganized pebbly sand and sand

This facies is composed of massive to disorganized, poorly- to well-sorted fine to coarse sand (Figure 19). Other fine sediments occur in minor amounts such as mud and tephra. Pebbles and cobbles occur in amounts of less than 25%. A total of 13 beds were encountered, comprising 4.83% of total beds measured. The following sections contained Facies 5: MBAC 1-1, EFN 2-2, WEB 1-1, WEB 2-1, EVA 2-1.

Facies 6 - Stratified pebbly sand and sand

This facies is composed of moderately to well-sorted fine to coarse granular sand with less than 25% pebbles and cobbles. Sedimentary structures include wavy and parallel stratification, planar tabular cross-beds (Figure 17), trough cross-beds, current ripples and convoluted bedding. A total of 34 beds were encountered, comprising 12.64% of total beds measured. The following sections contained Facies 6: LBAC 1-1, LBAC 2-2, MBAC 1-1, EFN 1-1, EFN 2-2, WEB 1-1, WEB 2-1, EVA 2-1, DIS 1-1, DIS 1-2, DIS 1-3, DIS 2-1, DIS 2-9, LDIS 1-1, VIC 1-1, VIC 1-2, VIC 1-3, K 1-2, NAN 1-1, DOL 1-1.



Figure 17 - Planar tabular cross-stratified pebbly sand (Facies 6) is truncated by pebble cobble gravel of Facies 10 on measured section DIS 1-3, upper Discovery Creek.

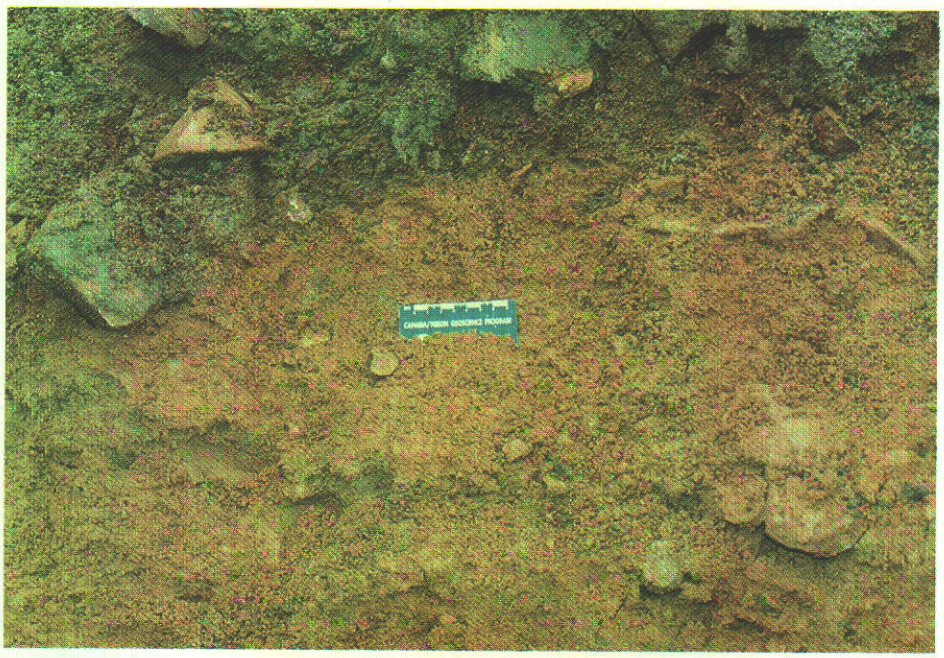


Figure 18 - Disorganized muddy pebble-cobble gravel of Facies 7 conformably overlies sandy pebble gravel of Facies 8 at measured section EVA 2-1, Eva Creek.



Figure 19 - Massive pebbly sand of Facies 5 and massive sandy pebble-cobble gravel of Facies 8 are intercalated on an alluvial fan in the mid-reaches of Discovery Creek, section LDIS 1-1.



Figure 20 - Disorganized gravel of Facies 9 overlies stratified gravel of Facies 10 at measured section EFN 2-1, on the East Fork of Nansen Creek. This section is highly weathered and is interpreted as pre-Reid glaciofluvial outwash.



Figure 21 - A pre-Reid glaciofluvial channel (measured section DIS 2-9) cuts bedrock at an elevation of 4270 feet on upper Discovery Creek.

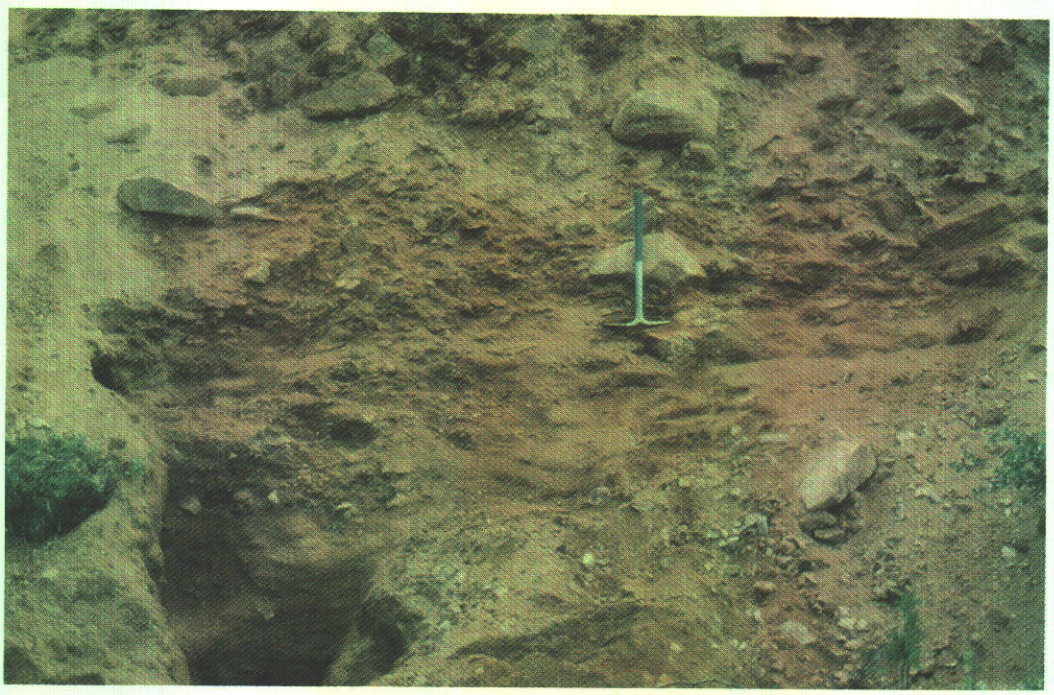


Figure 22 - A close-up of measured section DIS 2-9 shows massive to crudely stratified boulder-cobble gravel of Facies 10. Measured fabric in this highly weathered section shows a paleoflow direction which is transverse to the present valley.

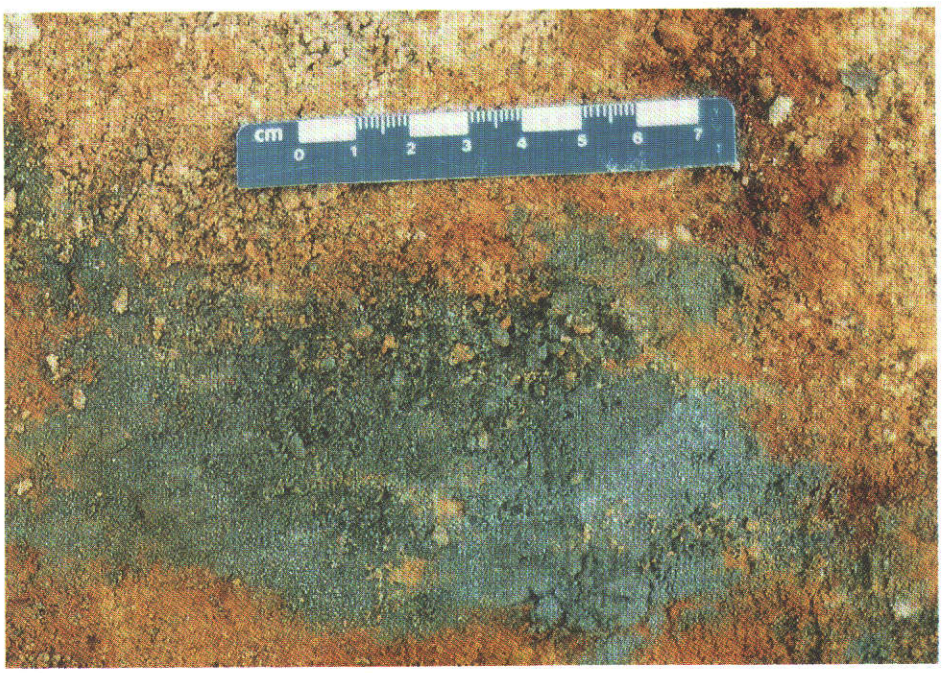


Figure 23 - Weathered arsenopyrite and pyrite occur in clay-altered pods in the bedrock near measured section DIS 2-9. Sulphides can be excavated as medium sand-sized grains.

Facies 7 - Disorganized muddy gravel

This facies is composed of gravels containing between 25% and 50% clasts and more clay and silt than sand. Strata are disorganized or crudely stratified and the units are mainly matrix-supported (Figure 18). Clasts vary from pebbles to cobbles and sorting is poor to moderate. A total of 7 beds were encountered, comprising 2.60% of total beds measured. The following sections contained Facies 7: K 2-1, EVA 1-1, EVA 2-1, EFN 2-1, EFN 2-2.

Facies 8 - Massive and stratified sandy gravel

This facies is composed of gravels containing between 25% and 50% clasts and more sand than clay and silt. Strata are massive, disorganized, or stratified and units are matrix- to clast-supported (Figures 18 and 19). Clasts vary from pebbles to boulders and sorting is poor to moderate. A total of 35 beds were encountered, comprising 13.01% of total beds measured. The following sections contained Facies 8: LBAC 2-2, MBAC 1-1, EFN 1-1, EFN 2-1, EFN 2-2, EFN 3-1, EFN 3-2, WEB 1-1, WEB 2-1, K 1-2, K 1-3, K 2-1, EVA 2-1, DIS 1-1, DIS 1-2, DIS 1-3, DIS 2-11, LDIS 1-1, DOL 1-1.

Facies 9 - Disorganized gravel

This facies is composed of gravels containing over 50% clasts. Units are disorganized and clast-to matrix-supported, and clast size includes pebbles, cobbles and boulders (Figure 20). Sorting is generally moderate. A total of 17 beds were encountered, comprising of 6.32% of total beds measured. The following sections contained Facies 9: EFN 1-1, EFN 2-1, EFN 2-2, K 2-1, EVA 1-1, DIS 1-1, DIS 1-3, VIC 1-3, NAN 1-1, DOL 1-1.

Facies 10 - Massive to crudely stratified gravel

This facies is composed of gravels containing over 50% clasts. Units are massive to crudely stratified and clast-supported, and clast size ranges from pebbles to boulders (Figures 20 to 23). Units are moderately to well-sorted. A total of 71 beds were encountered, comprising 26.39% of total beds measured. The following sections contained Facies 10: LBAC 1-1, 2-2, MBAC 1-1, UBAC 1-1, EFN 1-1, EFN 2-1, EFN 4-1, K 1-1, K 2-1, DIS 1-1, DIS 1-2, DIS 1-3, DIS 2-1, DIS 2-9, DIS 2-11, DIS 2-12, LDIS 1-1, VIC 1-1, VIC 1-2, VIC 1-3, NAN 1-1, WEB 1-1.



Figure 33 - A large bullet-shaped boulder was exposed by placer mining operations at an elevation of 4300 feet ASL on Back Creek. This streamlined boulder was derived from a diamicton which lay directly on bedrock. The diamicton in this location is interpreted as a glacial till.



Figure 34 - Glacially-striated boulders also occur on the East Fork of Nansen Creek.

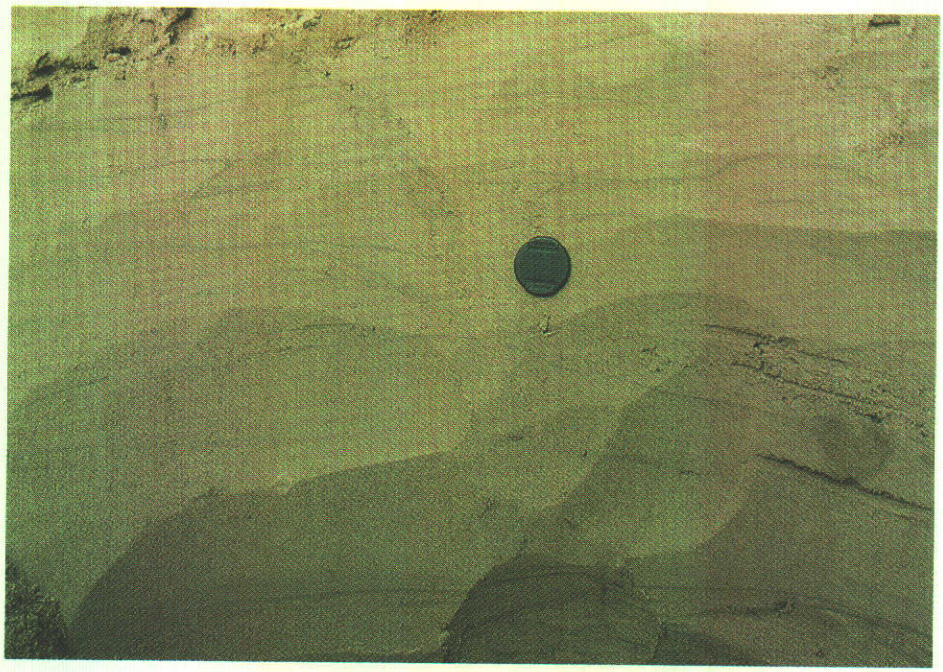


Figure 35 - Stratification consists of wavy parallel and ripple laminations in measured section WEB 2-1, located on a remnant alluvial terrace. An ice cast sand wedge can be discerned near the lens cap.



Figure 36 - A remnant alluvial terrace on the upper reach of Weber Creek has been dissected by the present stream, near the locality for measured section WEB 1-1.



Figure 37 - Interbedded cross-stratified sand and gravel occur in a remnant alluvial terrace on Weber Creek. Gravel clasts are angular, ventifacts are common and fine to medium sand is well-sorted. Measured section WEB 2-1.

Schematic Profiles and Lateral Relationships

Introduction

Figures 38 to 47 show schematic profiles and general lateral relationships between measured sections for each drainage. Sections were correlated based on field relationships and facies trends. Table 18 is the legend for the schematic profiles and all of the measured sections.

Discussion

Discovery Creek

Discovery Creek is characterized by three types of sedimentation, glaciofluvial channels (DIS 2-9), gulch gravels (DIS 1-1, DIS 1-2 and DIS 1-3), and periglacial alluvial fans (LDIS 1-1). At elevations of 4200 feet ASL and above, the glaciofluvial channel cuts bedrock in a paleoflow direction perpendicular

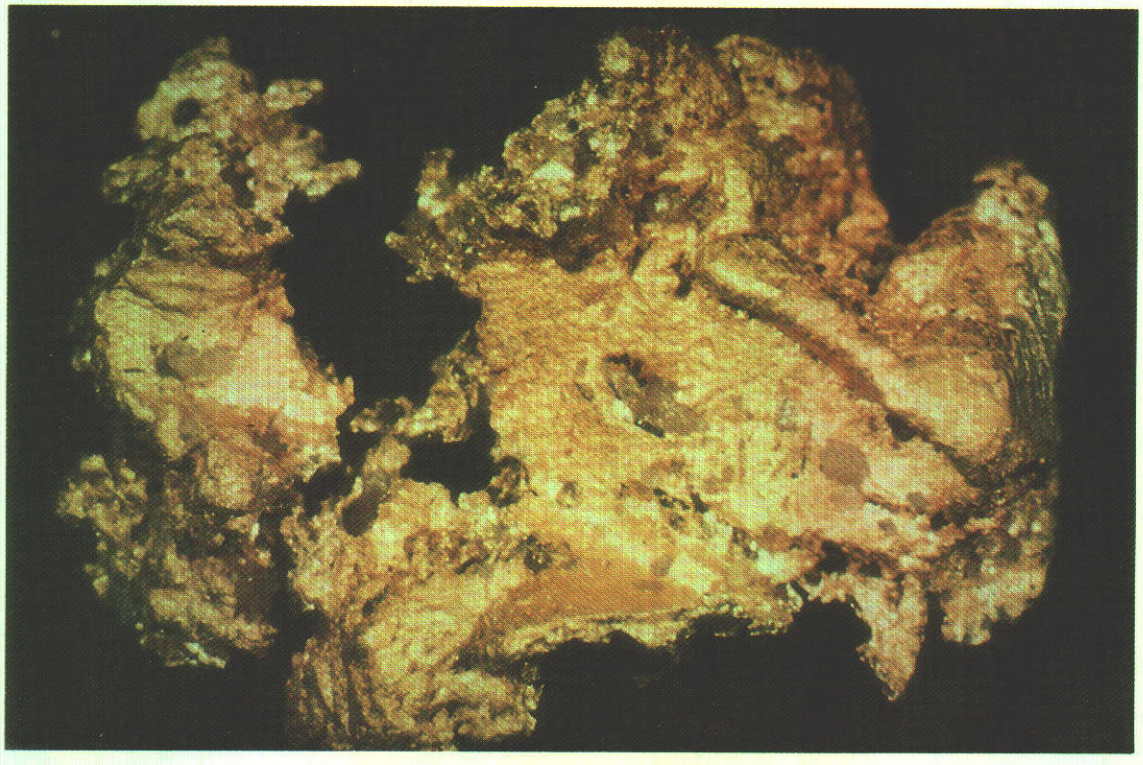


Figure 64 - Angular gold grain from alluvial fan gravels on Klaza River. Field of view approximately 1 cm.



Figure 65 - Gold specimen from Back Creek with attached quartz. Field of view 1 cm.



Figure 66 - An assortment of shapes are found in gold from the main valley of Nansen Creek. The silver grain in the upper left hand corner is bismuthinite. Field of view 3 cm.



Figure 67 - Striations on a flat gold specimen from Klaza River. Field of view 5 mm.

MOUNT NANSEN PROPERTY

Mount Nansen Mine Site

PROJECT STATUS

Site is under Receivership/Bankruptcy through PricewaterhouseCoopers.

Yukon government is maintaining and moving to final closure of the site.



Location
60 km west of Carmacks

Commodity
Gold, silver

Ore type
Sulphide

Mineral resource*

Brown-McDade zone
Underground resource: 193 706 tonnes grading 14.47 g/t Au and 100 g/t Ag

Flex zone
Indicated oxide resource: 69 977 tonnes grading 6 g/t Au and 234 g/t Ag
Inferred oxide resource: 38 615 tonnes grading 5.8 g/t Au and 333 g/t Ag

Webber zone
Historical resource of 58 524 tonnes grading 10.9 g/t Au and 611 g/t Ag

Huestis vein
Historical resource of 85 727 tonnes grading 14 g/t Au and 283 g/t Ag

*not NI 43-101 compliant

HISTORY

Placer gold was originally discovered on Nansen Creek in 1899. The first recorded lode gold discovery on the current Mount Nansen property was made by prospectors Brown and McDade in 1943.

The first underground work was conducted on the Brown-McDade zone in 1947 by the Spud Huestis Syndicate. After a few years of mine development, mapping, surface trenching and sampling, the property remained inactive until 1962 when the Mount Nansen Syndicate acquired the Brown-McDade, Webber and Huestis deposits and conducted additional exploration. Mount Nansen Mines Ltd. was acquired by Peso Silver Mines Ltd. which conducted exploration over the next three years on all three deposits. A 270-tonne/day flotation mill was constructed during 1967-68. A total of 14 500 tonnes of development muck produced during 1967-68 had an estimated average grade of 7.8 g/t Au and 162 g/t Ag, while mill feed of 5236 tonnes produced from stopes during 1969 had an estimated average grade of 11.7 g/t Au and 282 g/t Ag. Low gold recovery rates, estimated at 60% to 65%, led to the mine closure in April, 1969. In late 1975, a total of 5450 tonnes at an estimated grade of 16.8 g/t Au and 248.8 g/t Ag was produced from the Huestis deposit and processed during May, 1976, but the mine once again shut down shortly after. As of 1976, over 4572 m of underground development was completed on the three veins. Approximately 22 680 tonnes of ore were treated in the flotation mill in 1975 and 1976.

In 1984, BYG Natural Resources Inc. (BYG) acquired the properties and combined them with additional claims to form the current property. BYG and Chevron Minerals Ltd. carried out an exploration program from 1985 to 1987. Over $5 million was expended on geological mapping, geochemical and geophysical surveys, trenching, 2605 m of diamond drilling (41 holes) and 1283 m of rotary percussion drilling (17 holes). During 1988, BYG continued exploring on its own by carrying out surface trenching and 85 holes (5397 m) of diamond drilling. A previously unrecognized near-surface oxide zone was discovered and the underground sulphide reserves were

Reserves/resources are from a variety of sources and may not be compliant with National Instrument 43-101 Standards, unless specified.

expanded. Metallurgical testing, mill flow sheet designs, tailings disposal and environmental impacts were studied at this time, and commercial gold production began on January 1, 1997. Production continued intermittently until February, 1999, when all mining and operations ceased.

Between 1994 and 1997, BYG conducted exploration consisting of diamond drilling on the following zones: Brown-McDade and Flex (990 m, 12 holes in 1994), Flex and Huestis (1490 m, 21 holes in 1995), Webber and Flex (780 m, 10 holes in 1996) and Vince vein (745 m, 9 holes in 1997). During 1997, a program of overburden stripping and excavator trenching was completed on the Flex zone. During 1998, a further 16 holes (1092 m) were drilled on the Flex zone.

In May, 1999, BYG Natural Resources went into receivership (D. Manning and Associates) and was also convicted of violating its water licence. In July, 1999, the federal government took over mine-site maintenance.

In August 1999, the federal government formally declared the property abandoned and took over management of the mine site until 2003 when responsibilities devolved to Yukon government. In April 2004, the Supreme Court of Yukon appointed PricewaterhouseCoopers as interim receiver for the assets of BYG Natural Resources Inc. The Yukon government continues care and maintenance for the site and PricewaterhouseCoopers continues to manage the mine's assets.

In June 2007, PricewaterhouseCoopers, sold 199 mineral claims outside the disturbed mine site area to a Vancouver-based exploration company, 101073531 Saskatchewan Ltd. These claims included Webber Zone, portions of the Huestis vein and the Flex zone.

Yukon and federal government, together with the Little Salmon Carmacks First Nation are working towards a final closure plan.

PROJECT SUMMARY

The Mount Nansen mine is located 60 km west of the village of Carmacks, Yukon and is accessible by a gravel road from Carmacks to the minesite. The property consists of 257 mining claims and 30 mining leases covering an area of 53 km^2.

Geology, mineralogy and ore reserves

The Mount Nansen district is underlain by metamorphosed intrusive, sedimentary and volcanic rocks of the Yukon-Tanana Terrane. These rocks are intruded by Early Cretaceous felsic plutonic rocks and overlain by mid-Cretaceous Mount Nansen mafic to intermediate volcanic rocks and related sub-volcanic feldspar porphyry dykes and plugs.

The Mount Nansen property is host to four distinct gold deposits known as the Brown-McDade, Webber, Huestis and Flex zones. The zones are situated in a series of anastomosing veins in northwesterly trending faults or shear zones. The gold and silver mineralized structures consist of fault-shear-hosted veins and associated clay-rich and bleached alteration zones. The veins occur in a 2.5-km-wide corridor which has been traced over a strike length of 15 km. Clay-rich leach zones near the surface are underlain by blankets or lenses of gold-rich supergene ores.

Brown-McDade zone

The Brown-McDade zone lies at the southeasterly end of the belt. It is 55 m long by 200 m wide and consists of quartz veins and associated feldspar porphyry dykes. The oxide ore of the Brown-McDade was mined in a small open pit. A mineable open-pit reserve of 110 000 tonnes grading 12.33 g/t Au and 78 g/t Ag was outlined in the open pit, with an additional 80 000 tonnes of low-grade mineralized rock. Most of this was mined out by late 1998. Indicated and Inferred underground resources below the existing pit are estimated at approximately 150 000 tonnes grading 7 g/t Au and 50 g/t Ag.

In 2007, the claims containing the following zones were sold to Vancouver-based exploration company, 101073531 Saskatchewan Ltd.

Webber zone

A historical diluted oxide resource of 58 524 tonnes grading 10.9 g/t Au and 611 g/t Ag has been established in the Webber deposit from extensive trenching, drilling and underground development.

Huestis vein

A historical mineable sulphide resource of 85 727 tonnes grading 14 g/t Au and 283 g/t Ag has been defined on the Huestis vein by trenching, diamond drilling and detailed underground sampling. The ore is sulphide-rich and refractory.

Reserves/resources are from a variety of sources and may not be compliant with National Instrument 43-101 Standards, unless specified.

Flex zone

A preliminary, shallow open-pit design encloses a calculated mineable (Indicated) resource of 69 977 tonnes grading 6.0 g/t Au and 234 g/t Ag and a geological (Inferred) resource of 38 615 tonnes grading 5.8 g/t Au and 333 g/t Ag. This resource is not NI 43-101 compliant.

Production

The initial capacity of the mill was 700 tonnes/day.

Gold production from surface oxide ores commenced during the week of October 18, 1996 and the company poured the first bar of gold on November 23, 1996. Commercial production began on January 1, 1997. The mill was established to process 700 tonnes/day; intended yearly production was 50,000 oz. (1.5 million g) Au. The gold was sold through Gerald Metals Inc.

In January, 1997, the company produced 2700 oz. (84 000 g) Au and 13,000 oz. (400 000 g) Ag. Ore throughput increased to 450 tonnes/day, which was 64% of design capacity. Recoveries averaged 88% and the head grade averaged 0.235 oz./ton (8.06 g/t) Au equivalent.

The unanticipated presence of clay-alteration minerals in the ore forced the daily milling rate down to less than 325 tonnes during the first nine months of operations. The problem was solved by installing a semi-autogenous grinding mill (SAG). Also, record rainfall aggravated existing difficulties milling the gold-rich, clay-altered ores and restricted capacity to 36%. The SAG mill was operational by the end of August, 1997. During July and August, 1997, the mill operated largely on stockpiled ores leaving the high-grade open-pit clay-altered ores to be mined and processed when the SAG mill became operational.

Unseasonably heavy rainfall created a water imbalance problem in late 1997. There was inadequate provision for run-off of the rainfall, which led to an environmental discharge danger. BYG engineered a water treatment system in the spring of 1997 by transporting facilities from the Canamax mine controlled by YGC. The treatment facility enabled the company to meet water quality discharge levels.

The mine restarted production at the end of January, 1998 and delivered its first gold and silver for sale in April, 1998. At first, production was limited to 50% of the mill's 700 tonne/day capacity, then installation of new pumping facilities allowed the mill to operate at full capacity. BYG estimated that it would be able to produce gold at an operational cost of $160/oz.

The company downsized in 1998 and carried out exploration and drilling programs to delineate additional oxide ore reserves on the Mount Nansen mine property, particularly on the nearby Flex zone. The mine shut down in the spring of 1999.

Total production in 1998
472 kg (15,190 oz.) Au • 1208 kg (38,849 oz.) Ag

Total production in 1999
15 500 tonnes at a grade of 7.5 g/t Au and 50 g/t Ag, or 116.2 kg (3738 oz.) Au and 775 kg (24,917 oz.) Ag

Reserves/resources are from a variety of sources and may not be compliant with National Instrument 43-101 Standards, unless specified.

Bonnyville Oilfield Service & Supply Ltd.
Box 6409, Bonnyville, Alberta T9N 2G9
Phone 780-812-3000 Fax 780-812-3002

2018 VICTORIA CREEK TEST PIT VOLUME SUMMARY LOG	BOSS TP 01

Facility Name			Total #
Location			
Operator		Date Start	Date Finish
GPS	LAT.	LON.	

Equipment Used: Hitachi EX400C, Komatsu LC400-3	

Test Pit #	Dimensions (m3)			Volume (m3)	Volume of Frozen Material		Comments
	Width (m)	Length (m)	Depth (m)		thawed	frozen	

Comments

Representative (indicate role)	Name	Signature	Date
Operator			
Operator			

VICTORIA CREEK MINING

BORE HOLE # _____



Field Boring Log

Claim: _____

Block I.D. #_____

Quadrant: _____

Site Name: _____

Boring No. _____ Monitoring Well No. _____

Quadrangle: _____ Sec. _____ T. _____ R. _____

Surface Elevation: _____ Completion Depth: _____

Auger Depth: _____ Rotary Depth: _____

UTM (or State Plane) Coord. N. (X) _____ E. (Y) _____

Date: Start: _____ Finish: _____

Latitude: ____ ____ ____ (o ' ") Longitude: ____ ____ ____ (o ' ")

Boring Location: _____

Drilling Equipment: _____

Elev.	Description of Material	Graphic Log	Depth In Feet	SAMPLES: Sample No.	Sample Wt.	Sample Vol.	Concentrate Wt.	Gold Wt.	Gold Grade	Personnel / REMARKS
										G - D - H - H -

Soil Sampling Tips

- Surficial geology maps are your guide to the distribution of parent materials on the landscape.
- A complete list of surficial geology maps in Yukon is published on the Glacial Limits of Yukon Territory map (Duk-Rodkin, 1999). For more information about digital surficial geology information contact Jeff Bond or Panya Lipovsky at the Yukon Geological Survey.
- Understand the origin of the various parent materials and their suitability for conventional soil geochemistry.
- Do not assume an area is suitable for soil sampling. Check the surficial geology map first.
- Plot old soil geochemistry data against a surficial geology map and discard samples taken from unsuitable parent materials.
- Know the location of the glacial limits in your study area. If your property is close to the glacial limits, this will likely mark a change in parent material.
- Learn to recognize parent materials by the look and feel (texture) of the sediment in your hands. Note textural changes between samples.
- Beware of loess due to its dilution factor. Loess can be especially thick and widespread adjacent to large rivers.
- Past or present permfrost enhances slope dispersion.
- Be consistent in sample depth and parent material.
- Stress quality over quantity when soil sampling.

Information to include on a soil sampling field data form

Sample Number: UTM Position:
Sampler: Date:

Site Characteristics
Aspect:
Topographic position:
Drainage: poor/moderate/well

Parent Material Properties
Total depth (cm):
Genesis:
Texture: silty/sandy/silty sand
Density: low/moderate/high
Colour:
Clast shape: angular/subrounded/well rounded
Organic material present in sample: yes/no/minor

Notes:

Hand soil augers are the method of choice for accessing the C horizon and for ease of transport.

In the adjacent photo, each successively deeper sample is layed out on the surface giving an indication of colour and textural changes with depth.



photo courtesy of
Mike Burke and Ryanwood Exploration

Further Reading and References

Bloom, L., 2001. Writing geochemical reports: Guidelines for surficial geochemical survey, 2nd edition. The Association of Exploration Geochemists Special Volume No. 15, 38 p.

Bond, J.D. and Sanborn, P.T., 2006. Morphology and geochemistry of soils formed on colluviated weathered bedrock: Case studies from unglaciated upland slopes in west-central Yukon. Yukon Geological Survey, Open File 2006-19, 70 p.

Duk-Rodkin, A., 1999. Glacial limits map of Yukon. Geological Survey of Canada, Open File 3694, Exploration and Geological Services Division, Yukon Region; Indian and Northern Affairs Canada Geoscience Map 1999-2, scale 1:1 000 000.

McClenaghan, M.B., Bobrowsky, P.T., Hall, G.E.M. and Cook, S.J. (eds.), 2001. Drift Exploration in Glaciated Terrain. Geological Society Special Publication No. 185, The Geological Society, London, U.K., 350 p.

Smith, C.A.S., Meikle, J.C. and Roots, C.F. (eds.), 2004. Ecoregions of the Yukon Territory: Biophysical properties of Yukon landscapes. Agriculture and Agri-Food Canada, PARC Technical Bulletin No. 04-01, Summerland, British Columbia, p. 63-72.

Acknowledgements

This publication benefited from technical reviews by Panya Lipovsky (YGS) and Paul Sanborn (UNBC). Exceptional editing comments were provided by Leyla Weston and Diane Emond.

For more information, check the Yukon Geological Survey at:

www.geology@gov.yk.ca

Yukon Geological Survey
Department of Energy, Mines and Resources
Yukon Government
Box 2703
Whitehorse, Yukon
Canada
Y1A 2C6

phone: (867) 667-8508
fax: (867) 393-6232

Information in this brochure was compiled by:
Jeffrey D. Bond

Published: January 2007

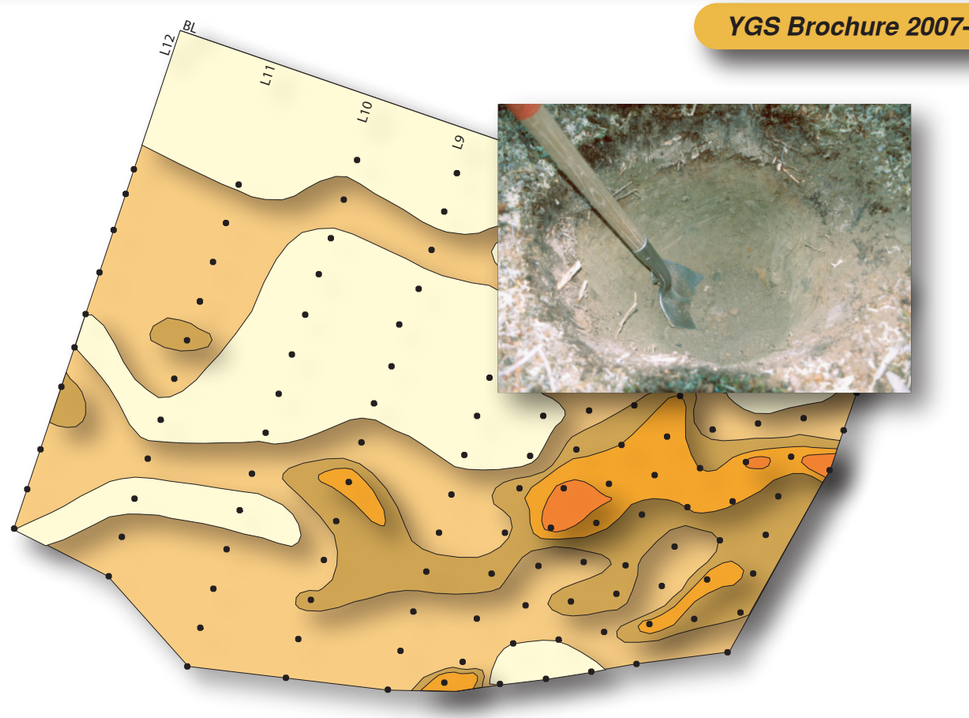
Yukon Geological Survey

Yukon
Energy, Mines and Resources

SOIL SAMPLING

A guide to soil sampling in Yukon

YGS Brochure 2007-2



- Approximately 70% of the Yukon has been glaciated and 30% is unglaciated.
- Wind-blown silt (loess) is a common component of the B soil horizon and is geochemical dilutant.
- The Cordilleran ice sheet flowed over some interior mountain ranges resulting in up-valley drift transport.
- Discontinuous permafrost is a common sampling inhibitor on north-facing slopes.

www.geology.gov.yk.ca

Introduction

CHOOSING THE BEST SOIL SAMPLE = CHOOSING THE BEST PARENT MATERIAL

Soil sampling and soil geochemical data are a common component of the mineral exploration process. This may involve collecting new soil data or compiling and evaluating pre-existing data from previous exploration programs. Traditionally, sampling within a consistent soil horizon, such as the B-horizon, was the only guideline used in conventional* soil sampling. Today, more attention is placed on choosing the appropriate parent material. In Yukon, there are a variety of parent material types each having a unique genesis. The genesis determines whether the material will be useful for conventional soil geochemistry. The greatest contrast in parent material assemblages occurs between the glaciated and unglaciated regions.

*Conventional soil geochemistry: *e.g.*, an aqua regia digestion (near total digestion) followed by ICP-MS
Unconventional soil geochemistry: *e.g.*, MMI or enzyme (weak) leach

Regional Surficial Geology

Glaciated and unglaciated regions of Yukon

modern glaciers

Late Pleistocene glacial deposits
(McConnell glaciation; < 30 ka years ago)

Early to late Pleistocene glacial deposits
(3 Ma to 50 ka years ago)

unglaciated

Older glacial deposits are found beyond the limit of the late Pleistocene McConnell surface in central Yukon. Glacial landforms on these older surfaces are more subdued and weathered compared to deposits from the subsequent glaciations.

Parent materials of upland soils in west-central Yukon's unglaciated areas consist of a mixture of loess and colluviated weathered bedrock. Permafrost is found on north-facing slopes and on the margins of valley bottoms.

A 1200-year-old volcanic eruption from Mount Churchill on the Alaska/Yukon border released volcanic ash that draped southern and central Yukon. The ash is visible between the A and B horizons and should be avoided if conventional soil geochemistry is utilized.

The Laurentide ice sheet advanced into the Peel River basin from the Mackenzie valley. This ice sheet also glaciated the eastern flank of the Richardson Mountains and Yukon's coastal plain on the Beaufort Sea.

The large glaciated valley bottoms of southern and central Yukon contain a wide variety of surficial materials. Most of these sediments, such as fluvial or glacial lake deposits, are unsuitable for soil geochemistry.

Mountain slopes and summits are typically mantled with colluviated weathered bedrock and/or a veneer of colluviated till. These parent materials make excellent samples for conventional soil geochemistry.

Upland areas that contained alpine glaciers and that were also glaciated by the Cordilleran ice sheet have a multi-phase ice-flow history to consider when reconstructing drift transport.

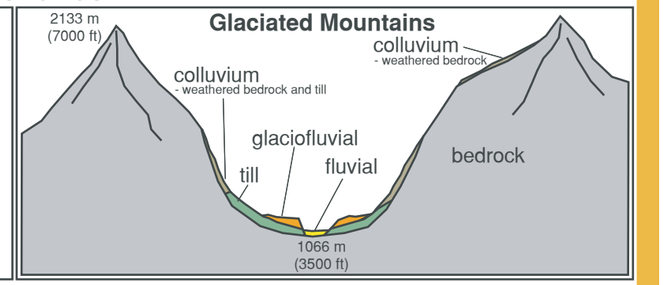
The Pelly Mountains were overriden by the Cordilleran ice sheet at glacial maximum. This resulted in up-valley drift transport in southerly and easterly draining valleys.

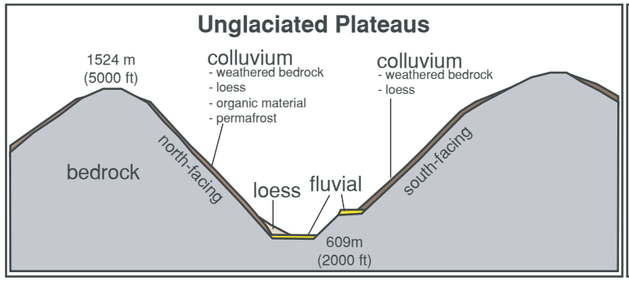
after Duk-Rodkin, 1999

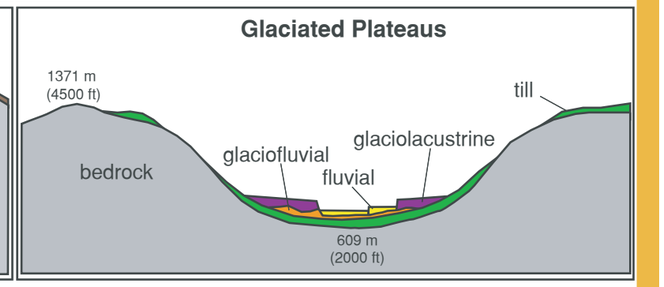
Parent Material and Soil Horizons

Idealized valley cross-sections displaying parent material distribution

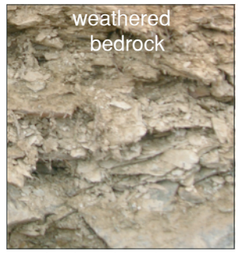
Parent material	Genesis	Sample rating
weathered bedrock	insitu weathing	excellent
fluvial	stream/river	poor
loess	wind	poor
lacustrine	lake	poor
moraine/till	directly by glacier	very good
glaciofluvial	glacial meltwater	poor
glaciolacustrine	glacial lake	poor
colluvium	slope/gravity	depends on moving material







Parent Material Textures



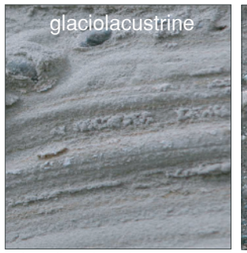
- sand and angular rock fragments



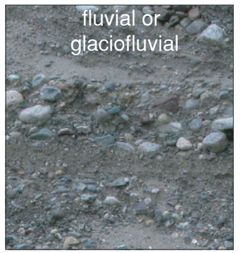
- silt with minor organics and roots
- oxidation common
- no bedding, cohesive



- mixed clay, silt, sand and gravel
- no bedding (massive)
- polished stones, compact



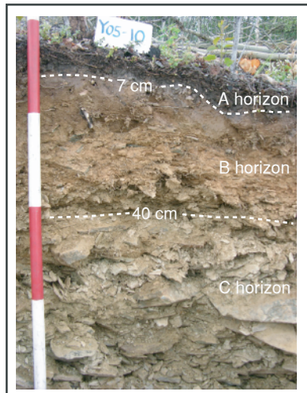
- clay, silt and sand
- few stones
- laminae (banded), bedding



- sand and gravel
- non-cohesive
- laminae, bedding, cross-bedding

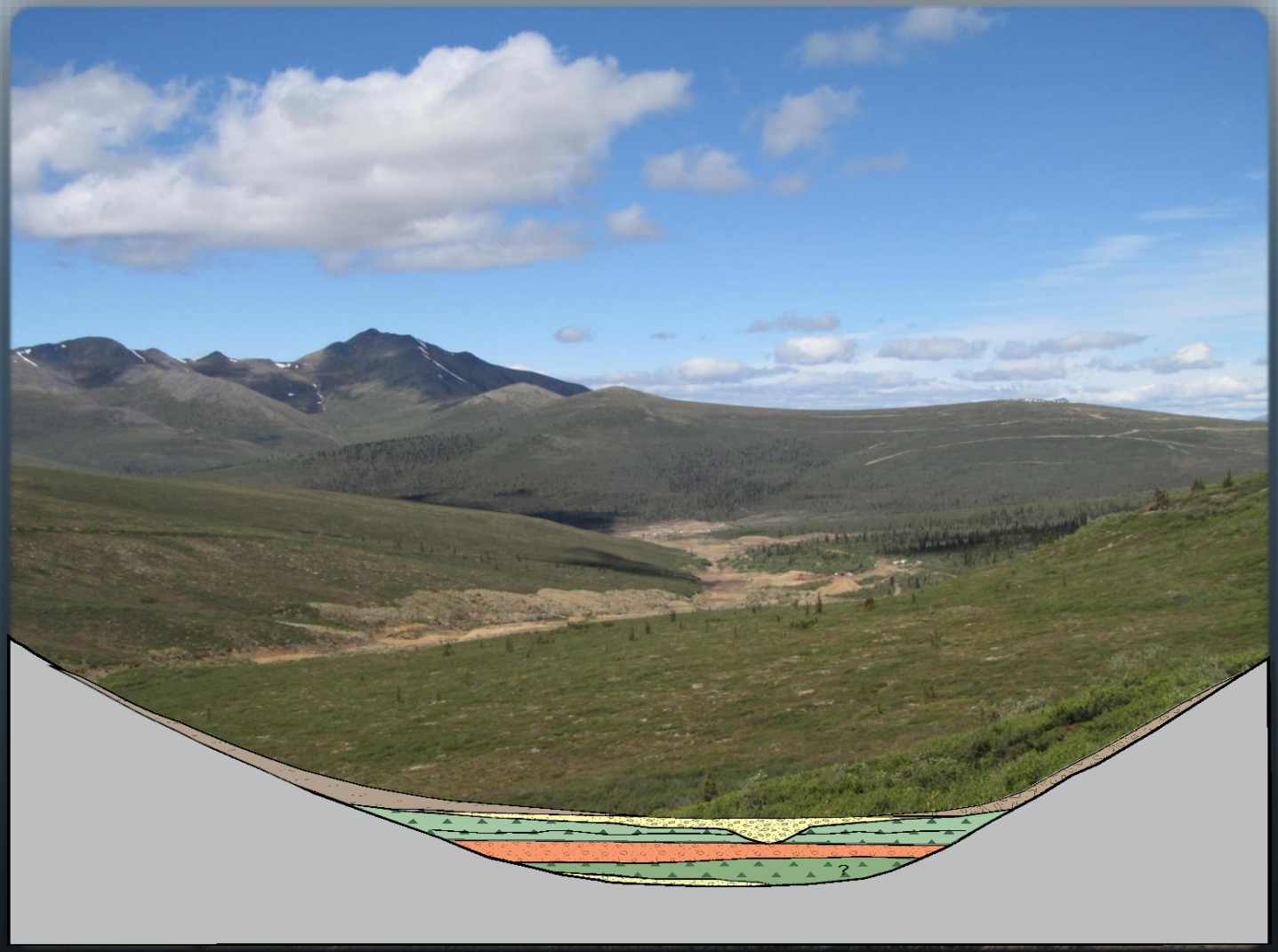
What about soil horizons?

A soil profile and its associated horizons are a reflection of the Earth's climate on the land surface. Humification of organic matter, as well as chemical and physical weathering all play a role in the development of a soil profile. So what is the significance of this process on altering the character of the parent material and how might this affect its geochemistry?



Horizon	Description	Utility for conventional soil geochemistry
A	mixed organic and parent material, zone of leaching	Generally considered poor for soil geochemistry due to the abundance of organic material.
B	mostly altered parent material; enriched in organic matter, iron, aluminum and manganese oxides transported from the A horizon	Adequate for soil geochemistry, but some elements may be enriched or depleted. Upper B-horizons may contain loess, which may alter the geochemistry.
C	weakly altered parent material; some enrichment from B horizon such as carbonate accumulation	Best horizon for conventional soil geochemistry (least oxidation). On north-facing slopes, this horizon may be inaccessible due to permafrost.

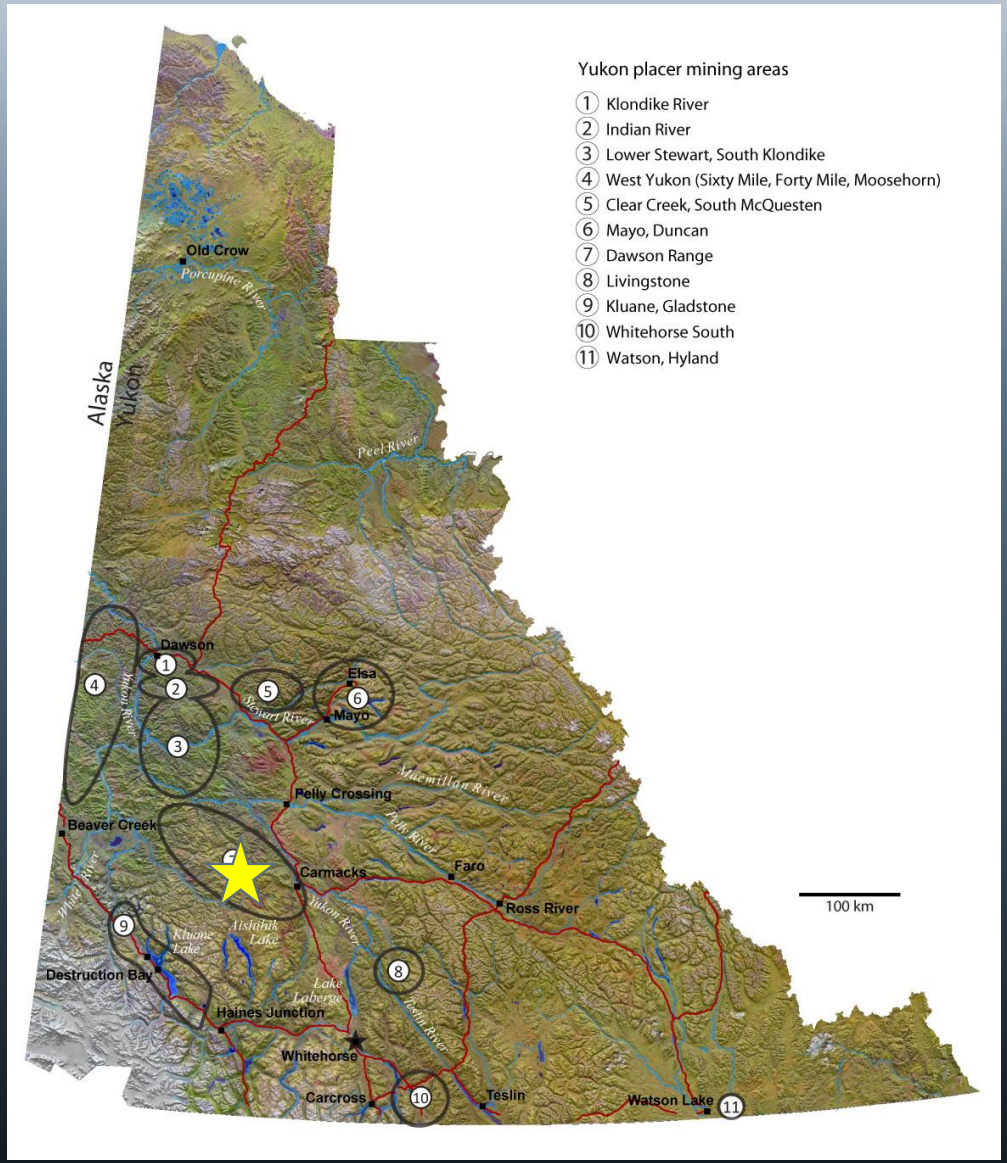
The Deep Placers of Mount Nansen (part 1)



Jeffrey Bond

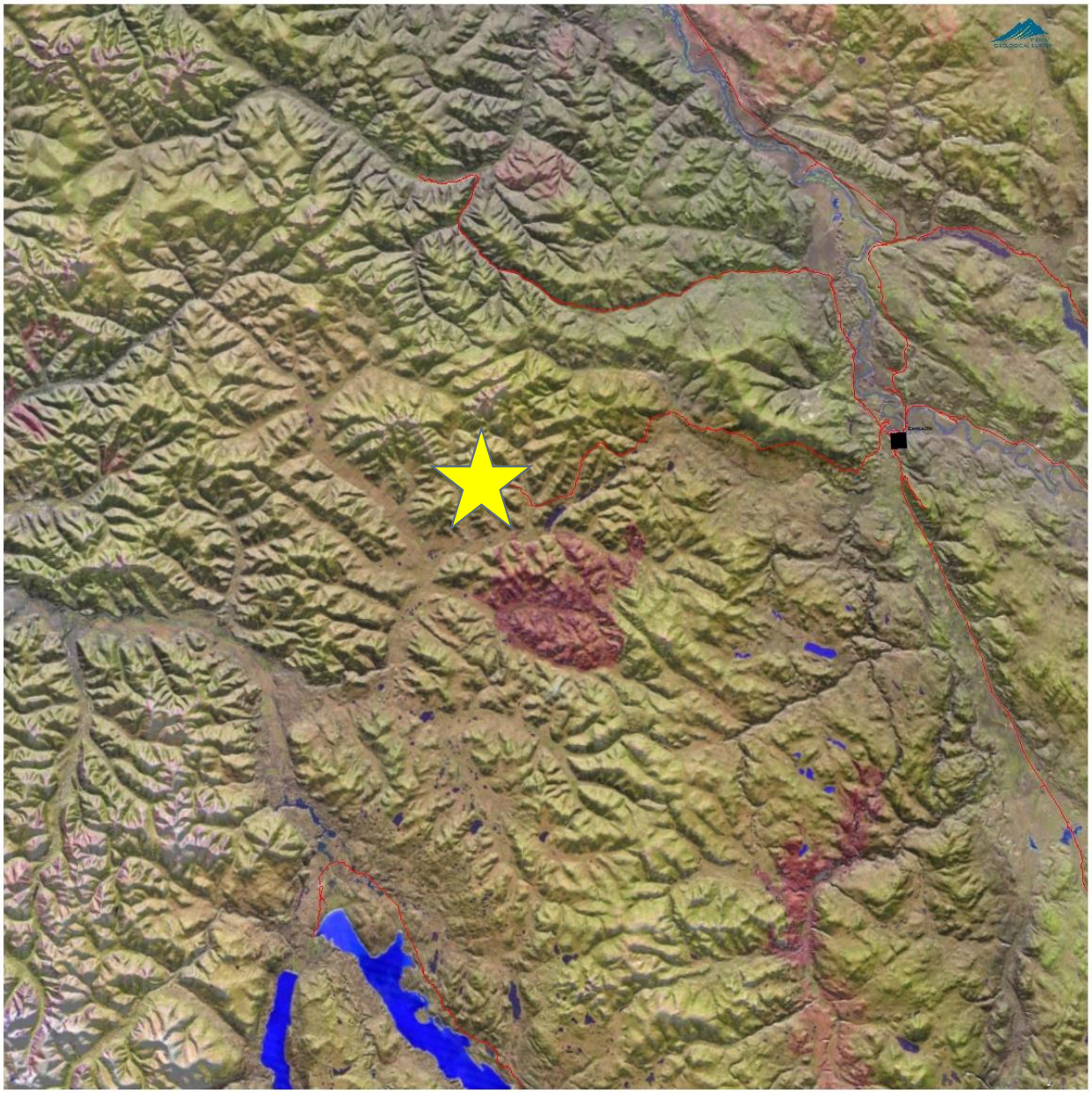
Yukon Geological Survey

Mount Nansen Location



Yukon Geological Survey

Mount Nansen Location



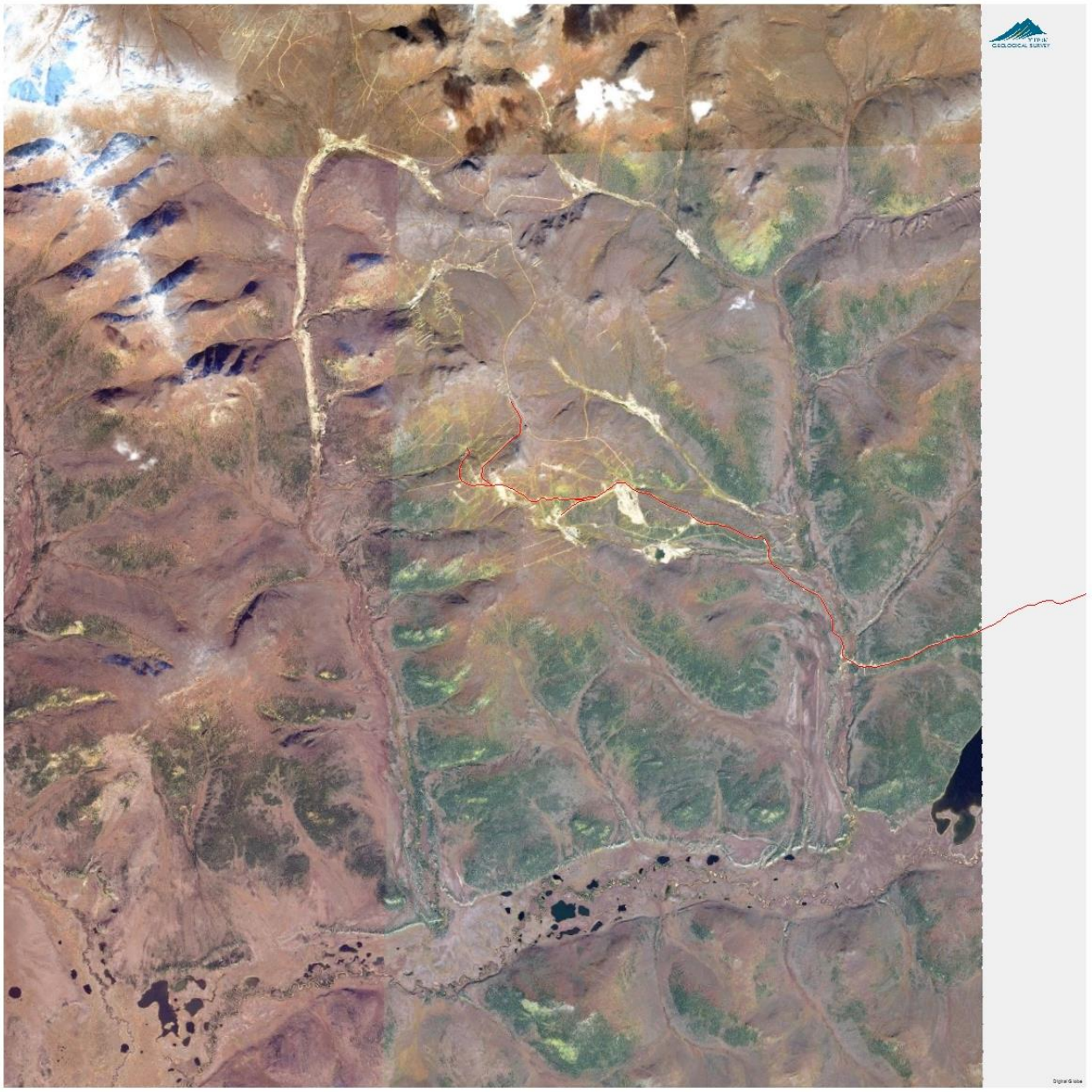
Physiography



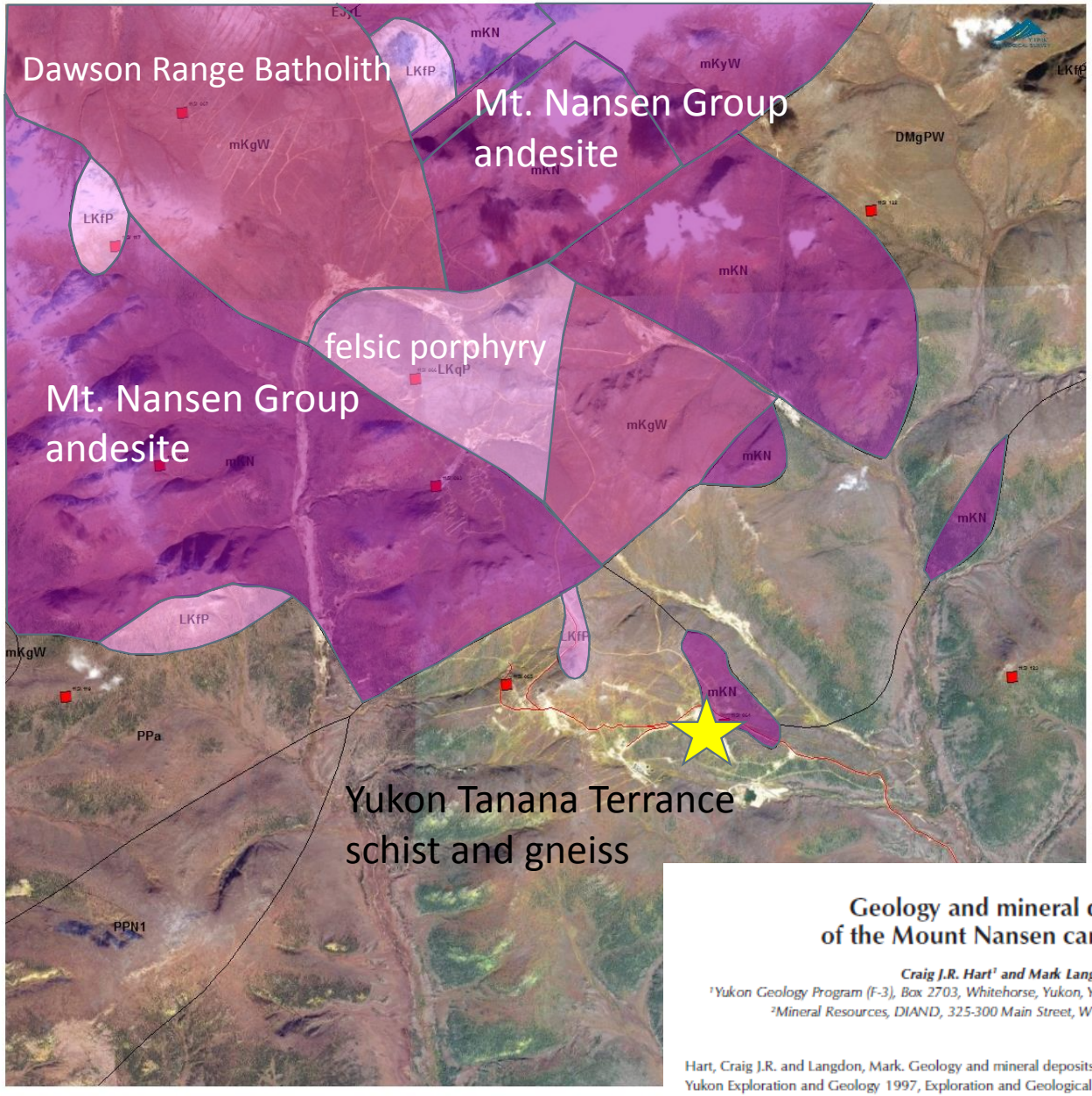
LeBarge photo

Yukon Geological Survey

Physiography



Geology



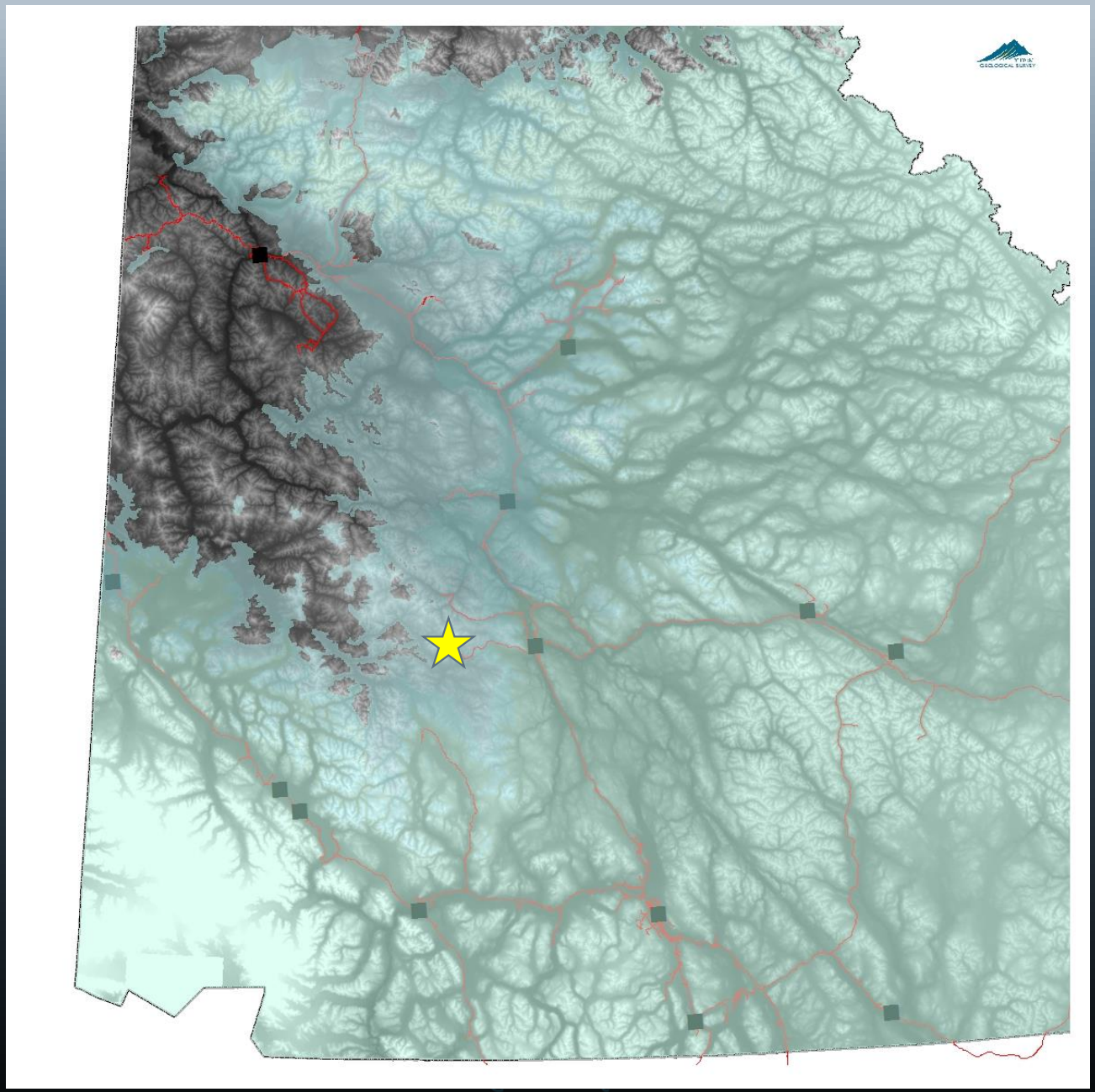
Cairnes, 1916
Bostock, 1936
Tenpelman-Kluit, 1984
Carlson, 1987

Geology and mineral deposits of the Mount Nansen camp, Yukon

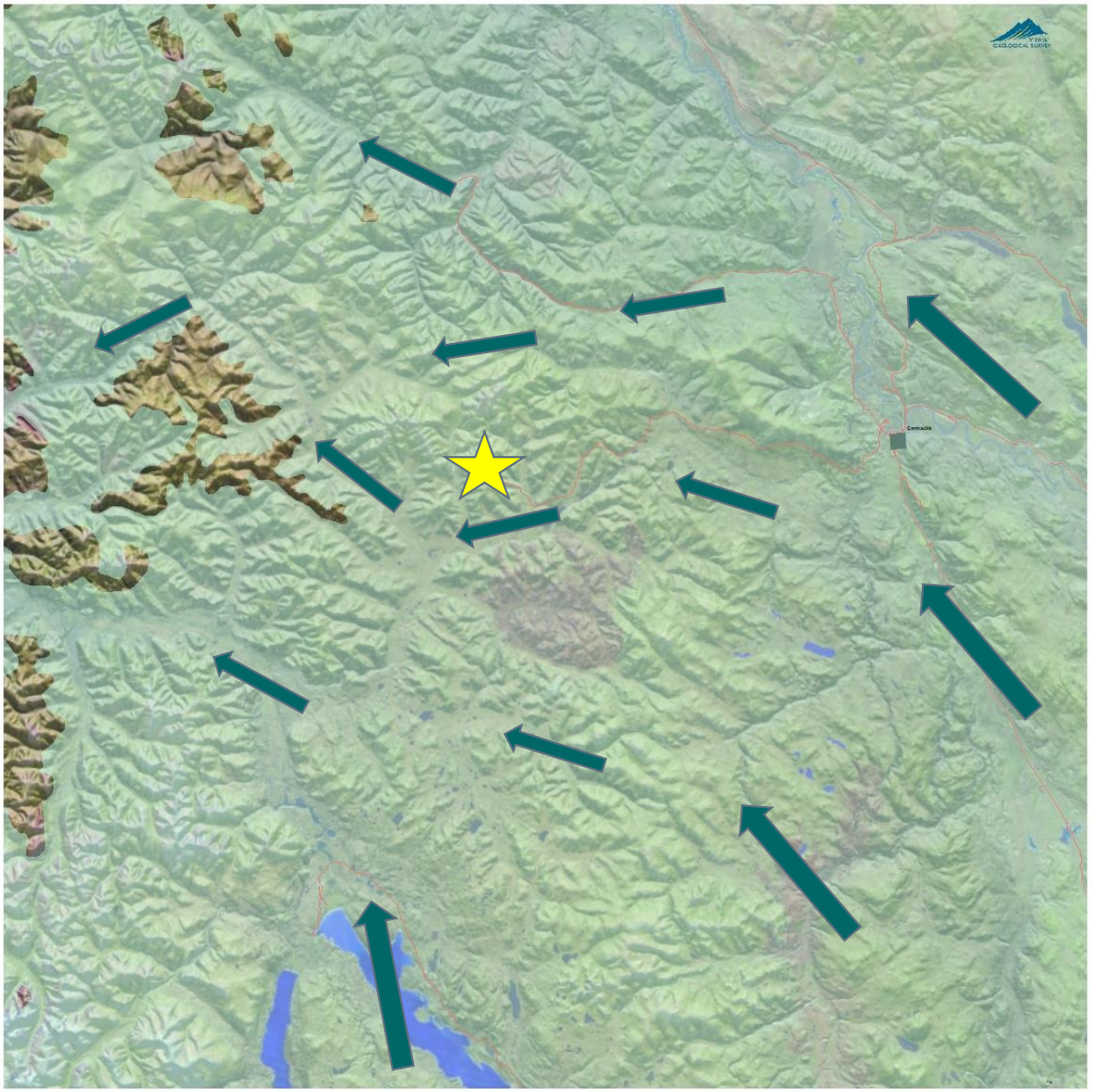
Craig J.R. Hart[1] and Mark Langdon[2]
[1]Yukon Geology Program (F-3), Box 2703, Whitehorse, Yukon, Y1A 2C6, e-mail: craig.hart@gov.yk.ca
[2]Mineral Resources, DIAND, 325-300 Main Street, Whitehorse, Yukon, Y1A 2B5

Hart, Craig J.R. and Langdon, Mark. Geology and mineral deposits of the Mount Nansen camp, Yukon. *In:* Yukon Exploration and Geology 1997, Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p.129-138.

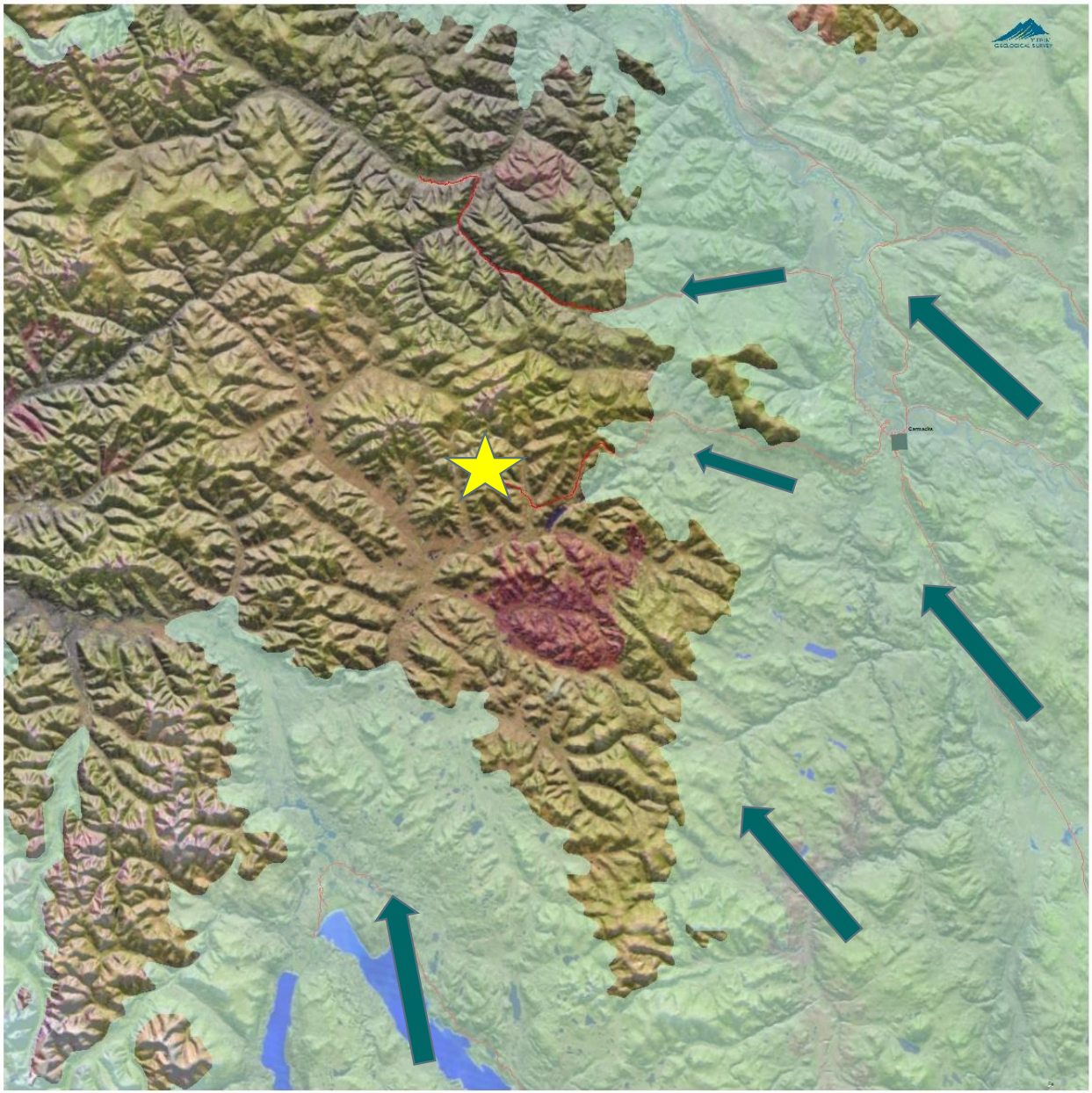
Mount Nansen Location



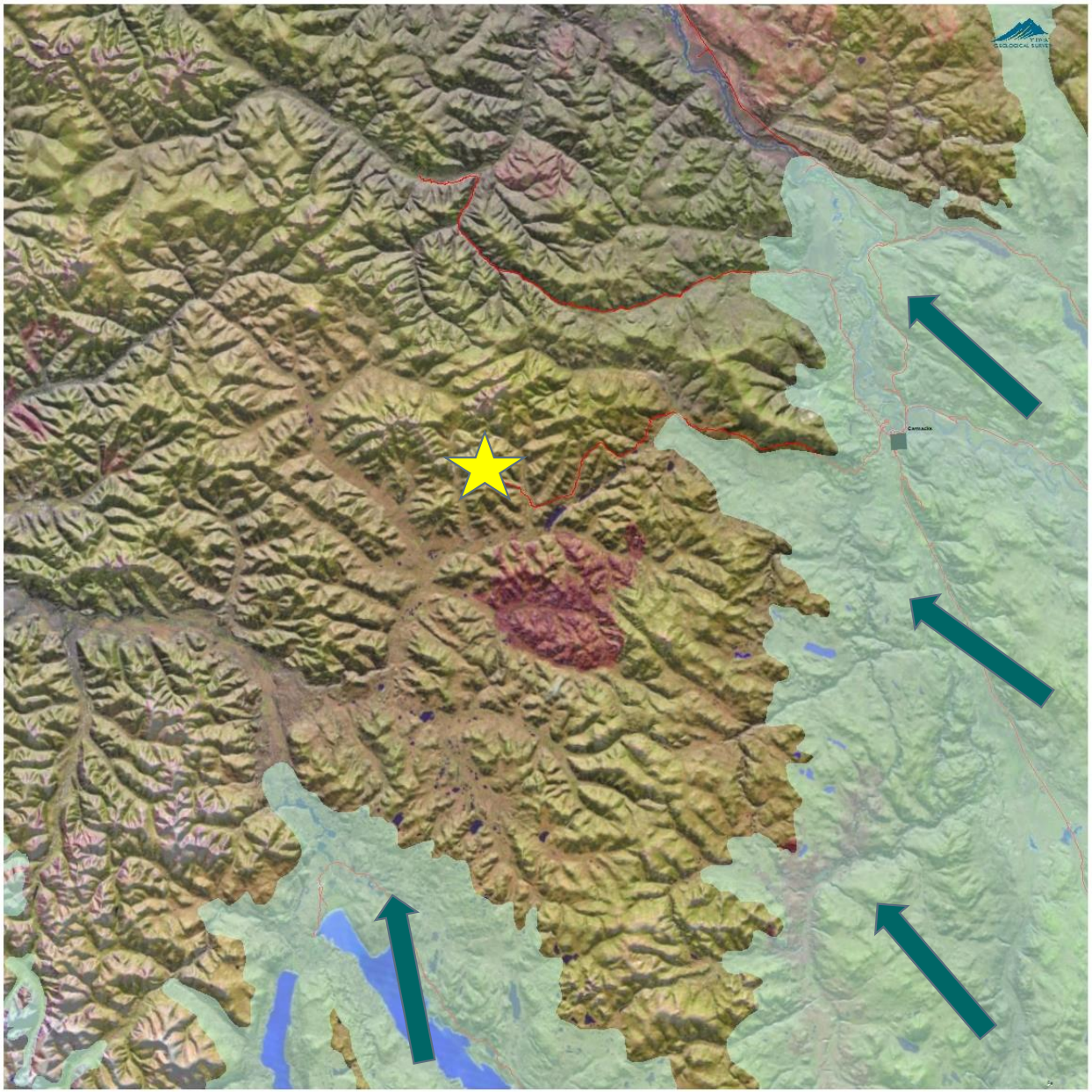
Early Pleistocene (Pre-Reid) ~2,600,000 yr ago



Reid Glaciation 150,000 yr ago



McConnell Glaciation 16,000 yr ago



Previous Placer Studies

LeBarge, 1995

Indian and Northern Affairs Canada | Affaires indiennes et du Nord Canada

Exploration and Geological Services Division, Yukon Region

BULLETIN 4

SEDIMENTOLOGY OF PLACER GRAVELS NEAR MT. NANSEN CENTRAL YUKON TERRITORY



W.P. LeBarge 1995

Canada

Yukon Geological Survey

Back Creek



Nansen Creek



Nansen Creek



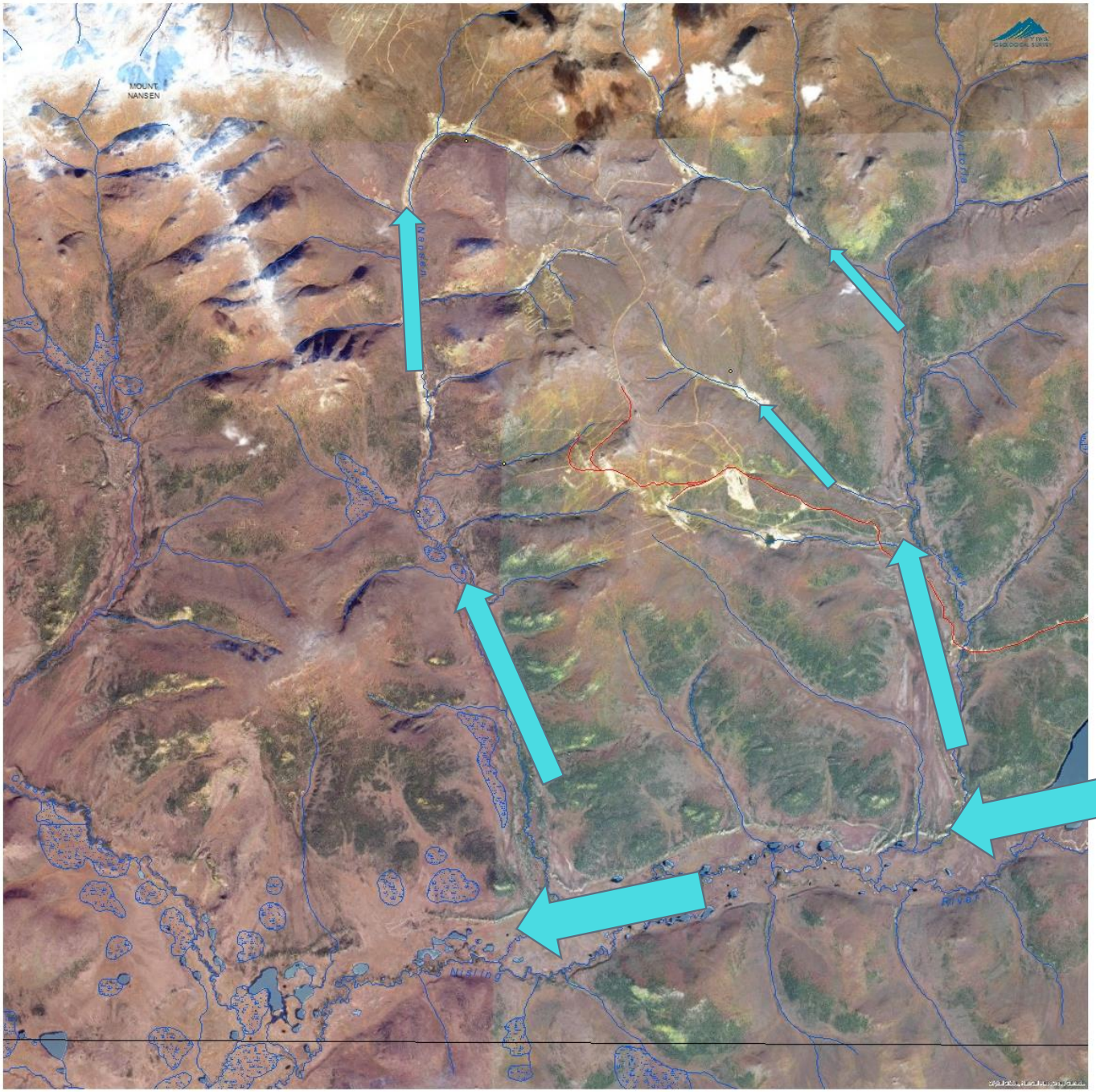
Yukon Geological Survey

Nansen Creek Till



Yukon Geological Survey

Dawson Range
Nansen



Pre-Reid Glacial History

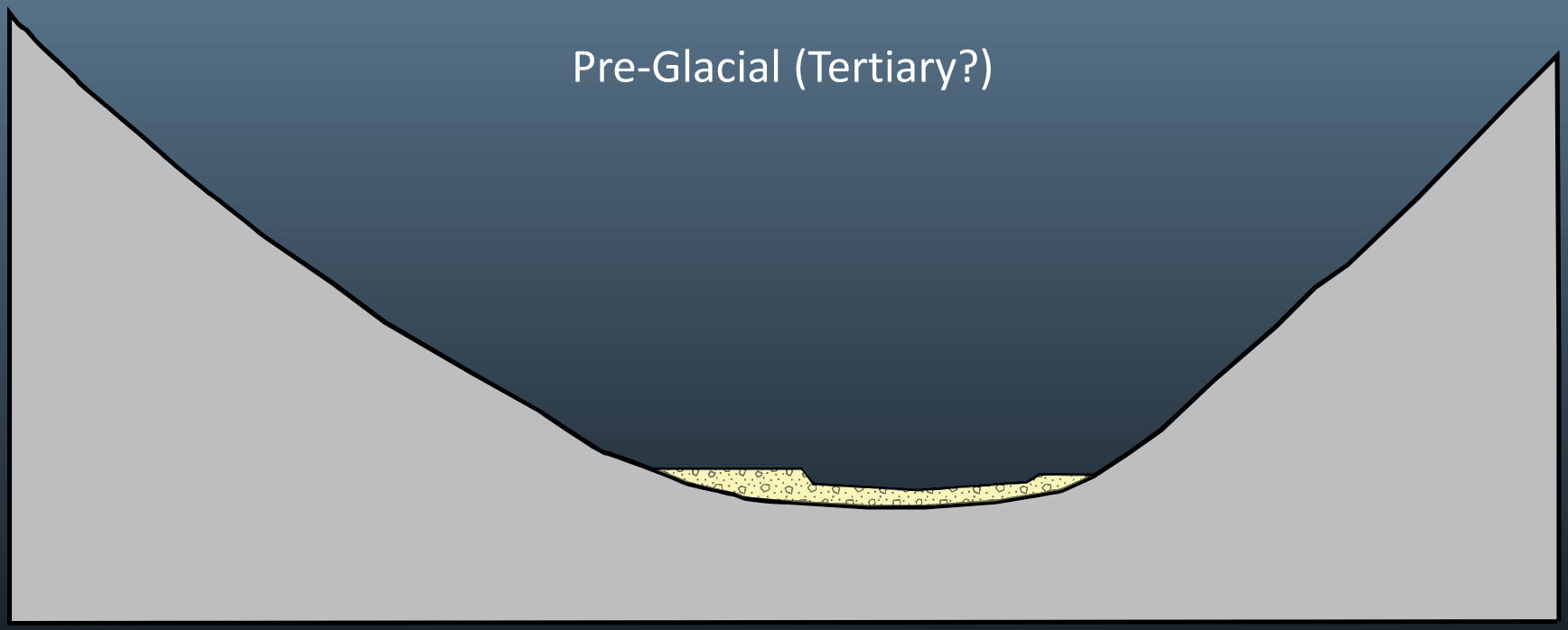


LeBarge photo

Yukon Geological Survey

Hypothetical Cross-section
Nansen Creek

Pre-Glacial (Tertiary?)



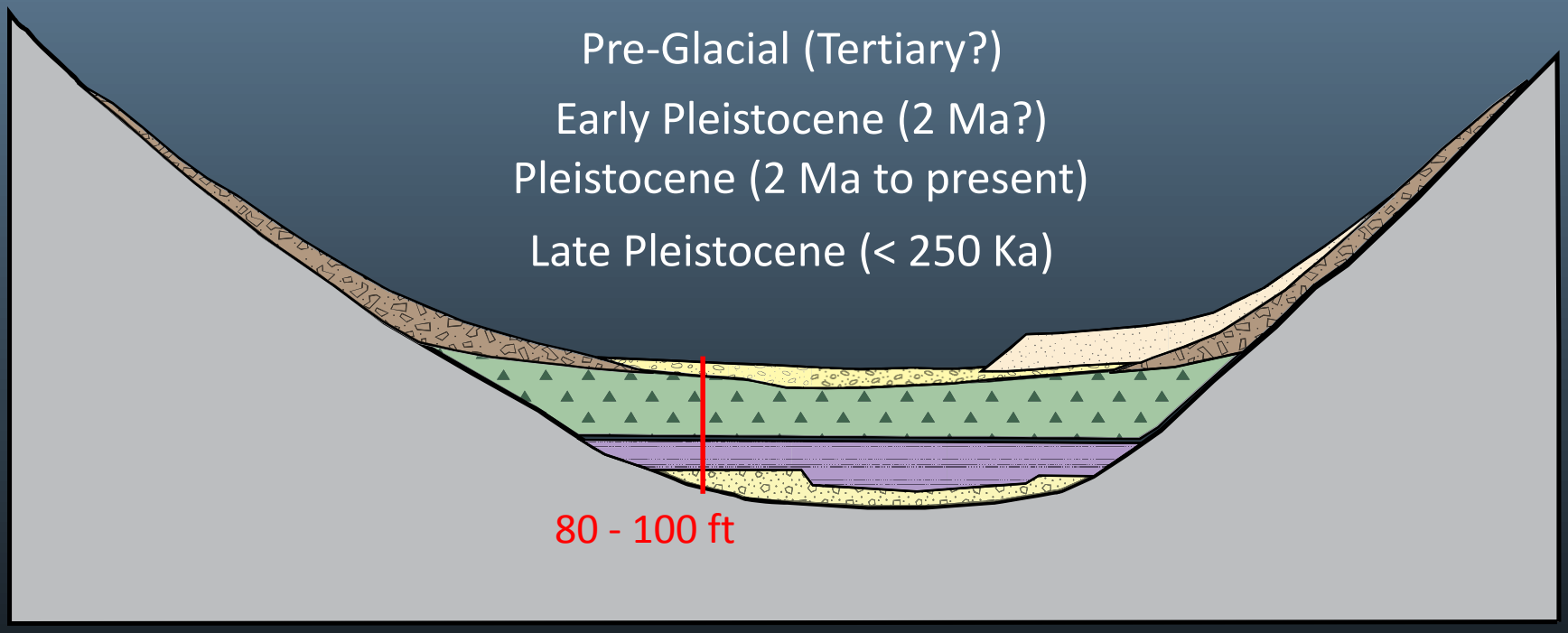
Yukon Geological Survey

Back Creek Pre-Glacial gravel



Yukon Geological Survey

Hypothetical Cross-section
Nansen Creek



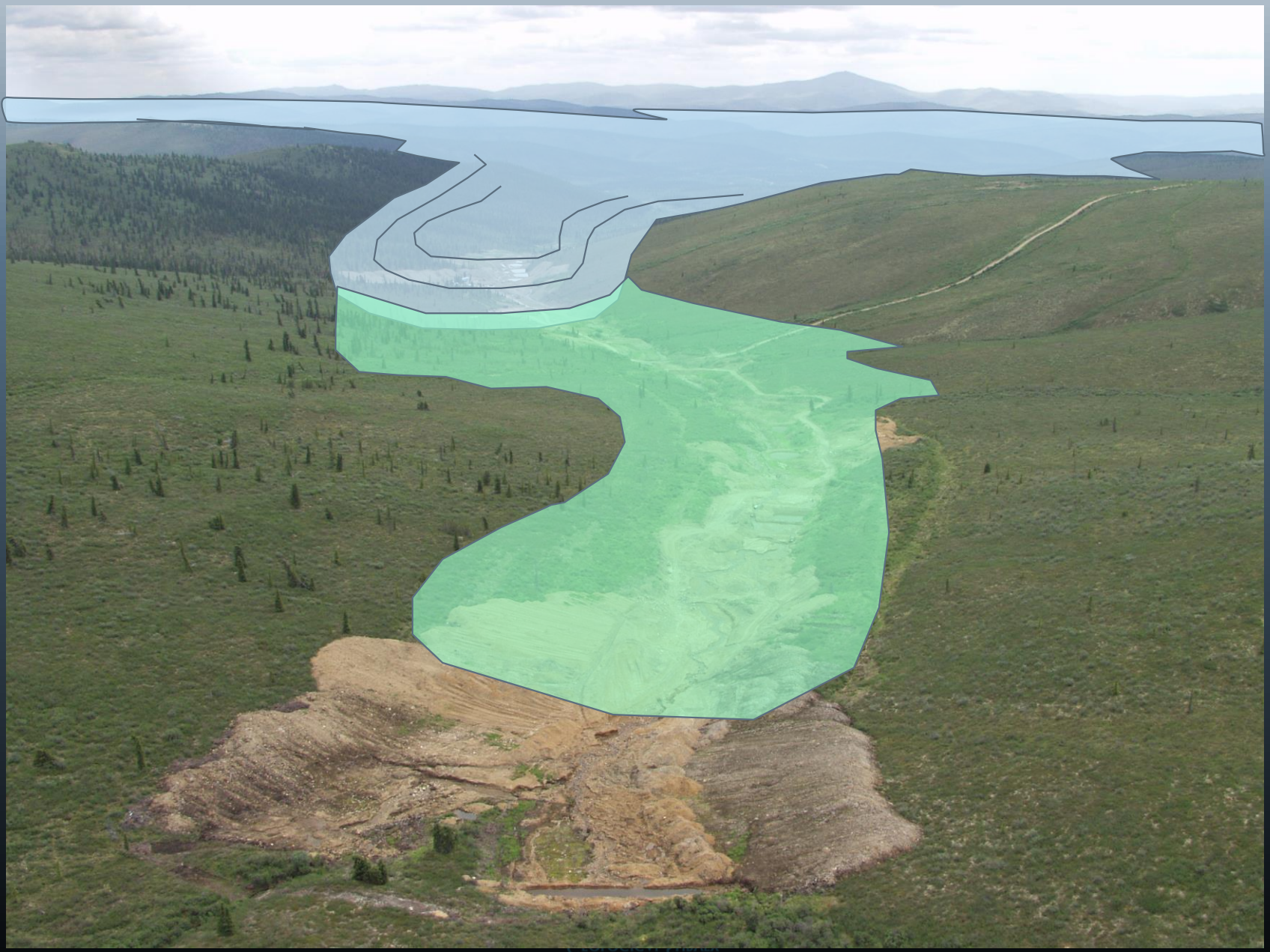
Yukon Geological Survey

Mouth of Discovery Creek



LeBarge photo

Back Creek - Pre-Reid Glacial History



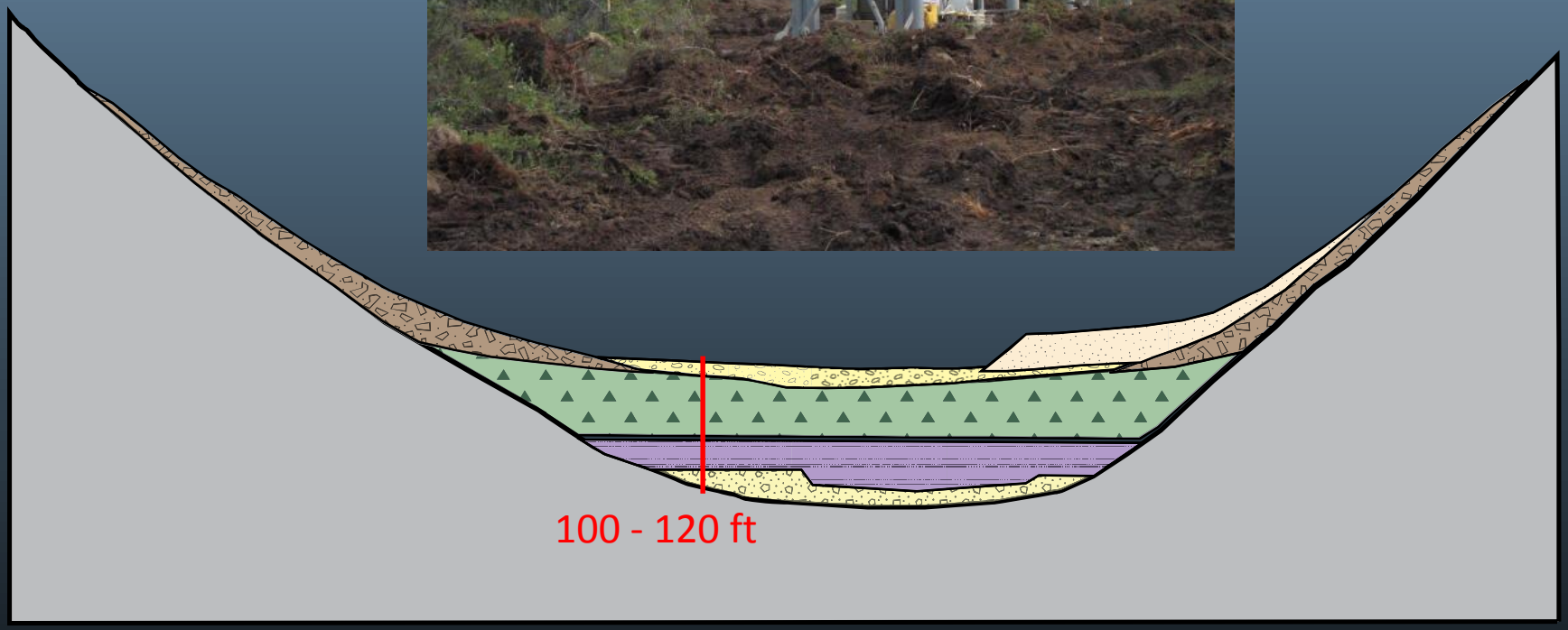
Back Creek



LeBarge photo

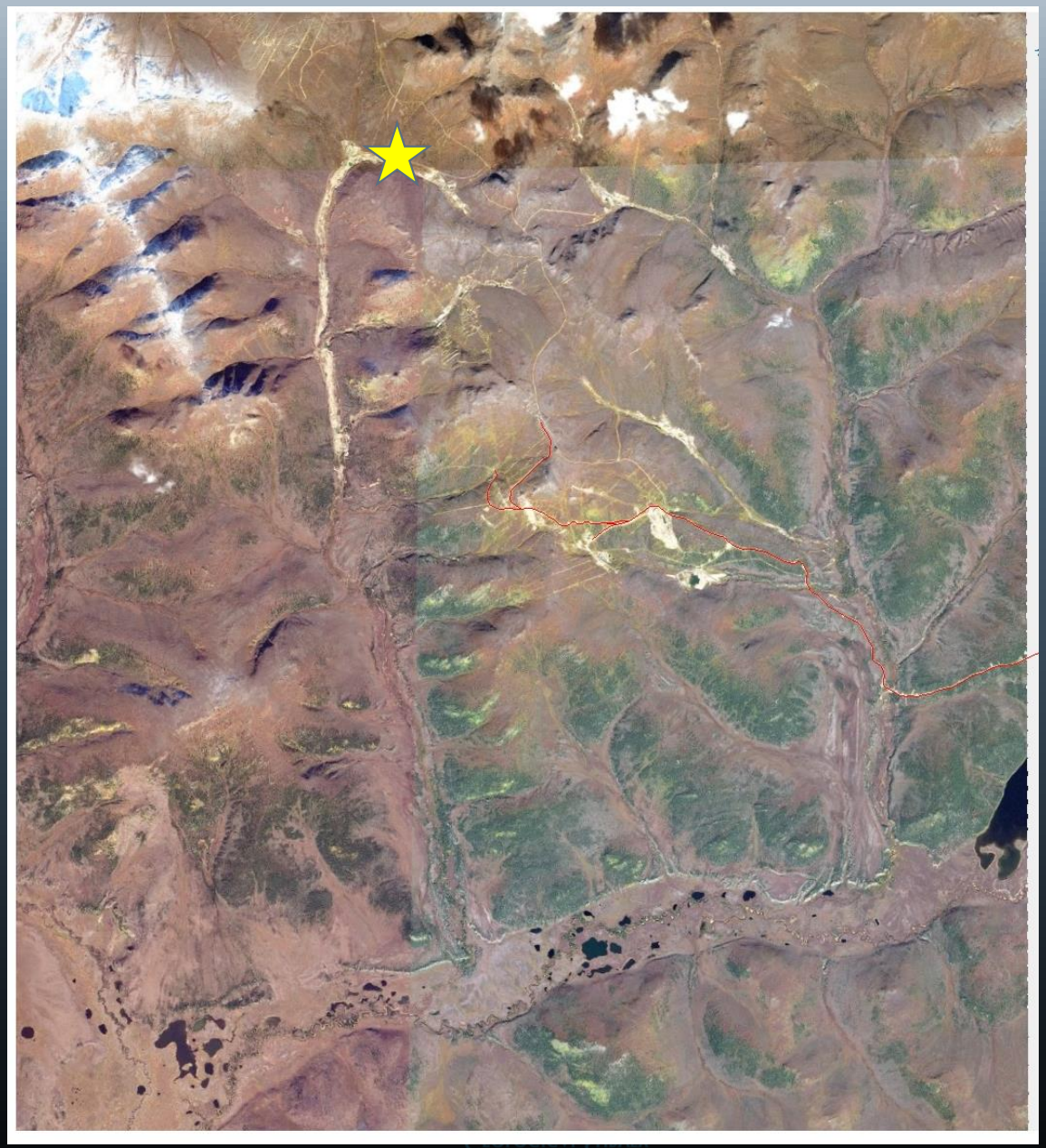
A-1 Cats
Back Creek 2014





Yukon Geological Survey

Upper Drainage Stratigraphy



East Fork of Nansen and Summit Creek



Geological Survey

LeBarge photo

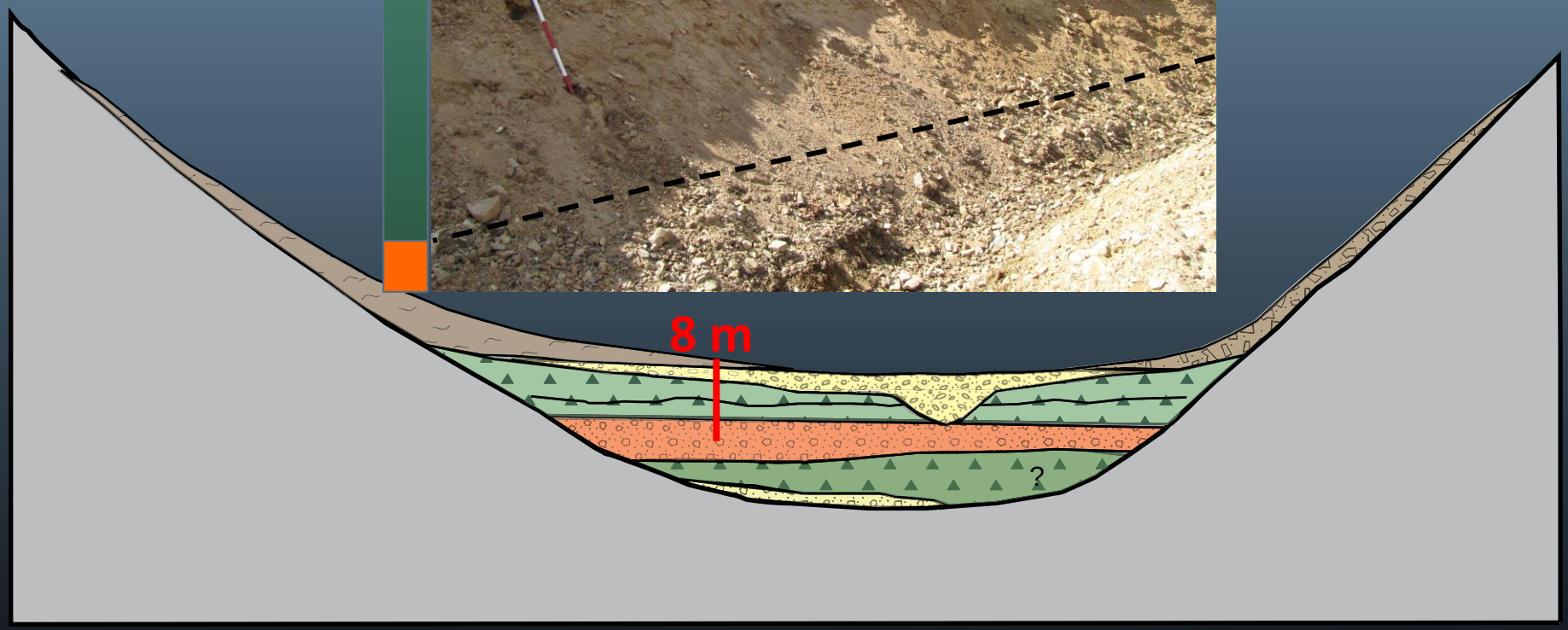
East Fork of Nansen and Summit Creek



LeBarge photo

Summit Creek – Pishon Gold

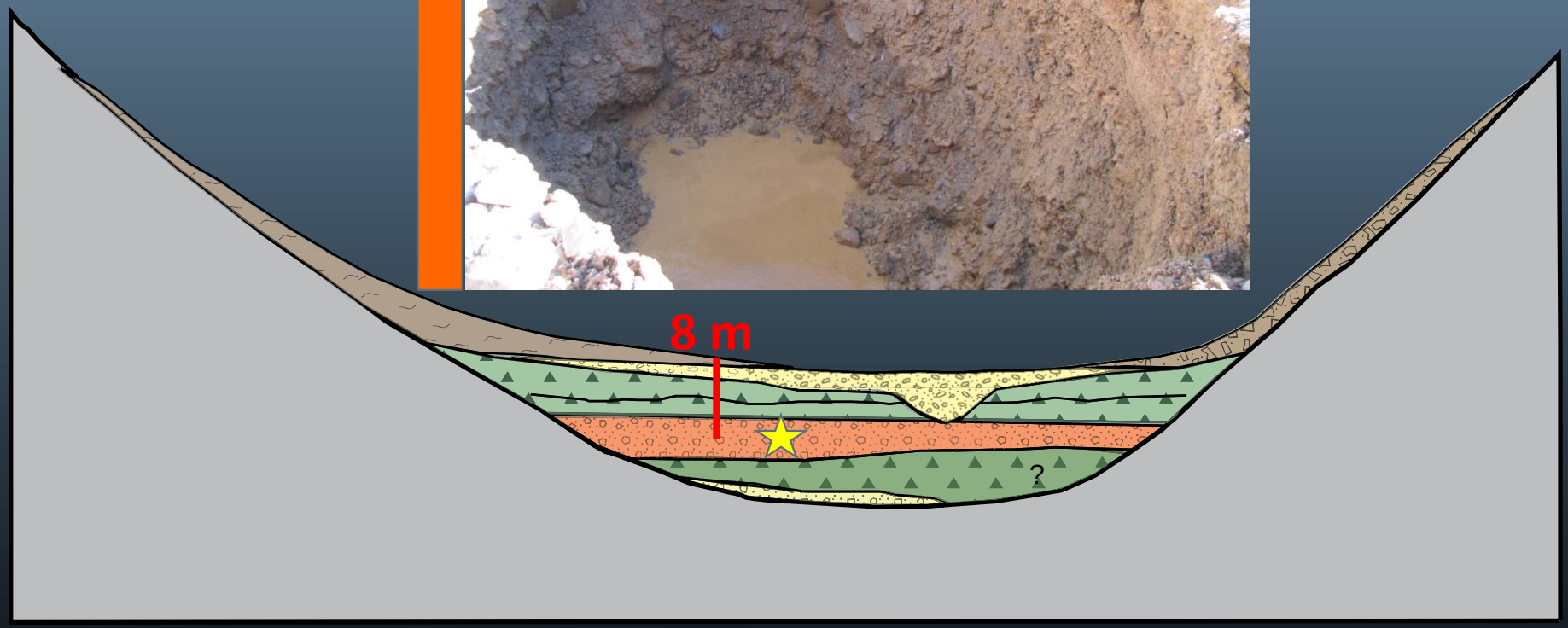




Yukon Geological Survey

Summit Creek – Pishon Gold





Yukon Geological Survey

Summit Creek – Pishon Gold
Ice sheet outwash



YUKON GEOLOGICAL SURVEY

Summit Creek – Pishon Gold
Local Alpine Till



Yukon Geological Survey

Summit Creek – Pishon Gold



Conclusions

- Deep placers have been confirmed in Back Creek
- Potential for deep placers exists in Nansen, Victoria, lower Summit, Cabin and Webber Creeks
- Depths will range from approx. 50-130 ft (15-40 m)
- Drilling and geophysics is required to locate the center line of the deep pay channel



Yukon Geological Survey

Placer-lode gold relationships in the Nansen placer district, Yukon

Rob Chapman[1], Matthew Cook, Matthew Grimshaw and Scott Myles
University of Leeds, UK

Chapman, R., Cook, M., Grimshaw, M. and Myles, S., 2016. Placer-lode gold relationships in the Nansen placer district, Yukon. *In:* Yukon Exploration and Geology, K.E. MacFarlane and M.G. Nordling (eds.), Yukon Geological Survey, p. 63-78.

ABSTRACT

Compositional studies have been undertaken on gold particles recovered from hypogene ore, eluvial material and placer samples in and around the Klaza property. These data have been correlated with previous descriptions of *in situ* mineralization to elucidate placer-lode relationships and systematic change in gold compositions between porphyry and epithermal environments.

Gold alloy from the porphyry environment is Ag-poor with respect to Au formed in later stage veins. Silver, and to a lesser extent Cu, have been the main discriminants for inferring the source of Au within the placers, and in general, vein mineralization is a more important source-type than porphyry mineralization.

The signature of Pb-Bi-Te previously identified in the inclusion suites of Au grains from Nucleus/ Revenue, Casino and Sonora Gulch has also been identified at Klaza, demonstrating that generic compositional signatures can underpin a robust exploration methodology. The relative sizes of porphyry and epithermal footprints of detrital Au together with their respective compositions are important considerations when targeting Cu-Au systems.

[1]*R.J.Chapman@leeds.ac.uk*

INTRODUCTION

The Dawson Range, south central Yukon is an emerging metallogenic province, and has been the focus of considerable study since 2009 (Allan *et al.* 2013). In part, this proliferation of exploration activity has been underpinned by the importance of widespread placer gold, which continues to support an important industry. The gold in the established placer regions can be broadly categorized into that derived from orogenic mineralization (*e.g.*, the Klondike, Sixtymile R., Tenmile R. and the White Gold District; Wrighton, 2013; Chapman *et al.*, 2014), and that derived from mineralization associated with early Late Cretaceous magmatism (Revenue/Nucleus, Casino, Sonora Gulch; Wrighton, 2013; Chapman *et al.*, 2014).

The Mount Nansen camp is situated at the south end of the Dawson Range (Fig.1); it comprises multiple mineral occurrences of porphyry and epithermal mineralization hosted within the 12 by 3 km 'Nansen Trend' within metasedimentary and meta-igneous rocks of the Yukon-Tanana terrane, (Hart and Langdon 1997; Fig. 1). The spatial relationships between porphyry mineralization and vein arrays, together with a parallel systematic change in mineralogy, are interpreted by Hart and Langdon (1997) as indicative of porphyry-epithermal transitions. Consequently, the mineralization in the Cyprus porphyry and gold-bearing precious metal veins of the Klaza deposit provide an excellent field area for study of mineralogical changes associated with an evolving magmatic hydrothermal system. The present study area comprises the northern part of the Nansen Trend and encompasses the Cyprus porphyry and the epithermal occurrences on the Klaza property, located between East Fork Nansen Creek and the Klaza River. The Klaza property is currently the focus of exploration by Rockhaven Resources.

In the Nansen Creek area, placer deposits are spatially located near the Klaza property, the very low grade

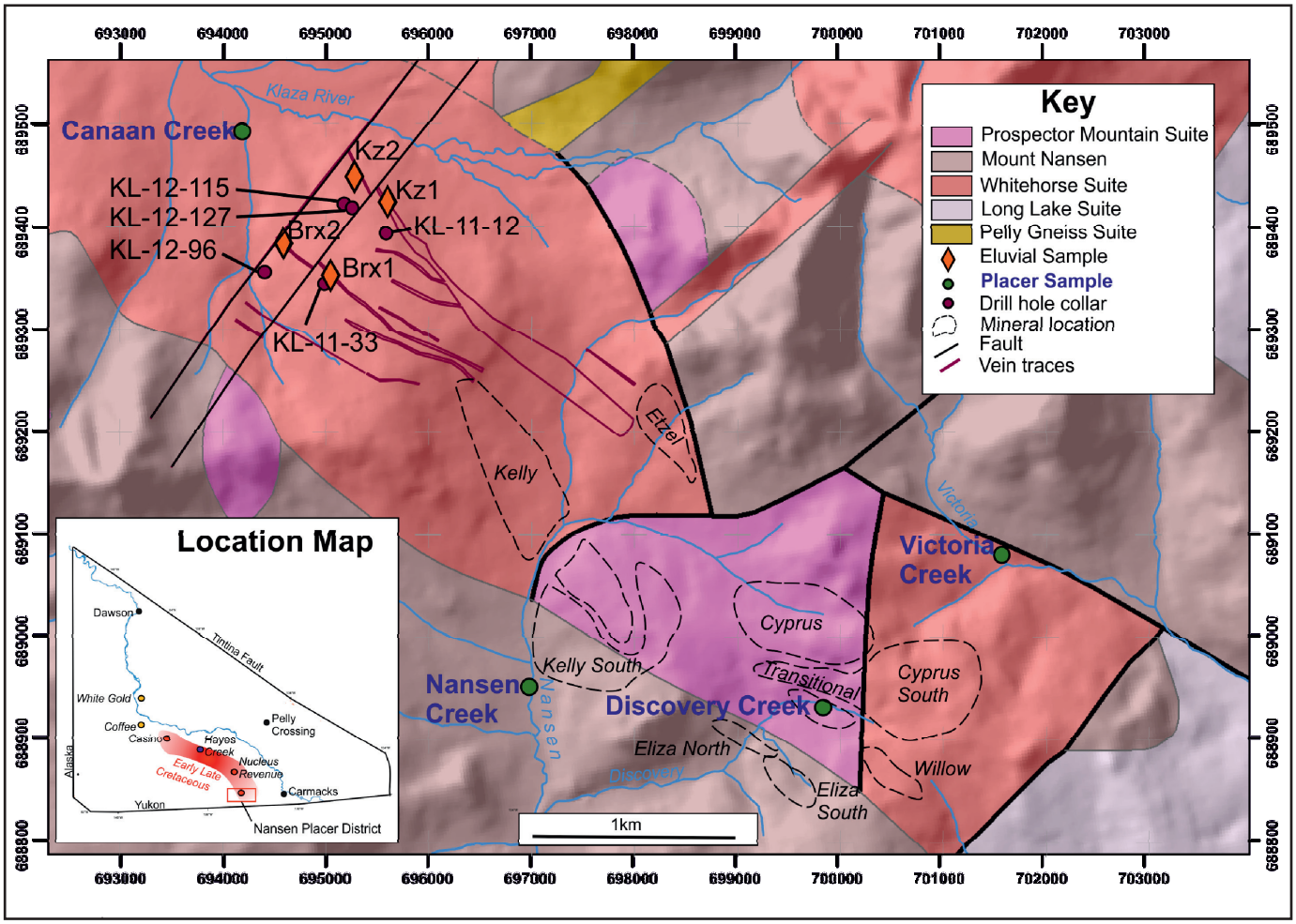


Figure 1. *Regional Geology and mineralization (after Colpron, 2006; Hart and Langdon, 1997.*

Cyprus Cu-porphyry and the Kelly occurrence. The YGS Placer Database (LeBarge, 2007) indicates that different gold fineness has been regularly reported from different creeks. Whilst bulk fineness data are only partially useful as a discriminant (due either to mixing of gold from different sources with different compositions, or derivation from a single source with a variable Au-Ag ratio), broad variation of gold composition with geographical location is suggestive of multiple sources. This study aims to establish clear compositional signatures of gold from both the hypogene and placer environments in the environs of the Klaza deposit to inform two avenues of investigation: i. evaluation of the variation in gold mineralogy within a porphyry-epithermal transition; and ii. evaluation of the relative importance of porphyry and epithermal Au as sources of local placers.

GEOLOGY AND MINERALIZATION

The regional and local geology of the study area is summarized by Hart and Langdon (1997) and depicted in Figure 1. The study area is situated in the north part of the Mount Nansen Trend; the trend is a 12 by 3 km NW-SE corridor which hosts approximately 30 mineral localities.

The locations of mineralization relevant to the present study are illustrated in Figure 1 and described in Table 1 which is organized according to the classification of Hart and Langdon, (1997)

The mineralogical descriptions of the various zones presented in Table 1 indicate a progressive decrease in Cu content away from the Cyprus porphyry both to the NW and SE, into Au-Ag-Pb-Zn dominated vein systems. The Klaza property hosts multiple sub-parallel veins of which the BRX vein and Klaza zone (Fig. 1) have been explored most extensively. The veins exhibit differences in their mineralogy with the Klaza zone containing higher levels of Pb and Ag, (Tarswell and Turner, 2014). The vein outcrops are offset by an up-thrown faulted block (throw probably around 150 m) perpendicular to strike. Tarswell and Turner (2014) propose that the Klaza veins correspond to a class of 'base metal carbonate' epithermal veins described by Corbett (2002), in which metal precipitation is induced by mixing with bicarbonate-rich groundwater. Such deposits are commonly zoned, reflecting marked differences in local temperature change, aH_2S (associated with sulphide precipitation) and degree of dilution. Samples of eluvial and hypogene material from these two zones formed part of the sample suite of the current study.

Table 1. *Descriptions of mineralized localities in the study area, adapted from Hart and Langdon (1997).*

Name	Description
Central Porphyry Zone	
Cyprus1,3	Quartz monzonite porphyry, Cu-Mo zone: py, cpy, mo, Cu 0.1-0.15%. Au anomalous but erratic
Kelly1	0.275 x 2.5km NW trending potassic alteration zone identified by soil geochemistry. Trench sample yielded 0.86 g/T Au and 0.25% Cu. cpy, Cc bn and mo
Peripheral porphyry zone	
Cyprus South1	Quartz sulphide veins and stockworks in phyllic zone. Au grade of 0.31g/T recorded in core.
Kelly South1	Au recorded in pyrite shell associated with phyllic alteration
Transitional zone	
Eliza Creek extension1	Veins and stockworks associated with porphyry stocks breccia and argillic/phyllic alteration. Au grades to 17.5g/T and Ag to 27 g/T in core
Transitional	Four veins very similar to those of the Eliza Creek extension
Epithermal veins	
Klaza Zone2	py, sp, ars, ga, sb, ss. au
BRX zone1	py, sp, ars, ga, sb, ss. au
Eliza Creek South 1	Au-Ag-Zn-Pb veins. Trench samples of Au to 3.9g/T
Eliza Creek North1	Au-Ag-Zn-Pb veins. Cu content > Eliza Creek North. Au to 10.3g/T
Etzel	Au-Ag-Pb-Zn veins
Willow1	3 Au-Ag-Pb-Zn veins containing Au to 3.5g/T

Key: py=pyrite, cpy=chalcopyrite, sp=sphalerite, ars=arsenopyrite, ga=galena, sb=stibnite. 1=(Hart and Langdon, 1997), 2=Tarswell and Turner (2014), 3=YGS Minfile 1151066.

The surficial geology of the Nansen area is described by LeBarge (1995) and comprises sediments originating in an array of pre-glacial, glacial and post glacial environments. Eight sedimentary facies are identified and each was investigated in terms of the concentration of detrital gold. Provenance of the gold in placers on Nansen and Victoria creeks and Canaan Creek was informed by clast analyses and morphological studies of the gold grains themselves. The highest concentrations of gold are observed in diamictons, interpreted to be the erosional products of pre-existing weathered ore and placers. *In situ* mineralization is observed in weathered bedrock, within the outcrop of the Cyprus porphyry such that direct liberation of gold from host to modern placer is possible at some localities. The presence of paystreaks on a false bedrock of early Pleistocene till in upper Nansen Creek till indicates that rejuvenation of the placer is ongoing (J. Bond pers. Comm.).

The Mount Nansen area has supported placer mining since the early twentieth century (LeBarge, 2007). An overview of the relative importance of various creeks is presented in Table 2, and summarizes production figures to 2005. The data show the placer resource in Nansen Creek is the most economically important. Bulk fineness data (LeBarge, 2007) indicate that most gold in the Nansen Creek system is between 800 and 850 fine, whereas gold from Victoria Creek, Canaan Creek and one of the reported Back Creek populations exhibits lower fineness values. LeBarge (2007) reports that many streams in the area were explored for their placer potential, but only a small number supported sustained activity.

PREVIOUS STUDIES OF GOLD GRAIN COMPOSITION IN THE DAWSON RANGE

Understanding the relationship between economically important placer gold deposits in Yukon and their potential lode sources has developed significantly during the last decade. Various studies have characterized gold particles derived both from lode and placers in terms of their alloy compositions and suite of mineral inclusions revealed in polished section, (*e.g.* Chapman *et al.*, 2010a,b; Chapman *et al.*, 2011; Wrighton, 2013; Chapman *et al.*, 2014). These combined data sets yield a 'microchemical signature' for a specific population of grains. Comparison of microchemical signatures of hypogene Au grains with detrital Au particles from local placer populations can establish placer-lode relationships. Wider studies are ongoing which seek to establish the characteristics of each signature which are diagnostic for different styles of gold mineralization.

A regional study of placer-lode gold relationships in the Dawson Range was undertaken between 2010 and 2012 under the auspices of the Yukon Gold Project, an academia- industry collaboration based at the Minerals Deposit Research Unit (MDRU) at UBC. Studies of placer and lode gold grains derived from the early Late Cretaceous intrusions of Revenue and Nucleus are distinct from those associated with orogenic mineralization, (Wrighton, 2013). Chapman *et al.* (2014) expanded this study to show that porphyry mineralization at Casino, Revenue/Nucleus and Sonora Gulch yield gold grains with a distinctive Bi-Pb-Te inclusion signature.

Table 2. *placer gold information (data from LeBarge 2007).*

Placer Creek	Fineness	Production (oz) to 2005	Comments
Discovery	820-850	1586	
E. Fork Nansen	No data	448	Some dendritic gold
Nansen	805-820	21,251	
Victoria	720-730	1185	
Back	760-836	3478	'Coarse' pay streak reported
Slate	800	-	Minor trib, no mining
Canaan	750	Unknown	No data in YPDB

SAMPLING

CORE SAMPLES

Core samples were selected based on the proximity of the hole collar to the localities of trench sampling (Table 3a). Selection of the intersections studied in each hole was based on the location of high Au grade. Sample preparation and analysis was undertaken at the University of Leeds.

OXIDIZED VEIN MATERIAL IN TRENCHES

The vein system at Klaza outcrops at surface and has been exposed by trenching. Decomposed vein material was collected from four localities, (*see* Table 3b and Fig. 1) and was thoroughly wetted before processing using a 'Le Trap' portable sluice. Sluice concentrates were panned to recover a 'super concentrate' containing gold grains.

COLLECTION OF PLACER SAMPLES

Samples of placer gold were collected using a combination of panning and sluicing. The details of the sample sites are provided in Table 3c and Figure 1. Characterization of Au from Nansen Creek was facilitated by study of two sample populations, the first of which is described in Table 3c. The second Nansen Creek sample comprised 56 gold grains collected by the Yukon Geological Survey close to the confluence of Nansen and East Fork Nansen creeks, although the exact locality is unknown. The inclusion assemblage of this second sample was useful to augment that observed in the sample collected slightly downstream during the current study.

Table 3. *Samples collected for this study.*

3a. Core samples used in preparation of polished blocks

Hole _ID	Close to	Sample depth m	From (m)	To (m)	Interval (m)	Collar Easting	Collar Northing	Au ppm	Ag ppm
KL-11-33	BRX 1	121.1	120.3	121.64	1.34	382080	6889865	5.51	180
KL-12-96	BRX 2	342.8	342.46	345.36	2.9	381509	6890034	10.55	92.7
KL-11-12	KZ1	221.7	221	222.6	1.6	382724	6890305	6.81	123
KL-12-115	KZ2	219.7	219.48	221.59	2.11	382340	6890627	13.75	357
KL-12-127	KZ2	169	168.11	169.11	1	382418	6890581	5.73	204

3b. Eluvial samples collected from vein outcrop

label	Trench	E	N	g/T Au	g/T Ag	intercept (m)	Volume of -2.5 cm material sluiced (L)
BRX 1	TR 13-49	382410	6889676	8.4	548	1.31	140
BRX 2	TR 13-47	381715	6890310	87	768	1.15	400
KZ 1	TR13-66	382758	6890614	25.7	449	2.27	200
KZ 2	TR 13-70	382462	6890888	16.76	1052	3.03	200

3c. Placer samples

locality	E	N	Comments	Potential sources
Discovery Ck	386521	6885312	Sample from headwaters of creek	CyS, El.N, El.S, Tr,
Victoria Ck	388391	6886630	Side pay	Unknown
Canaan Ck	381422	6891421	From active cut	BRX, Klaza zone
Nansen Ck	383700	6885781	From active cut	K, KS, Et, Cy

Abbreviations, corresponding to mineralization described in Table 1. Cy=Cyprus porphyry, CyS=Cyprus South, El.N=Eliza North, El.S=Eliza South, Tr=transitional, WC=Willow Creek, K=Kelly, KS=Kelly South.

ANALYTICAL WORK

Polished blocks were prepared from core samples and examined using both reflected light microscopy and the scanning electron microscope (SEM). Analysis of Au grains >5 µm in diameter was undertaken by electron probe microanalysis (EMP). Gold grains from eluvial and placer samples were isolated from the sluice concentrates by picking under a binocular microscope. These gold grains were mounted according to size as described by Chapman *et al.* (2000). The extreme small size of some of the gold particles necessitated the design of a new polishing technique specifically for extremely tiny (30-50 µm) particles. This involved introducing the grains into small pools of resin placed on a glass slide. The gold grains were revealed during controlled polishing of the slides in a manner similar to that employed when preparing rock thin sections to the required thickness.

Analysis of the Au grains was carried out in two stages. Firstly, qualitative analyses were undertaken using a FEI Quanta 650 FEG-ESEM. This involved inspection of each grain section and recording alloy heterogeneity and the presence of inclusions, either of minerals or intermetallic compounds. Secondly, quantitative alloy compositions were determined by EMP using a Jeol 8230 Superprobe. The minor element suite analyzed was Ag, Cu and Hg and the detection limits for each element were 0.03%, 0.02% and 0.1% respectively. All values are expressed in wt%. Polished blocks of core samples were prepared for inspection by reflected light microscopy and SEM/EMP analysis.

RESULTS

HYPOGENE ORE

The aim of this element of the project is to identify minerals coeval with the gold and that could be subsequently correlated to the suite of inclusions recorded in placer gold samples. Native gold is identified in samples from both veins, (in cores Kl-12-96 and Kl-12-115) although many of these gold grains are less than 2 µm in diameter and consequently too small to analyze by EMP. Mostly, gold is observed as small blebs in early stage pyrite, as is Bi telluride (Fig. 2a,b). Both galena and arsenopyrite post-date the pyrite, but Au is only observed in galena (Fig. 2c). Only gold in core from hole KL-12-96 (adjacent to BRX-2) is sufficiently coarse to analyse by EMP. The Ag contents of these grains are illustrated in Figure 3a, and the co- variance of Ag with Cu is illustrated in Figure 4.

SAMPLES COLLECTED FROM VEIN OUTCROPS

The alloy compositions of Au grains from BRX 1 and BRX 2 are shown in Figure 3a. Both populations are dominated by grains in the 18-25% Ag range; however there are other small contributions from other sub-populations which exhibit lower Ag contents, one of which appears similar to the Ag range of gold grains observed in the core samples. Table 4 shows that around 90% of grains from the BRX zone contain Hg to above LOD of 0.06%, although the maximum value recorded is only 1.5%. The percentage of grains containing measurable Cu is much lower at 35% and 36% in BRX 1 and BRX 2 respectively.

The low incidence of inclusions in the samples from the BRX zone grains is probably related to the tiny size of most of these gold grains. Table 4, shows the number of gold grains that contained specific minerals. Overall the inclusion assemblage reflects the mineralogy of the hypogene ore, with minerals coeval with Au observed as inclusions (*e.g.*, galena and Bi telluride; Fig. 2d,e). Arsenopyrite is not observed as an inclusion, (neither are Au grains observed within arsenopyrite in hypogene ore) but secondary As minerals are observed coating Au grains.

Covariance of minor alloying metals is investigated using the bivariate plots shown in Figure 4. Figure 4a shows the compositional fields of grains from Discovery Creek and Figure 4b superimposes these data onto that describing gold from the BRX Zone. In the Discovery Creek sample, the relationship of Ag to Cu is generally inverse, although most grains cluster in the mid-range of Ag and Cu. The distribution of alloy compositions of gold from the BRX zone shown in Figure 4b differs because the majority of points cluster in two Ag ranges, and within these Cu varies independently. A small number of grains contain relatively high Cu values but their compositional field does not correspond to that observed for grains from Discovery Creek (Fig 4a). These two differing compositional fields have been used as a template for comparison with sample populations of placer gold from the Canaan Creek (Fig. 4d), Nansen Creek (Fig. 4c) and Victoria Creek (Fig. 4e).

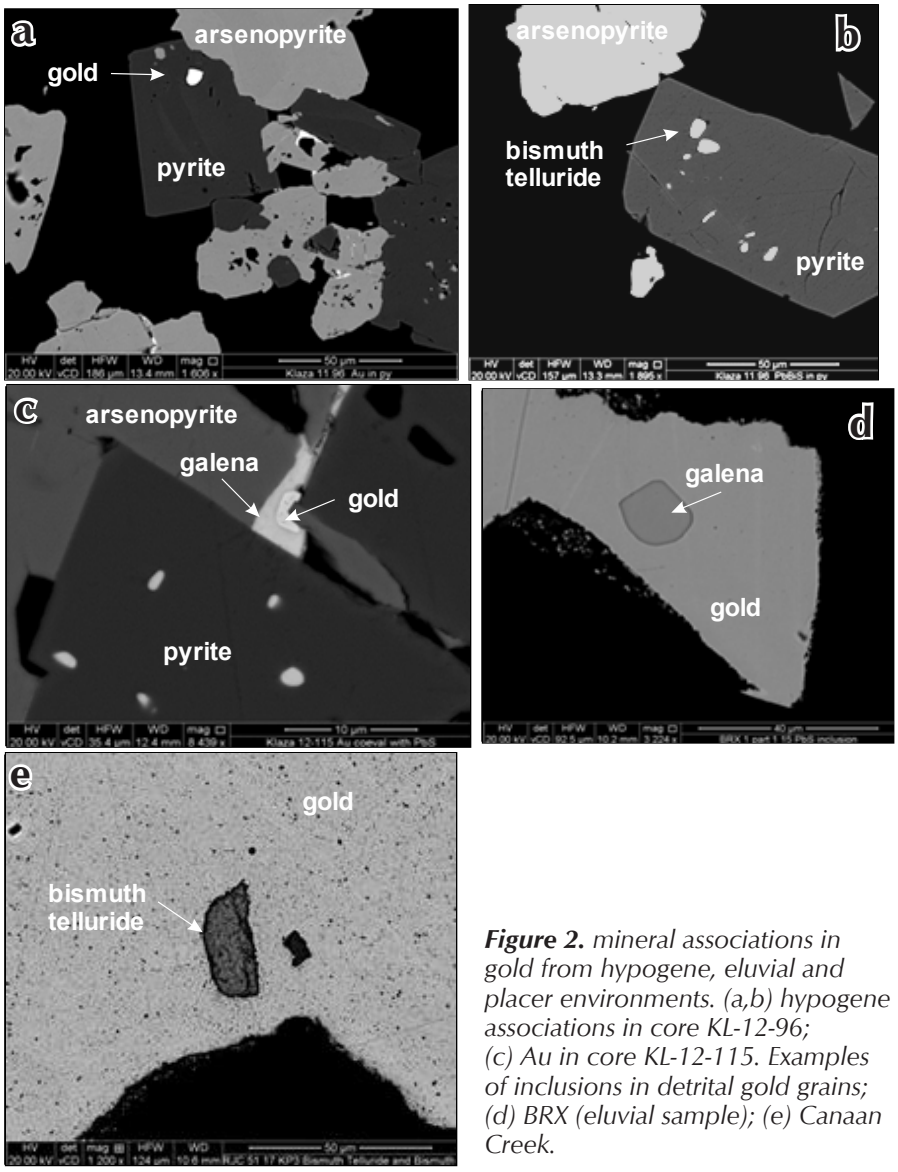


Figure 2. *mineral associations in gold from hypogene, eluvial and placer environments. (a,b) hypogene associations in core KL-12-96; (c) Au in core KL-12-115. Examples of inclusions in detrital gold grains; (d) BRX (eluvial sample); (e) Canaan Creek.*

PLACER SAMPLES

The morphology of the placer gold grains within the different sample populations are illustrated in Figure 5. Gold grains from Discovery Creek and Canaan Creek are rough, whilst the other placer samples include grains which exhibit a range of morphologies. The Ag content of the placer populations are depicted on the plots in Figure 3b. The sample from Canaan creek shows the highest overall Ag values, whilst the sample from the Discovery Creek exhibits the lowest values. These two samples have been used as 'end members' to evaluate other placer samples which exhibit features of both, but in different proportions. The placer sample from Victoria Creek resembles most closely that from the Canaan Creek, whereas that from Nansen Creek appears to conform to the Discovery Creek signature at low Ag values, but deviates thereafter.

The Ag curve describing Au from Discovery Creek also exhibits a shallow gradient for lower Ag values (Fig 3b). It also contains a substantial number of grains which contain higher levels of Ag, which could represent either an evolving system within the porphyry environment or additions from later vein mineralization as discussed above.

The covariance of Ag and Cu within the sample populations from Canaan Creek, Nansen Creek and Victoria Creek are shown in Figure 4c-e, where they are compared with the signatures of gold from both the BRX zone and Discovery Creek. The compositional field of gold from Canaan Creek overlaps with that of the gold from the BRX zones and shows the same general form, but it extends to a more Ag-rich area. Gold from Nansen Creek generally conforms to the compositional field of gold from Discovery Creek but there is also a clustering of more Ag-rich points similar to that observed in the sample from the Klaza River. Finally the small gold sample from Victoria Creek most closely resembles gold from the Canaan Creek, but a few grains show a high-Ag and high-Cu signature similar to the Discovery Creek sample.

The inclusion suites of the placer samples are shown in Table 4. Galena and Bi telluride are observed in every sample.

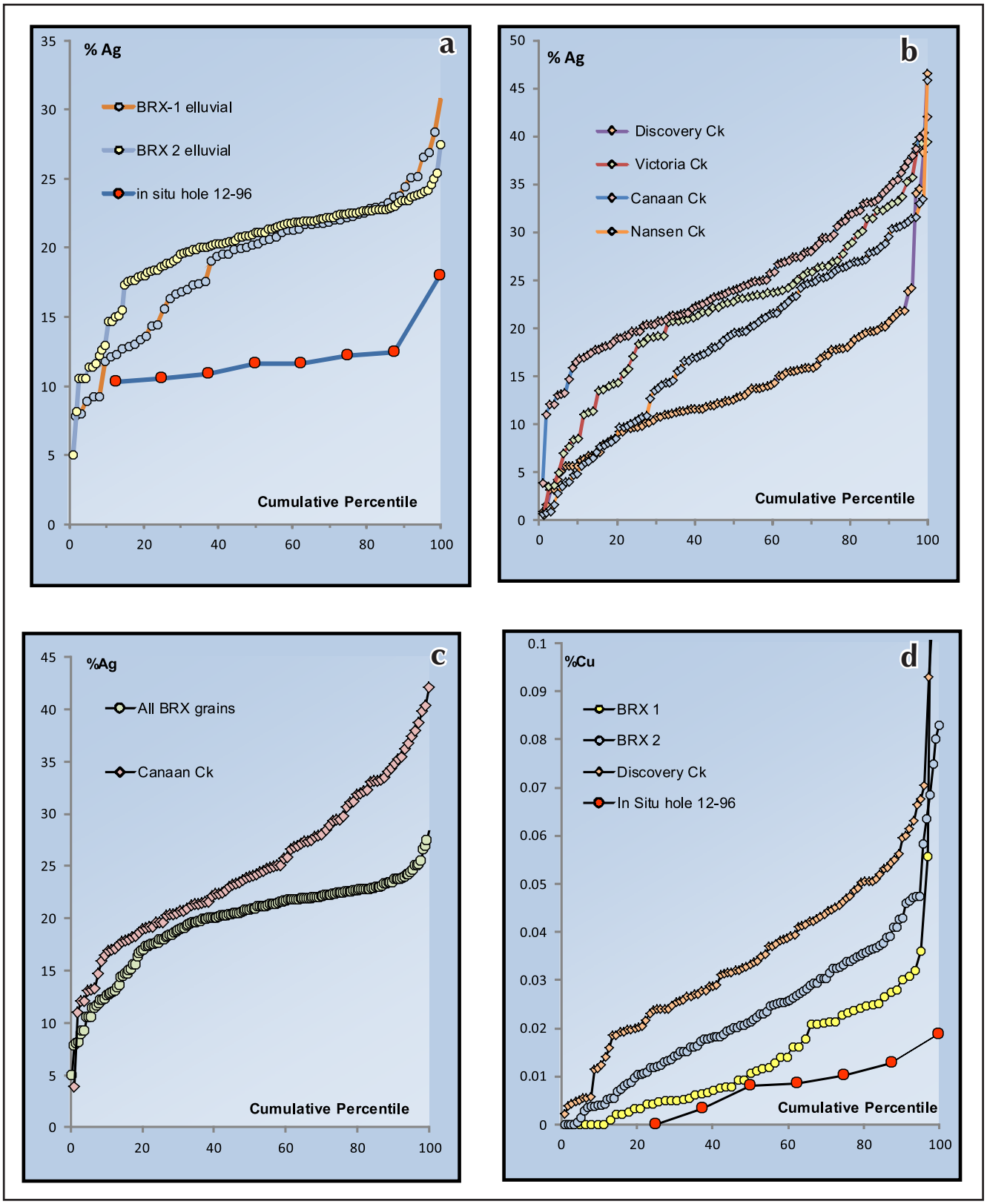


Figure 3. *Alloy compositions of gold grains from in situ eluvial and placer environments (a-c) Ag contents of alloys; (d) Cu content.*

Table 4. *Inclusion assemblages in placer and eluvial gold.*

Locality	Grains	Hg	Cu	Inclusion species											
				py	po	cpy	ga	sp	ars	Bi	ss	cv	hs	l	Sec
Discovery Ck	102	100	80				4		1	2					
Victoria Ck	78	95	54	1		1	1	1		3					
Canaan Ck	104	91	32	6		2	2			2		4			
Nansen Ck	157	100	40	12			5	2	3	3	1		1		
BRX-1	63	86	35	2		1	1				1				
BRX-2	114	90	56	1	1		1	1		2	1			1	2
Hayes Ck	122	12	32	6	2	3	8		2	3		1			

Mineral key as for Table 1, plus po=pyrrhotite, cv=cervelleite, (Ag_4TeS), hs=hessite, l=loelingite (FeAs), Sec=undetermined secondary (PbAs) bearing mineral on grain surface. 'Hg' and 'Cu'=% grains containing that metal to> LOD.

PLACER-LODE GOLD RELATIONSHIPS

RELATIONSHIP BETWEEN HYPOGENE ORE AND GOLD IN THE ELUVIAL ENVIRONMENT

The gold identified in polished blocks is much smaller in size than the eluvial grains recovered by sluicing. Consequently it is possible that there is a bias in the relationship between grain size and composition, although no such bias is observed in the data obtained from each block (where the samples are mounted according to size). Figures 3 and 4 show the relationships between the alloy compositions of hypogene and eluvial gold grains. The majority of the *in situ* grains (in core from around 340 m depth) show lower Ag content in comparison to most grains collected at surface. However, the lower Ag range exhibited by the gold in core is evident as a sub-population in the eluvial sample.

There is an overall similarity between the mineralogy of the hypogene ore and the inclusion suite observed within gold grains from the eluvial environment. Inspection of polished sections suggests that Au, Bi minerals and pyrite form the first phase of mineralization followed by arsenopyrite, galena and sphalerite. Table 4 and Figure 2 show that pyrite and Bi minerals form inclusions within the eluvial gold particles, whereas As is observed only as coatings of a Pb-As secondary mineral. Figure 2c shows that Au may also be coeval with galena, and galena inclusions in placer gold are also observed (Fig. 2d).

RELATIONSHIP BETWEEN ELUVIAL GOLD GRAINS AND PLACER GOLD GRAINS

The signatures of the BRX vein eluvial samples are used as a template to aid characterization of other placer samples in the study area. Figure 3c compares the Ag content of all grains collected from the BRX zone to the placer sample from the Canaan Creek. Gold grains containing >25% Ag form 97% of the population of grains from the Canaan Creek, but only 40% of the eluvial population of BRX vein Au. Figure 1 shows that the placer locality could also contain Au grains derived from veins situated between the BRX vein and the Klaza zone, although no information is available regarding their mineralogy. The Western Klaza zone is known to be relatively Ag-rich (Tarswell and Turner, 2014; Table 3) and Au grains from here could have travelled downslope to the placer sampling locality.

The suites of inclusion species observed within gold grains from the BRX zone and placer gold grains from Canaan Creek are largely compatible (Table 4), with the exception of cervelleite (Ag_4TeS). Four inclusions of cervelleite are observed the placer sample, but this mineral is not observed in either the BRX hypogene or the eluvial samples. All cervelleite inclusions are hosted by relatively Ag-rich Au alloy, and two of these exhibited Ag contents higher than any of the grains from the BRX vein. It is possible that the cervelleite-bearing grains are derived from the relatively Ag-rich Western Klaza zone or veins situated between the BRX and Klaza zones (Fig. 1).

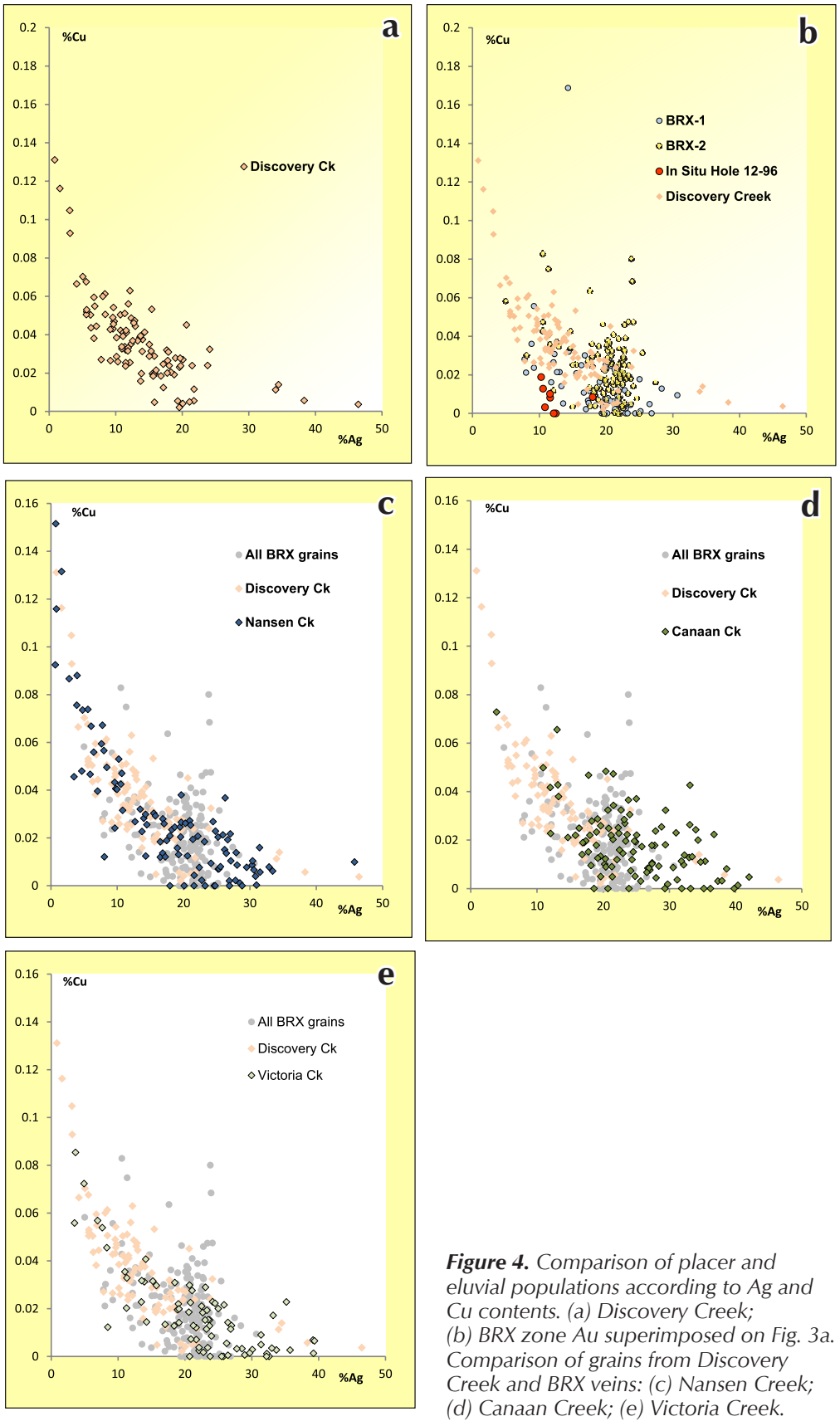


Figure 4. *Comparison of placer and eluvial populations according to Ag and Cu contents. (a) Discovery Creek; (b) BRX zone Au superimposed on Fig. 3a. Comparison of grains from Discovery Creek and BRX veins: (c) Nansen Creek; (d) Canaan Creek; (e) Victoria Creek.*

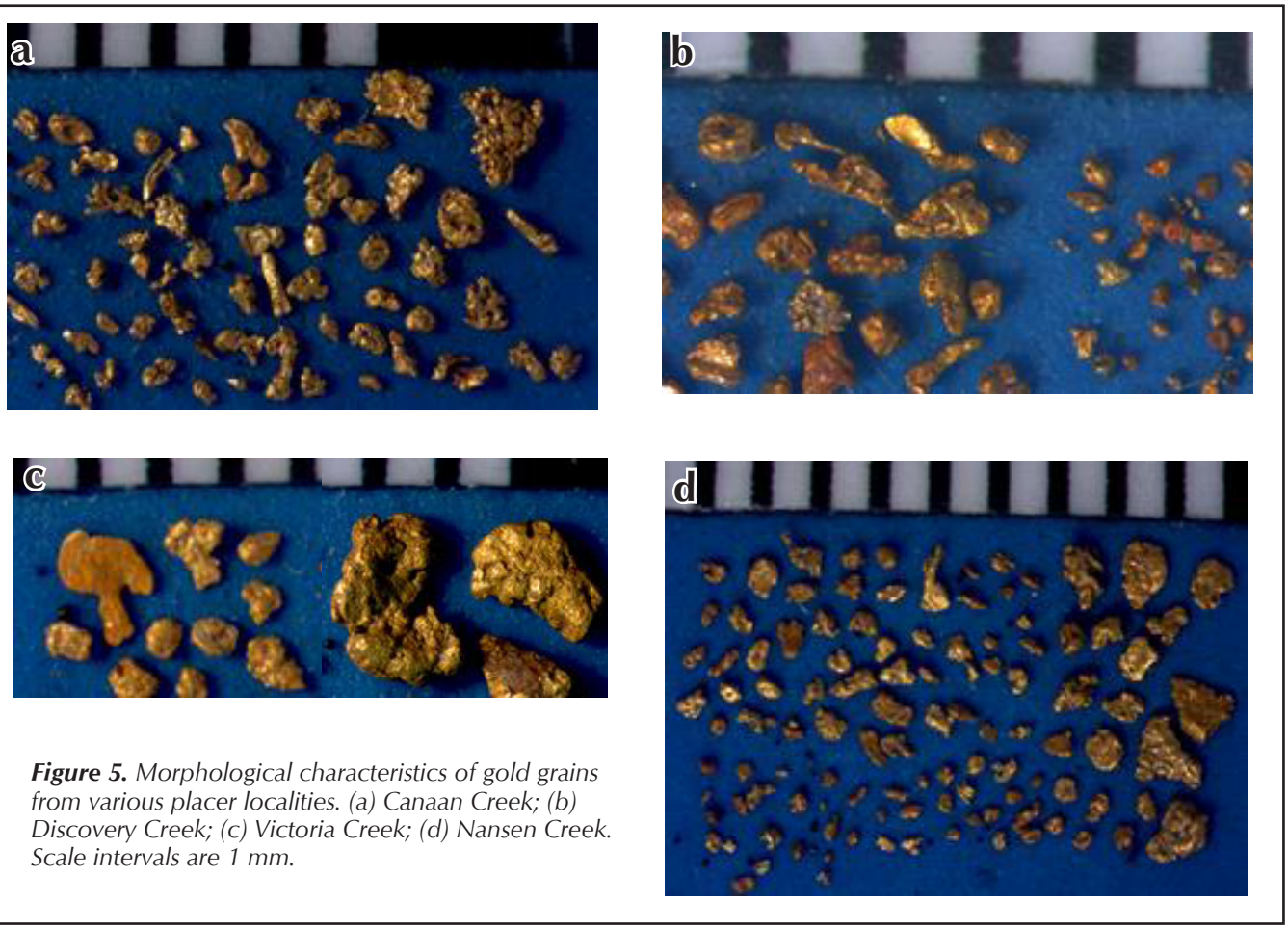


Figure 5. *Morphological characteristics of gold grains from various placer localities. (a) Canaan Creek; (b) Discovery Creek; (c) Victoria Creek; (d) Nansen Creek. Scale intervals are 1 mm.*

POTENTIAL SOURCES OF PLACERS

Consideration of the new data presented in this study has been undertaken in conjunction with bulk assay data from mining records, consideration of surficial geology (LeBarge, 1995) and the overview of regional mineralization presented in Hart and Langdon (1997) to clarify the most likely sources/source styles of mineralization for the various placers.

The Discovery Creek sample was collected from within the outcrop of the Cyprus South porphyry in the peripheral porphyry zone as defined by Hart and Langdon (1997). LeBarge (1995) reports that over 99% of the clasts in the drainage are proximal and consequently it is almost certain that all the placer Au grains were collected close to their source. Figure 5 shows that the Au grains have a rough surface texture and show little signs of fluvial transport. There are three possibilities for the source of these grains. Firstly, Au has been recorded in core samples from the phyllic alteration of the Cyprus south zone. Gold grains from this environment are probably formed from Au-bearing fluids which have stripped Au from pre-existing Cu-Au mineralization formed in the potassic zone, (Gammons and Williams-Jones, 1997). Secondly the 'Transitional' zone, in the headwaters of the Creek comprises veins and stockworks in a phyllic/argillic alteration zone (Table 1). An argillic overprint would probably not remobilize Au so the Au grains in this zone would likely resemble those in the Cyprus south mineralization. Finally there is a possibility of contribution of grains from the Eliza Creek localities although these occurrences outcrop slightly downstream of the sampling locality. From consideration of known *in situ* mineralization it could be expected that the Discovery Creek Au would consist predominantly of Au formed in an evolving porphyry environment, and indeed this sample is distinguished both by a lower Ag content (Fig. 3b) and higher Cu content (Fig. 3d).

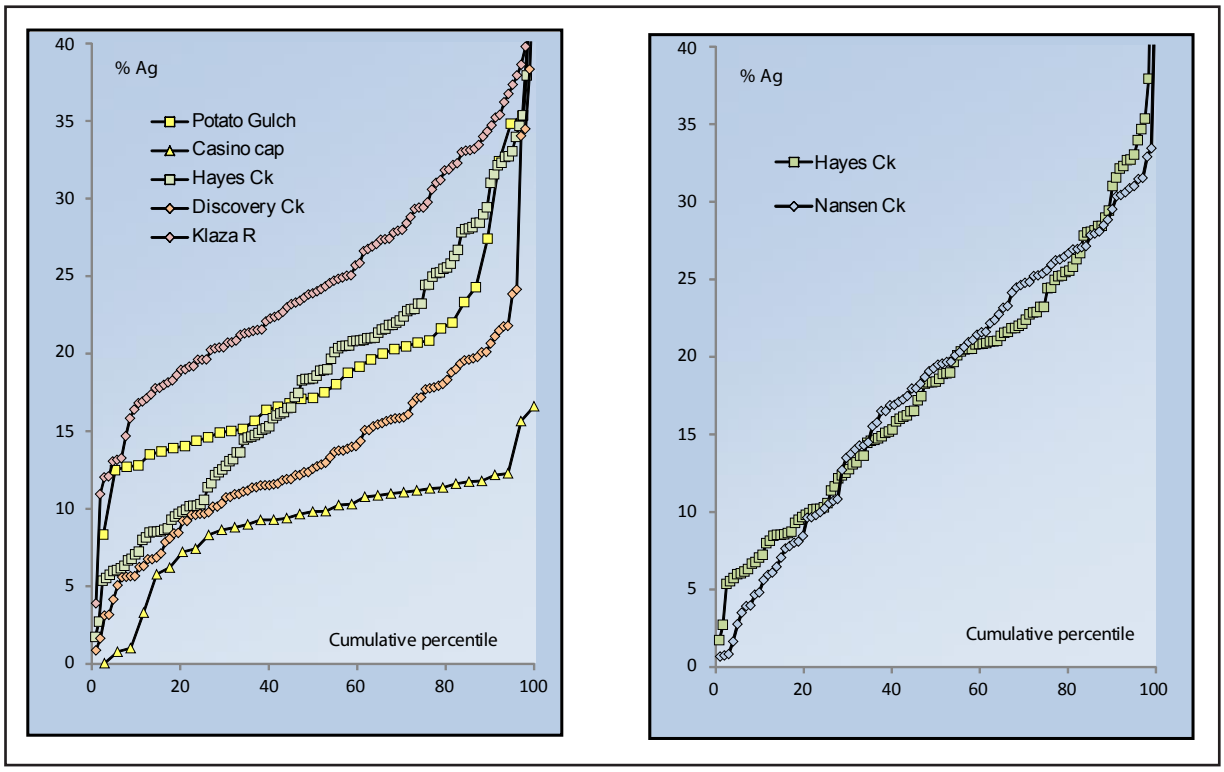


Figure 6. *Comparison of Ag contents of gold from porphyry and epithermal environments.*

Figure 3b shows that the Ag cumulative curve for Nansen Creek follows that of the gold from the Cyprus porphyry for the low-Ag component, but deviates to resemble that of the Canaan Creek sample at higher Ag values. Consideration of the Cu and Ag contents of the alloy also suggests multiple sources (Fig. 4d) as the cluster of compositions of around 30% Ag with variable Cu content is more similar to the signature of the BRX vein than the Discovery Creek gold. Figure 1 shows that Nansen Creek drains a number of potential *in situ* occurrences, principally Cyprus, Kelly and Kelly South. The Kelly and Kelly South occurrences also represent a potassic-phyllic transition, and it is entirely possible that Au from the Kelly South locality is of similar composition to that from the Cyprus south locality. There is no information available to establish whether the Au grades reported from either the Cyprus or Kelly porphyries (Table 1) relates to free Au, *i.e.*, tiny Au grains exsolved from Cu-bearing sulphides which are mostly too small to collect in placers (*e.g.*, Arif and Baker, 2004) or Au distributed within sulphide lattices.

The evidence presented in this section and the previous one, indicates that the Ag content of vein-derived Au is in general higher than that associated with porphyry mineralization. Consideration of Nansen Creek placer gold in the context of Ag content from contributing sources strongly suggests that a large proportion of the placer Au is derived from veins rather than the Kelly porphyry. Table 2 shows the large difference between the mass of placer Au recovered from Nansen and East Fork Nansen creeks. This spatial variation of Au appears incompatible with the model of the Cyprus porphyry being the major local source. It seems more probable that the bulk of Au in Nansen Creek is derived from either undiscovered or eroded veins associated with the Kelly porphyry system.

Data derived from the present study and gold fineness data (Table 2) show the Au from Victoria Creek to be relatively Ag-rich. Figure 5 shows that the grains exhibit varied morphologies, and there is a distinct population of relatively coarse, rough grains. Figure 4e shows a Ag-Cu signature very similar to that of the BRX vein sample, and it is proposed that similar, as yet undiscovered veins form the source of the Victoria Creek placer.

Although no samples of placer Au from Back Creek were available for this study, the range of fineness values reported (Table 2) suggests a contribution from both

porphyry and vein Au. van Loon and Bond (2014) report that nuggets up to 2 oz have been recovered recently, and these are most likely associated with a local vein source, rather than a porphyry environment. Figure 1 shows that the Willow Creek vein and the Cyprus South occurrences could constitute distinct sources consistent with this model.

The geomorphological development of the Nansen area described by LeBarge (1995) involves glacial erosion and transport of Au from pre-existing deep weathered material and associated fluvial sediments. LeBarge (1995) reports that Au grains are present within till, particularly at the bedrock-till contact. Consequently, it could be expected that some placer samples show an influence of relatively distal Au grains, although it is clear that that individual samples retain a strong signature of the most local source. The size of Au reservoir within present glacial sediments is unknown, consequently the placer mining records represent an unknown fraction of the total regional Au inventory. In addition, the most important placer creek (Nansen Creek) has not been mined to bedrock, but to a clay layer which is approximately 24 m thick (van Loon and Bond, 2014).

VARIATION IN GOLD SIGNATURE ASSOCIATED WITH THE PORPHYRY-EPITHERMAL TRANSITION

Whilst porphyry mineralization has a localized focus, the associated epithermal expression may be considerably more widespread, and consequently the peripheral geochemical footprint of the mineralization in the surficial environment may be influenced mostly by distal epithermal veins. From an exploration perspective, establishing the link between gold signatures in porphyries and related epithermal systems provides a mechanism to establish a vector to the most economically attractive mineralization. This study has provided the opportunity to examine the relationship between the composition of native gold formed in the porphyry environment and that of gold found in the associated epithermal expression.

EMPIRICAL CONSIDERATIONS

Hart and Langdon (1997) report four zones in the porphyry epithermal transition in the Nansen area, although this sequence is best developed to the southwest of the Nansen porphyry complex, outside the current study area. Sample suites available to the current study correspond to the peripheral porphyry zone and the epithermal zone. The most striking compositional difference is the variation in Ag content between gold derived from the placer sample from Discovery Creek (low Ag-peripheral porphyry) and the vein systems on the Klaza property (high Ag; Fig. 3b), and their placer expression at the Canaan Creek. It seems probable that the higher Cu signature of the Discovery Creek placer Au is also related to a systematic compositional trend, whereas the distribution of Hg within Au alloy appears variable.

Chapman *et al.* (2014) propose a generic relationship between porphyries and associated epithermal mineralization in which some key geochemical signatures of the porphyry system are retained (*e.g.*, a Bi and Te signature in the inclusion suite) whereas the Ag content of the Au grains increases. Studies of the Casino Creek-Canadian Creek drainage and Sonora Gulch-Hayes Creek systems provided the basis for this assertion (Fig. 6a). The similarity of the Ag content of Au grains from Hayes and Nansen creeks is striking, (Fig. 6b) and indicates that the same range of alloy compositions is evident in Au grains formed in these two different mineralizing systems. This similarity is also reflected in the inclusion assemblages (Table 4) by which Hayes Creek placer may be interpreted as derived from several sources, most of which are veins.

CONSIDERATIONS OF FLUID CHEMISTRY

Correlations between the fluid chemistry of a hydrothermal system and the resulting Au alloy compositions has been discussed in general by Morrison et al. (1991), and Gammons and Williams-Jones (1995). The alloy compositions reported above may be considered in terms of the nature of the prevailing and evolving hydrothermal systems. Gold and Ag are transported as their chloride complexes ($AuCl_2$-, $AgCl_2$-), in the environment of potassic alteration (Gammons and Williams-Jones, 1997; Williams-Jones and Heinrich, 2005). The most common manifestation of Au in this zone is as tiny exsolved blebs on grain boundaries of bornite and chalcopyrite (Kesler *et al.*, 2002), which are too small to report to the placer inventory. Subsequent remobilization of Cu and Au in propylitic and phyllic environments occurs under a different hydrothermal regime following the collapse of the original hydrothermal system (Gammons and Williams-Jones, 1997) in which Au is transported as the hydrosulphide complex. Depending on specific conditions, Au may be re-precipitated within the porphyry (together with chalcopyrite) or removed into the epithermal environment. In both cases the controls on alloy

composition are the same, *i.e.* $([Au]/[Ag])_{aq}$, temperature, pH, $aHS^-_{(aq)}$ and $aCl^-_{(aq)}$ (Gammons and Williams-Jones, 1995). Decreasing temperature results in a decrease in the Ag content of the alloy, as does decreasing $(Au/Ag)_{aq}$ resulting from the preferential precipitation of Au over Ag. It follows that small temperature variation in the porphyry setting could be expected to generate a relatively small range in Au alloy compositions, and this is observed in the grains from the hypogene environments at Casino, reported by Chapman *et al.* (2014), and in the sample from Discovery Creek reported here. Transition to the epithermal environment would be associated with more variable and generally lower temperature, and rapidly evolving $(Au/Ag)_{aq}$ following precipitation. In addition, there may be influences on fluid composition associated with fluid mixing. The net effect is to generate more Ag-rich Au alloy, and whilst locally the Au alloy signature may be constrained, it could be expected that there would be larger variation over the whole mineralizing system. This hypothesis is consistent with the observed compositional variation in the BRX and western Klaza zones as inferred by the eluvial samples and consideration of Canaan Creek placer sample. In general these observations are compatible with the 'Base-Metal-carbonate' model of Corbett (2002) but equally do not provide diagnostic evidence for that model.

Figure 4 shows two different types of relationship between the Ag and Cu contents of Au alloys. The porphyry mineralization (Discovery Creek) shows a predominant inverse relationship between Ag and Cu. The vein samples and their placer expressions yield Au in which Ag and Cu vary independently. At present, the underlying reasons for this difference in behaviour is not understood, but it has proved a useful discriminant in interpreting the origins of detrital gold in different placer populations. Similarly, the underlying reasons for the sporadic presence of Hg in some grains remain unclear.

The data presented in Table 4 show that the Bi-Pb signature is strong and pervasive. Interpretation of the significance of the abundance of other mineral inclusions is to some extent constrained by the relatively small sample sizes.

IMPLICATIONS FOR EXPLORATION

A study of the microchemical signatures of gold grains derived from the porphyry mineralization at Revenue/Nucleus, Casino and Sonora Gulch reported by Chapman *et al.* (2014) identified a common Pb-Bi-Te signature in the inclusion assemblage. This association is also observed in the present study which has further enhanced the potential for applying microchemical characterization of detrital gold grains in an exploration context. In addition, gold grains from these porphyry environments exhibit concentrations of Cu in the Au alloy consistently higher than gold grains derived from orogenic mineralization. Populations of placer grains from associated epithermal mineralization show wider variations in the concentration of Ag and perhaps substantial variation between the signatures of placer samples collected within a small area if there are multiple vein sources.

The Nansen trend is regionally atypical in the abundance of Au-bearing veins associated with the porphyry systems. Furthermore, the Cu-Au porphyry mineralization is weaker than that observed in broadly equivalent mineralized environments elsewhere. Gammons and Williams-Jones (1995) suggest that collapse of a magmatic hydrothermal system may result in overprinting of the potassic alteration zone by retrograde pyrite-rich phyllic alteration with the associated remobilization of gold in a hydrosulphide-rich fluid. Hart and Langdon (1997) report pervasive strong phyllic alteration and pyrite in a halo surrounding the potassic core of the Cyprus porphyry, and a similar feature is reported in Kelley South. Remobilization of Au provides a source for strongly developed epithermal mineralization which would inherit some of the geochemical signatures of the source mineralization, (*e.g.*, Bi, Pb and Te). It is also highly probable that the particle size of Au within late stage and epithermal veins is larger than that found in the earliest porphyry mineralization. Consequently the size and mineralogy of Au grains within placers may not correspond to the Au particles within the primary ore that are ultimately one of the targets of exploration. Understanding the genetic relationships between evolving porphyry systems and their epithermal expressions in terms of Au mineralogy is therefore key to interpretation of the characteristics of placer grains collected during reconnaissance.

CONCLUSIONS

The mineralogy of the inclusion suite revealed within polished sections of detrital gold grains from weathered outcrop in the BRX zone and the Canaan Creek placer are comparable with that of the Au-bearing stages of the hypogene ore observed in core samples, indicating that gold grains pass from the hypogene to the surface environments unmodified.

In this study, Ag content has proved a useful discriminant between porphyry and vein-derived Au. In general it has been possible to map Ag content onto end members of the porphyry-epithermal transition, and this has facilitated interpretation of the origins of placer Au in the Nansen district. The signature of gold grains collected from the BRX vein outcrop is replicated in the Canaan Creek placer, but a (very) high Ag component of the Canaan Creek placer is probably derived from other vein systems such as Western Klaza Zone. The placer Au in Nansen Creek is primarily of vein origin, although there is likely a strong contribution of Au from the Kelly rather than Cyprus porphyry. The wide range of Ag content observed in the Nansen Creek placer Au corresponds to fluctuations in fineness reported in production records and is interpreted as indicative of influx from several sources. The placer Au in Victoria Creek is predominantly vein derived although the sources remain undiscovered. Overall the study has shown that Au derived from veins is the most important contributor to placer development in the Nansen Creek area. In general the composition of Au in the various placers is consistent with the nature of the potential sources and generic relationships between porphyry and surrounding epithermal mineralization.

The values and variability of Ag and Cu contents of Au derived from porphyry and vein mineralization observed during this study may be correlated with the environment of Au precipitation. Gold veins formed during phyllic alteration from fluids which stripped Au from pre-existing mineralization in the potassic zone yielded Au of high Cu content and low Ag content and range, reflecting the relatively stable environment of mineralization. In contrast the precipitation of Au in the epithermal environment may be in response to abrupt changes in a variety of parameters and this is mirrored in the alloy signature, although the grains exhibit a similar inclusion suite as their porphyry derived counterparts.

This study augments previous work which described a generic Bi-Pb-Te signature of gold from calc-alkaline Cu-Au porphyries in Yukon, and that signature has also been identified in both porphyry and epithermal Au from the Nansen area. The importance of understanding the relationship between a porphyry system and its epithermal expression has been highlighted. The compositional ranges of populations of detrital Au particles collected during reconnaissance stream sediment sampling are more likely to be derived from relatively widespread epithermal mineralization than the relatively geographically constrained porphyry. The epithermal Au may be Cu-poor even though the primary mineralization is a Cu-Au porphyry.

The study has highlighted the need to consider stream order when interpreting Au-grain signatures. Both the Canaan Creek and the Discovery Creek placer samples were collected from first order streams, with geographically well constrained sources. The delicate nature of many Au particles reflects this proximity to source, and these samples were the most useful in developing a placer-lode model for the study area. The morphology of Au grains from Nansen Creek indicate fluvial transport, which raises the potential for multiple sources cited in various tributaries. In cases such as this it is more difficult to develop robust placer-source relationships, unless a large (typically >200) number of Au grains are available which may be considered in terms of both morphology and composition.

ACKNOWLEDGMENTS

This study was made possible by the provision of SINED funding through the Yukon Geological Survey. We are extremely grateful to Rockhaven Resources for providing us with access to the site and to excellent on-site accommodation. Finally we would like to thank Jared Tarswell and Heather Burrell of Archer Cathro; they were enthusiastically engaged with our work and went out of their way to provide maps, background information and samples of hypogene ore.

REFERENCES

Allan M.M., Mortensen J.K., Hart C.J.R., Bailey L.A., Sánchez M.G., Ciolkiewicz W.,McKenzie G.G. and Creaser R.A., 2013. Magmatic and metallogenic framework of west-central Yukon and eastern Alaska. *In:* Tectonics, Terranes, Metallogeny and Discovery in the northern circum-Pacific region, M. Colpron, T. Bissig, B. Rusk and J. Thompson (eds.), Society of Economic Geologists, Special Publication vol. 17. p. 111-168.

Arif, J. and Baker, T., 2004. Gold paragenesis and chemistry at Batu Hijau, Indoneisa: implications for gold-rich porphyry copper deposits. Mineralium Deposita vol. 39, p. 523–535.

Chapman, R.J., Leake, R.C., Moles, N.R., Earls, G., Cooper, C., Harrington, K. and Berzins, R., 2000. The application of microchemical analysis of gold grains to the understanding of complex local and regional gold mineralization: a case study in Ireland and Scotland. Economic Geology, vol. 95, p. 1753-1773.

Chapman, R.J., Mortensen, J.K., Crawford, E.C. and Lebarge, W., 2010a. Microchemical studies of placer and lode gold in the Klondike district, Yukon, Canada: 1. evidence for a small, gold-rich, orogenic hydrothermal system in the Bonanza and Eldorado Creek area. Economic Geology, vol. 105, p.1369-1392.

Chapman, R.J., Mortensen, J.K., Crawford, E.C. and LeBarge, W.P., 2010b. Microchemical studies of placer and lode gold in the Klondike District, Yukon, Canada: 2. Constraints on the nature and location of regional lode sources. Economic Geology, vol. 105, p. 1393-1410.

Chapman, R.J., Mortensen, J.K. and LeBarge, W.P., 2011. Styles of lode gold mineralization contributing to the placers of the Indian River and Black Hills Creek, Yukon Territory, Canada as deduced from microchemical characterization of placer gold grains. Mineralium Deposita, vol. 46, p. 881-903.

Chapman, R.J., Allan, M.M., Grimshaw, M.K., Mortensen, J.K., Wrighton, T.M. and Casselman, S., 2014. Pathfinder signatures in placer gold derived from Au-bearing porphyries. *In*: Yukon Exploration and Geology 2014, K.E. MacFarlane, M.G. Nordling, and P.J. Sack (eds.), Yukon Geological Survey, p. 21-31.

Colpron, M. (compiler), 2006. Tectonic assemblage map of Yukon-Tanana and related terranes in Yukon and northern British Columbia (1:1 000 000 scale). Yukon Geological Survey, Open File 2006-1.

Corbett, G., 2002. Epithermal Gold For Explorationists. Australian Institute of Geoscientists Journal - Applied geoscientific practice and research in Australia, Paper 2002-1.

Gammons, C.H. and Williams-Jones, A.E., 1995. Hydrothermal geochemistry of electrum: Thermodynamic constraints. Economic Geology, vol. 90, p. 420-432.

Gammons, C.H. and Williams-Jones, A.E., 1997. Chemical mobility of gold in the porphyry epithermal environment. Economic Geology, vol. 92, p. 45-49.

Hart, C.J.R. and Langdon, M., 1997. Geology and mineral deposits of the Mount Nansen camp, Yukon. In: Yukon Exploration and Geology 1997, Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p.129-138.

Heinrich, C.A., 2005. The physical and chemical evolution of low-salinity magmatic fluids at the porphyry to epithermal transition: a thermodynamic study. Mineralium Deposita vol. 39, p. 864–889.

Kesler, S.E., Chryssoulis, S. L. and Simon, G., 2002. Gold in porphyry copper deposits: its abundance and fate. Ore Geology Reviews vol. 21, p. 103–124.

LeBarge, W.P., 1995. Sedimentology of Placer Gravels near Mt. Nansen Central Yukon territory. Exploration and Geological services Division, Indian and Northern Affairs Canada, Yukon Region, Bulletin 4, 155 p.

LeBarge, W.P. (compiler), 2007. Yukon Placer Database 2007 - geology and mining activity of placer occurrences. Yukon Geological Survey, CD-ROM.

Morrison, G.W., Rose, W.J. and Jaireth, S., 1991. Geological and geochemical controls on the silver content (fineness) of gold in gold–silver deposits. Ore Geology Reviews, vol. 6, p. 333-364.

Tarswell, J. and Turner, M., 2014. Assessment report describing excavator trenches, geophysical surveys and metallurgical tests at the Klaza property. Prepared by Archer, Cathro & Associates (1981) limited for Rockhaven Resources Ltd., Assessment Report #096667.

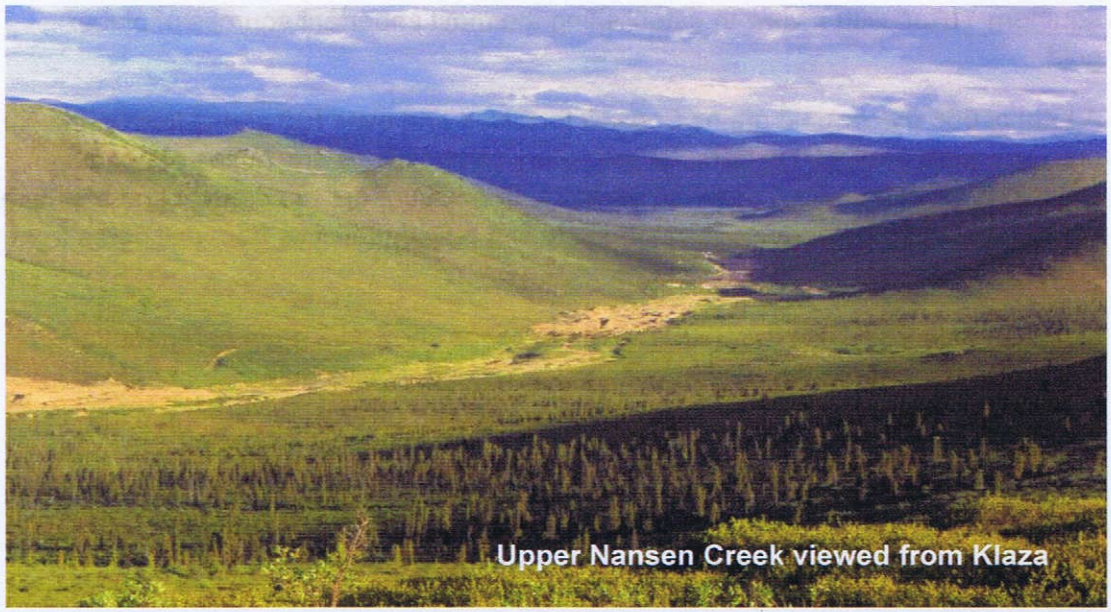
van Loon, S. and Bond, J.D. (compilers), 2014. Yukon Placer Mining Industry 2010-2014. Yukon Geological Survey, 230 p.

Williams-Jones, and A.E., Heinrich, C.A., 2005. Vapor Transport of Metals and the Formation of Magmatic-Hydrothermal Ore Deposits. Economic Geology, vol. 100, no. 7, p. 1287-1312.

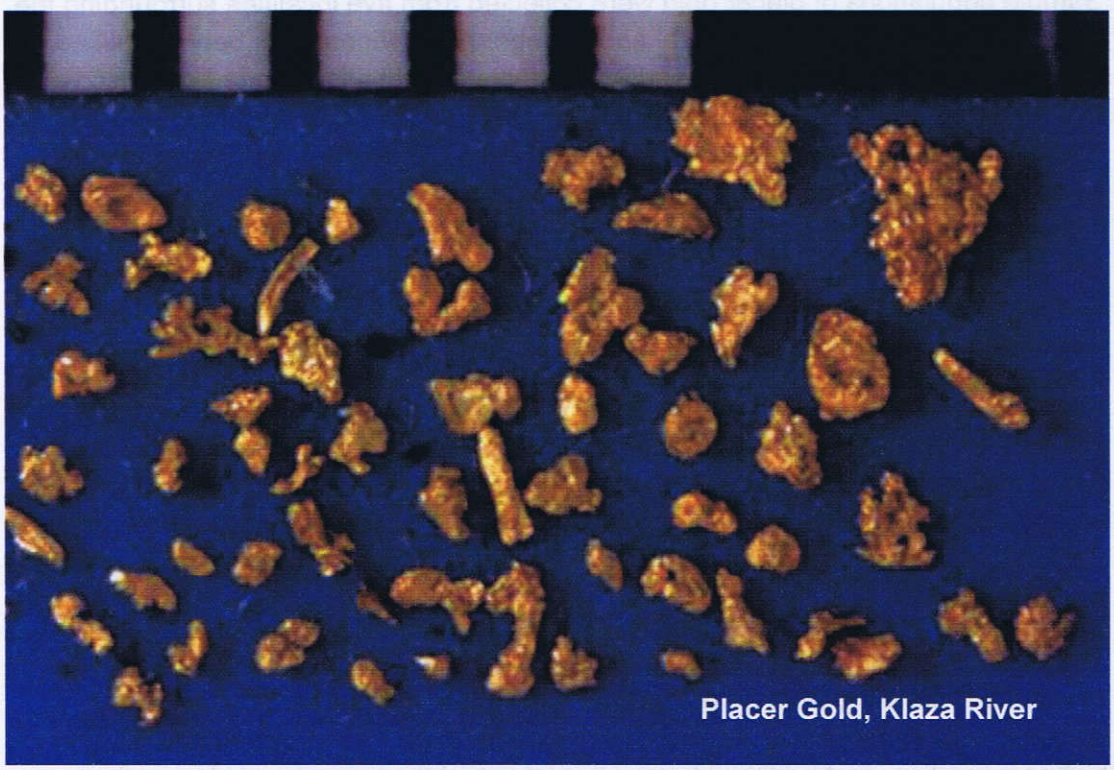
Wrighton, T.M., 2013. Placer gold microchemical characterization and shape analysis applied as an exploration tool in western Yukon. Unpublished MSc Thesis, University of British Columbia, 140 p.

Yukon MINFILE, 2015. Yukon MINFILE - A database of mineral occurrences. Yukon Geological Survey, <http://data.geology.gov.yk.ca> [accessed September 22, 2015].

Placer- Lode Gold Relationships in the Nansen Placer District Yukon



Upper Nansen Creek viewed from Klaza



Placer Gold, Klaza River

Rob Chapman, Matt Grimshaw, University of Leeds

Summary

The focus of the project was to characterize the mineralogy of gold grains derived from porphyry and associated epithermal environments in the Mount Nansen trend, southern Yukon with a view to establishing the most important sources of placer gold.

A total of 608 placer gold grains from six localities and over 100 grains from vein outcrops were analysed in terms of their alloy compositions and suites of opaque inclusions revealed within polished sections. In addition, ore mineralogy and a simple paragenesis was determined through study of 6 polished blocks from drill cores from boreholes adjacent to the outcrops.

Mineralization from both the BRX and Klaza zones showed a main paragenetic sequence of pyrite- (arsenopyrite/sphalerite)- galena. Native gold was observed in the early pyrite and in the later phase associated with galena. Bi- bearing minerals occurred as inclusions in early pyrite. This vein mineralogy was also evident in the suite of inclusions revealed within polished sections of gold grains collected from vein outcrops. The project currently awaits analyses of the alloy compositions of gold grains identified in polished section and in the elluvial grains.

Sample populations of placer gold were collected from five localities surrounding the Klaza property. Two compositional end member populations have been identified, through consideration of the Cu and Ag contents of gold alloys: one from Discovery Creek, (interpreted to represent a single porphyry source) and the other from the Klaza River, (interpreted as derived from the BRX vein in the Klaza property). Other placer localities yielded populations which were a mixture of these two signatures. The suite of mineral inclusions reported within the placer grains is directly comparable to the ore mineralogy of the Klaza zone (as identified in this study) and to the mineralogy of the Cyprus porphyry. Consequently, strong evidence for specific placer- lode relationships exists, which will be further clarified on the receipt of the full data set.

The widespread Au-Ag-Pb-Zn veins appear to comprise the major source of gold in the economic placers of Nansen and Victoria creeks. In addition, consideration of the compositional signature of gold from Victoria Creek suggests a local source which is yet to be identified. The extent to which individual vein systems have contributed to the local placers remains unclear.

The study is the first to investigate systematic variation in gold mineralogy associated with the porphyry- epithermal transition. The study area provides an excellent locality for further detailed investigation underpinned by vein sampling at higher resolution, and additional sampling of autochthonous placers in small drainages.

Introduction

Understanding the relationships between economically important placer gold deposits in the Yukon and their potential lode sources has developed significantly during the last decade. Various studies have characterized gold particles derived both from lode and placers in terms of their alloy compositions and suite of mineral inclusions revealed in polished section. These combined data sets yield a 'microchemical signature' for a specific population of grains. Signatures of lode and placer gold may be compared, both to establish the lode source of the placer, and in some cases to establish typical signatures for different styles of gold mineralization.

Study of the gold signatures at Klaza provides the opportunity to study in detail the variation in gold microchemical signatures associated with an epithermal system and potentially the range of signatures across a porphyry epithermal transition. There have been no studies reported on similar epithermal systems elsewhere. The vein system at Klaza outcrops at surface and has been exposed by trenching. Decomposed vein material is available at surface for collection and processing through panning to recover gold particles. Consequently it has been possible to study the mineralogy of gold within hypogene ore, and to track progress through the elluvial environment and into the placer deposits.

The Klaza property is encircled by placer mining operations and the YGS Placer Database indicates that different gold fineness or fineness ranges has been consistently reported from different creeks. Whilst bulk fineness data is only partially useful, broad correlation between gold composition and geographical location is suggestive of multiple sources. The approach to characterizing placer- lode relationships developed at the University of Leeds has been applied to investigate several aspects of placer-lode relationships in the study area:

1. The variation in microchemical signature within an epithermal system
2. The extent to which the microchemical signature of grains in the surficial environment reflects the lode source
3. The source(s) of placer gold in the various creeks surrounding Klaza
4. The gold endowment of the Cyprus porphyry and associated vein systems

Geology and Mineralization

The regional and local geology of the study area was summarized by Hart and Langdon (1997), and is depicted in Figure 1. Around 30 mineral localities have been identified in a 12km x 3 km NW-SE trending belt referred to as the Mount Nansen trend. The study area is situated at the northern extreme of the Mount Nansen belt and includes various porphyry and vein occurrences.

Hart and Langdon (1997) proposed that the porphyry and vein mineralization comprised a gradational porphyry-epithermal transition and speculated that the most

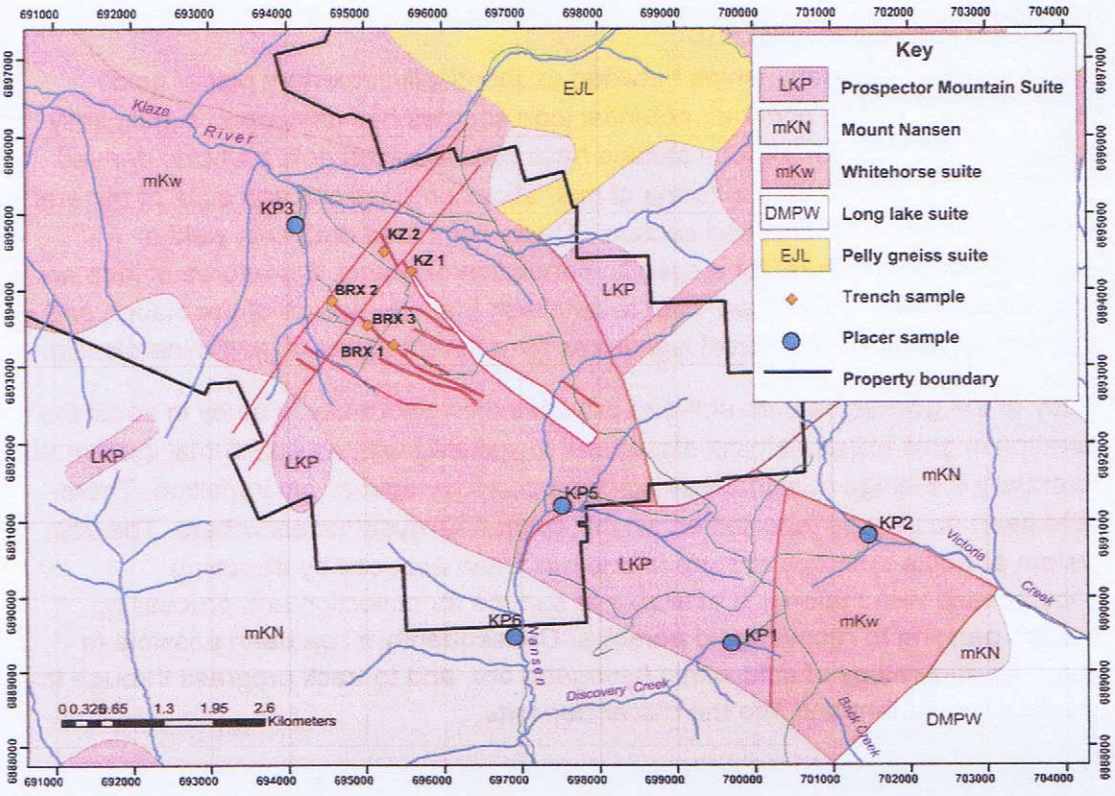


Figure 1. Sample locations and major lithologies

important contribution to the placer inventory was derived from porphyry mineralization

Descriptions of the most important localities in the context of the present study are provided in Table 1, which adopts the overall porphyry-transitional- epithermal classification as Hart and Langdon (1997). Mineralogical descriptions of the various zones show a progressive decrease in Cu content away from the porphyry both to the NW and SE into a Au-Ag-Pb-Zn dominated vein system.

Placer gold

The mount Nansen Area is a historically important placer area. Information concerning production and gold fineness data is available for some creeks in the Yukon Placer database (Lebarge 2005) and has been summarised in Table 2. Placer gold production from Nansen Creek accounts for around 75% of recorded production in the placer mining district. LeBarge (2007) reports that many streams were explored for their placer potential, but only a small number supported sustained activity.

Table 1. Descriptions of mineralized localities in the study area.

Name	Description
Central Porphyry Zone	
Cyprus[1,3]	Quartz monzonite porphyry, Cu-Mo zone: py, cpy, mo, Cu 0.1-0.15%. Au anomalous but erratic
Kelly[1]	0.275 x 2.5km NW trending potassic alteration zone identified by soil geochemistry. Trench sample yielded 0.86 g/T Au and 0.25% Cu. Cpy,Cc Bn and Mo
Peripheral porphyry zone	
Cyprus South[1]	Quartz sulphide veins and stockworks in phyllic zone . Au grade of 0.31g/T recorded in core.
Kelly South[1]	Au recorded in pyrite shell associated with phyllic alteration
Transitional zone	
Eliza Creek extension[1]	Veins and stockworks associated with orphyry stocks breccia and argillic/phyllic alteration. Au grades to 17.5g/T and Ag to 27 g/Tin core
Epithermal veins	
Klaza Zone[2]	Py, Sph, Ars, Ga, Sb, Ss. Au
BRX zone[1]	Py, Sph, Ars, Ga, Sb, Ss. Au
Eliza Creek South[1]	Au-Ag-Zn-Pb . Trench samples of Au to 3.9g/T
Eliza Creek North[1]	Cu content > Eliza Creek North. Au to 10.3g/T
Etzel	Au-Ag-Pb-Zn veins
Willow[1]	3 Au-Ag-Pb-Zn veins containing Au to 3.5g/T

[1]: Hart and Langdon 1997, [2]: Tarswell, 2014, [3]: YGS Minfile, 066, (2013)

Table 2. Placer gold information

Placer Creek	Fineness	Production to 2007 (oz)	Comments
Discovery	820-850	1586	
East Fork Nansen	No data	448	Some dendritic gold
Nansen	805-820	21,251	
Victoria	720-730	1185	Placer operations 3k apart
Back	760-836	3478	'Coarse' pay streak reported
Slate	800	-	Minor trib, no mining
Klaza	750*	Unknown	No data in YPDB

* Mean Ag value form the present study

Methodology

Field activities

Sampling of oxidized vein material from trenches

Decomposed vein material was collected from five localities, (see table 3 and Figure 1). A typical 'bag' (Table 1) comprised 20L of material screened at 1". This material was thoroughly wetted before sluicing using a 'Le Trap' portable sluice. Sluice concentrates were panned to recover a super concentrate containing gold grains. Samples were collected from five localities: three in the BRX zone and two in the Klaza Zone.

Table 3 Trench samples, assays from previous sampling and amount processed

label	Trench	E	N	g/T Au	g/T Ag	intercept (m)	bags sluiced
BRX 1	TR 13-49	382410	6889676	8.4	548	1.31	7
BRX 2	TR 13-47	381715	6890310	87	768	1.15	20
BRX 3	TR 13-58	382142	6889949	50.1	910	3.25	20
KZ 1	TR13-66	382758	6890614	25.7	449	2.27	10
KZ 2	TR 13-70	382462	6890888	16.76	1052	3.03	10

Collection of placer samples.

Samples of placer gold were collected using a combination of panning and sluicing. The details of the sample sites are provided in Table 4 and Figure 1:

Table 2: Locations of placer samples

label	locality	E	N	Comments
KP1	Discovery Ck	386521	6885312	Sample from headwaters of creek
KP2	Victoria Ck	388391	6886630	Side pay
KP3	Klaza R.	381422	6891421	From active cut
KP5	East Fork Nansen	384401	6887398	Sluiced gravel bar in tailings area
KP6	Nansen Ck	383700	6885781	Panned pay in active cut.

Analysis of gold particles revealed in core.

Core samples corresponding to the trench samples were provided by Rockhaven Resources, (Table 3). Intercepts of relatively high gold grades have been bracketed *by adjacent samples. Polished sections were prepared for analysis in Leeds.*

Table 3 location of samples for preparation of polished blocks.

Hole _ID	Close to	Sample Depth m	From_m_	To_m_	Interval_m	Collar		Au_ ppm	Ag_ ppm
						Easting	Northing		
KL-11-12	KZ1	221.7	221	222.6	1.6	382724	6890305	6.81	123
KL-11-33	BRX 1	121.1	120.3	121.64	1.34	382080	6889865	5.51	180
KL-11-37	BRX 3	90.0	88.95	90.17	1.22	381759	6890090	34	298
KL-12-96	BRX 2	342.8	342.46	345.36	2.9	381509	6890034	10.55	92.7
KL-12-115	KZ2	219.7	219.48	221.59	2.11	382340.2	6890627	13.75	357
KL-12-127	KZ2	169	168.11	169.11	1	382418.4	6890581	5.73	204

Analytical work

Gold grains from elluvial and placer samples were isolated from heavy mineral concentrates recovered from panning by picking under a binocular microscope. These grains were mounted according to size according to standard procedures described by Chapman et al. 2000. The extreme small size of some of the gold particles recovered from elluvial samples necessitated the design of a new polishing technique specifically for tiny particles.

Analysis of the Au grains was carried out in two stages. Firstly, qualitative analyses were undertaken using a FEI Quanta 650 FEG-ESEM. This involved inspection of each grain section and recording alloy heterogeneity and the presence of inclusions, either of minerals or intermetallic compounds. Secondly alloy compositions were determined using a Jeol 8230 Superprobe. The element suite analysed was: Au, Ag, Cu, and Hg. Polished blocks of core samples were prepared for inspection by reflected light microscopy and SEM/EMP analysis.

Results

An overview of the mineralogy of the core samples is provided in Appendix 1 .

Inspection of the polished blocks by SEM permitted construction of a simple paragenesis for each vein, which is presented below. It is appreciated that the number of samples examined is relatively small and therefore these results may lack detail. Nevertheless there are some generic features which emerge, together with mineralogical differences between the veins. In this analysis, the effect of variation in mineralization with depth, (as a consequence of examining samples from both upthrown and downthrown blocks) has been ignored, but major differences are higlighted in the text. The purpose of this stage of the project was to identify minerals coeval with gold (to relate to particulate gold signatures) rather than to establish a definitive vein paragenesis.

The three polished blocks from the Klaza zone which were examined all indicate an early pyrite stage, with later arsenopyrite and sphalerite. Chalcopyrite was a minor component of this stage, presenting as chalcopyrite disease in sphalerite. Galena and minor sulphosalts postdate the arsenopyrite and sphalerite. A small amount of gold was observed, which was coeval with the late galena. Barytes was observed as a major late stage but only in the sample from the upthown block, i.e. the barytes mineralization appears to be related to depth.

Samples from the BRX zone exhibited a more complex parageneses, which extends to four stages. Pyrite forms the first phase, but this is coeval with Bi- bearing minerals (telluride, sulphide and Bi-Pb sulphide) and gold. The second stage of mineralization shows some similarities with that at Klaza, but sphalerite was less common, and small amounts of galena were present. Galena is more common in a later stage as well where it infills sphalerite and arsenopyrite. Pyrrhotite was a

second stage mineral, and enargite and chalcopyrite postdated some of the later stage galena.

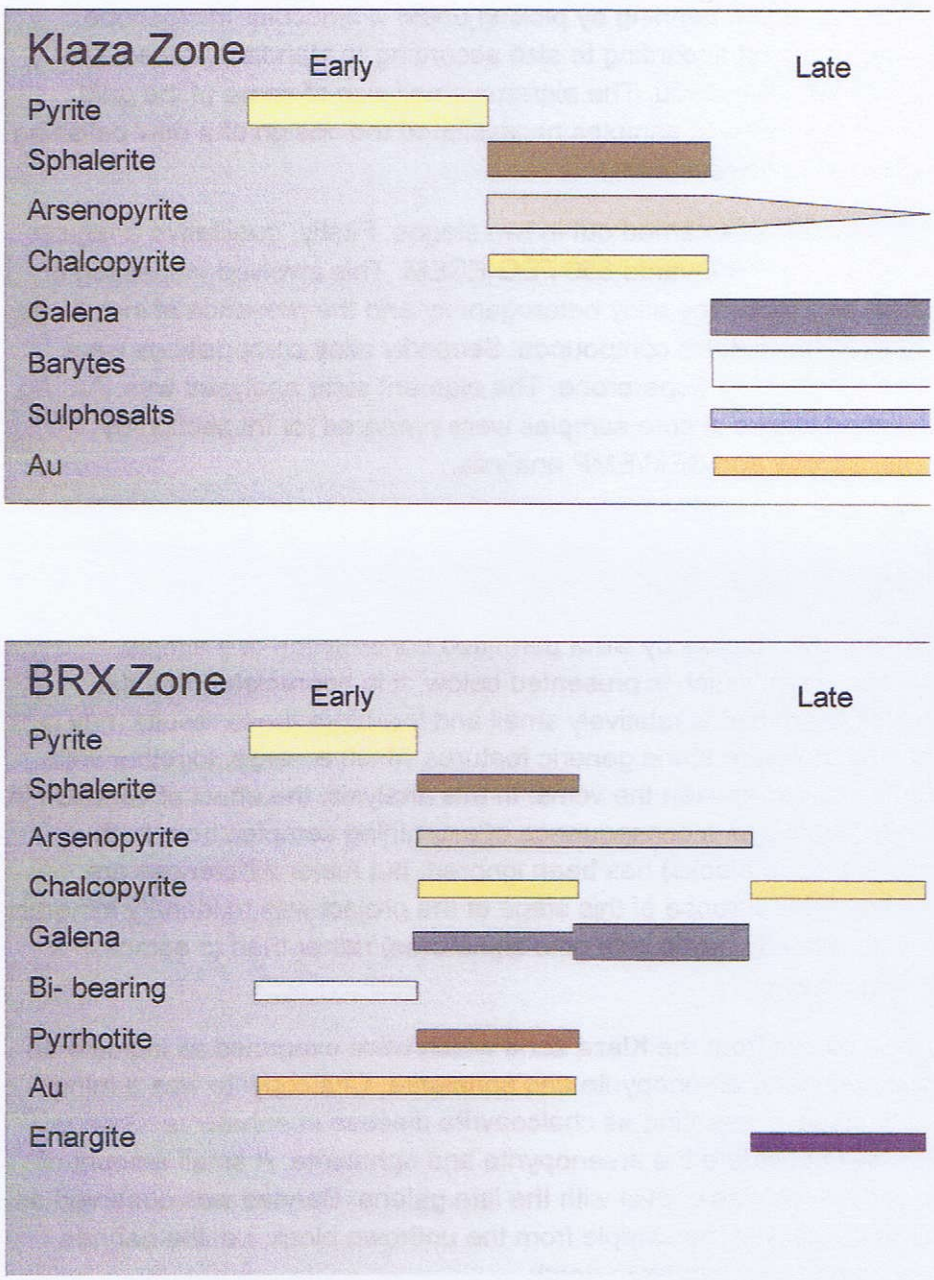


Figure 2. Simple paragenesis of core from the Klaza and BRX zones based on observation of a small number of polished sections

A small number of semi quantitative analyses of the gold particles was undertaken using the EDS facility of the SEM. Gold in sample 12-96 exhibited several gold blebs (1-5 µm) in pyrite, and these are plotted onto Fig 4A for comparison with placer gold from the Klaza River

Samples collected from surface

At the time of writing, analyses of alloy compositions of the gold grains collected from the vein outcrops are incomplete, but are scheduled to be undertaken in late April 2015. The inclusion suites established during SEM analysis are presented in Table 4 below.

The tiny size of most of these gold grains provides an explanation for the low incidence of inclusions, but a variety of minerals were observed as indicated in table 4 . Inclusions of Bi telluride and galena are illustrated in Appendix 2. All gold grains from BRX-1 exhibited a coating of iron oxide, and in section some showed a cloud of fine Au on the periphery of this coating (Appendix 2).

Placer samples.

Morphology

Images of the placer samples collected in this study are provided in Appendix 3, together with comments describing the morphology. The sample KP-5, from East Fork Nansen was not included because this sample was won from placer tailings, in which flaky gold is preferentially concentrated. Sample populations from Discovery Creek and the Klaza River both exhibited morphologies consistent with very limited fluvial transport, whilst the other samples appeared to include a range of morphologies.

Alloy compositions

The Ag content of the placer populations are depicted on the plots in Figure 3A. The sample from the Klaza River (KP3) shows the highest overall Ag values, whilst the sample from the Discovery Creek exhibits the lowest values. Placer samples from Nansen Creek appear to exhibit elements of both these signatures. The sample from Victoria creek resembles that from Klaza River most closely. Figure 3B shows the relationship between Ag and Cu in the Discovery Creek and Klaza River placer populations. Two broad compositional fields are observed although there is a small degree of overlap.

Placer lode relationships in the study area.

1. *Relationship between hypogene ore and gold in the elluvial environment*

At the time of writing the analysis of the alloy compositions of hypogene and elluvial gold grains has not been completed. The evaluation of the data set is made mainly on the basis of the ore mineralogy and inclusion species observed in gold particles weathered out of the veins.

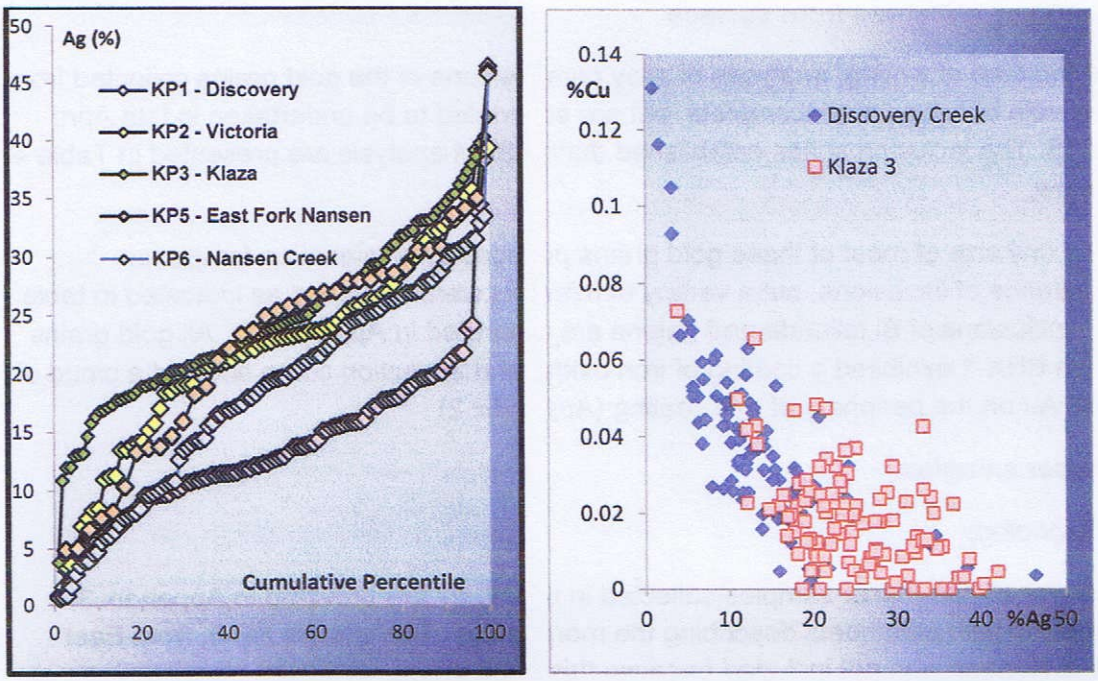


Figure 3. Alloy compositions of placer gold

Table 4. Inclusion assemblages in placer and elluvial gold

	Grains	Py	Po	Cpy	Ga	Sp	Ars	Bi	SS	B	Hs
KP1	102				4		4	2			
KP2	78	1		1	1	1		3			
KP3	104	6		2	2			2			4
KP5	37	1		1	2				1	1	
KP6	101	4			3		1	1	1		
EFN , YGS	97	9		1	5	2	1	3			2
BRX-1		1		1	1		1				
BRX-2		1	1		1	1		2	1	3	
KZ-2					1						

Studies of the ore mineralogy undertaken by SEM and RL microscopy have indicated a broad paragenesis for the two vein systems. There are insufficient samples to evaluate in detail whether the mineralogy varies systematically with either location or depth, but samples from both vein systems exhibit common features in the samples observed and some broad differences can be tentatively proposed.

Both vein systems exhibit an initial stage which involved pyrite deposition. In the BRX zone, this stage also involved deposition of Bi bearing minerals and Au. Similarities also exist in the second stage, which comprises arsenopyrite and sphalerite as major minerals in the Klaza zone, but as more minor components in the BRX zone. Very minor chalcopyrite was observed as chalcopyrite disease in

sphalerite in the Klaza zone. One sample suggests that gold post dates pyrite, but it is not possible to identify the actual stage of emplacement from the observations available, consequently ascribing gold to stage 2 in Figure 2 is tentative.

The third stage of mineralization involved galena, which is commonly observed as infills within pyrite, sphalerite and arsenopyrite. In the Klaza zone, major barytes was observed in the sample from the upthrown block which suggests that the presence of barytes is related to depth. This interpretation suggests a generic process, because barytes was abundant in the pan concentrate of the elluvial sample from BRX-2, (also in the upthrown block). Minor sulphosalts were observed in stage 3 in the Klaza zone samples, and one very small gold grain was present within a grain of galena, itself infilling a crack between pyrite and arsenopyrite, (Appendix 1.1A). Enargite and chalcopyrite postdated galena in one sample from the BRX-zone, and comprise a minor 4th stage.

Table 4 indicates the abundance and mineralogy of the inclusion suites found within the elluvial grains, Inclusions are regarded as coeval with the Au alloy, and hence the inclusions suites can be related to the paragenetic dagrams constructed in Figure 2. Most of the important ore minerals are represented, although this relationship does not always extend to minerals seen to be coeval with gold in the hypogene ore. Inclusions were absent in the sample of gold grains from KZ- 1 and only galena was identified in hypogene ore from KZ-2. In the BRX zone, the Au-Pyrite- Bi mineral association was evident, together with an Au- galena association which was not observed in the hypogene ore at this locality. Further discussion of the hypogene- elluvial relationship will be facilitated by the generation of alloy data.

2. *Placer signatures and their interrelationship*

Figure 4A shows the variation in Ag contents of the gold grains from the various placer localities. The samples from Discovery Creek and the Klaza River represent the most extreme populations of the suite studied. In addition, both populations comprise a single continuum of Ag compositions whereas the placer samples from Nansen Creek generated stepped plots, usually interpreted as indicative of multiple sources. The images in Appendix 2 show that gold grains collected in the Klaza River and Discovery Creek exhibit a rough morphology indicating proximity to source. The Klaza river site is adjacent to the Klaza vein systems whilst the Discovery Creek locality is entirely within the outcrop of the Cyprus porphyry. These observations indicate that populations of Au grains derived from the porphyry mineralization are lower in Ag than their epithermal counterparts.

The headwaters of Nansen Creek (East Fork Nansen) are close to several potential gold sources identified by Hart and Langdon (1997): the Klaza zone, Etzel, and the Cyprus porphyry. Three samples donated by YGS and analysed previously were also available to the present study. Unfortunately their precise sample locations are unknown. The Ag plots of these samples are presented in Figure 4B. All samples

show mixtures of the two end member populations, and the shape of the three curves shows varying proportions of each are present. The hypothesis of variable contributions from two sources at different sampling sites in a small catchment is explained by the position of the Creek with respect to the various potential sources, and possibly also a function of the position of the mining cuts in relation to the creek, i.e. left or right limit.

The placer sample from Victoria Creek generated a Ag plot far more similar to the epithermal signature described above than to that associated with the Cyprus porphyry, (Fig. 4A). The varied morphology of the grains within this sample population suggests multiple sources, and it is proposed that most of these are epithermal in nature, with at least one very close to the sampling locality.

Relationship between hypogene mineralization,elluvial gold grains and placer gold grains.

Whilst detailed examination of this relationship is currently impaired by the lack of gold alloy analyses for hypogene and elluvial gold grains, and the small number of polished blocks examined, there are clear similarities between the gold mineralogy in the hypogene, elluvial and placer settings. The mineral species observed in the hypogene ore are distinctive and are also evident in gold grains collected from the elluvial and placer environments. During examination of the hypogene samples from the BRX zone by SEM, a small number of semi quantitative analyses of gold grains was undertaken using the EDS facility. These analyses are not of the same quality as those produced by EMP, neither is analysis of the small concentrations of Cu possible. Nevertheless the data illustrated in Figure 4A shows an extremely close correlation between the composition of hypogene gold from BRX 2 and that of placer gold from the Klaza River at a sampling locality downslope. It is emphasized that this correlation must be substantiated with larger amounts of higher quality data.

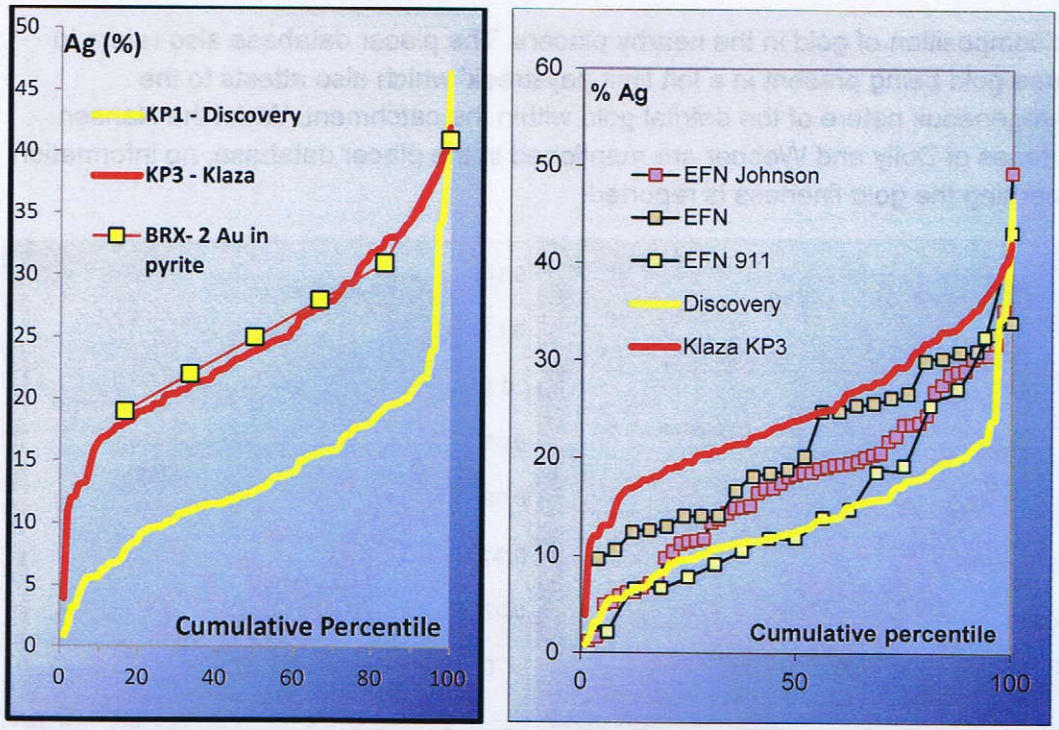


Figure 4 A: Relationship between Klaza River placer gold and gold in the hypogene BRX zone. 4 B Relationship of different samples collected from East Fork Nansen, Klaza River and Discovery Creek.

3. *Implications for source of gold in the placer district.*

The analysis provided in the sections above permits differentiation between gold particles derived from the Klaza zone veins and that originating from the Cyprus porphyry. This difference is evident in the shapes of the Ag curves and the compositional fields with Cu-Ag plots such as Figures 3A and 3B. However it is not possible to establish whether the high Ag, low Cu gold is derived from the Klaza veins or other Au-Ag-Pb-Zn occurrences in the area. Similarly, there is, at present, no signature available to describe gold derived from the Kelly zone. Consequently, whilst it is possible to interrogate placer data sets in terms of the relative amounts of each alloy type it is more difficult to establish clear lode source- placer relationships. Nevertheless, some broad conclusions may be drawn from the data sets available Consideration of the Ag-Cu plot (Fig. 5A) shows that only around third of the grains from Nansen Creek exhibit compositions compatible with derivation from the porphyry. Similarly, the alloy signature of the population of placer gold grains from Victoria Creek is clearly more similar to that of the vein hosted gold, (Fig 5B). The fineness of gold from Victoria Creek (720-730) reported by LeBarge (2007) is in agreement with the data from the present study,(Fig 3A) and therefore the implications of a fineness rage of 760-836 from Back Creek (Fig 1) can be interpreted with confidence. This compositional range suggests the presence of both high and low Ag signatures, and is interpreted to indicate that both porphyry and vein mineralization are present within the catchment and have strongly influenced the

bulk composition of gold in the nearby placers. The placer database also refers to 'coarse gold being present in a left limit paystreak' which also attests to the heterogeneous nature of the detrital gold within the catchment. Whist the Nansen tributaries of Dolly and Webber are mentioned in the placer database, no information concerning the gold fineness is reported.

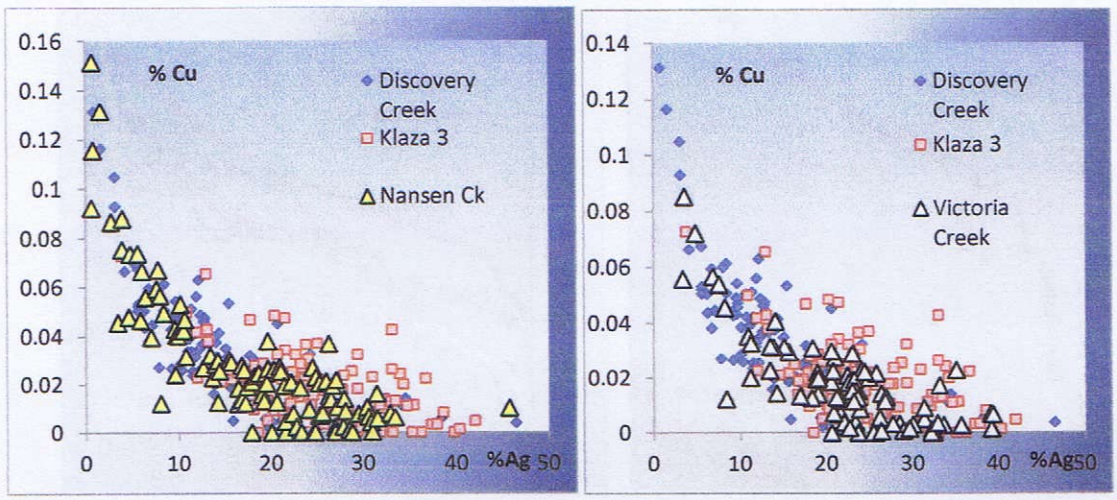


Figure 5. Use of Cu-Ag plots to evaluate the proportion of placer grains derived from porphyry and vein sources

An overview of placer lode relationships is provided in Table 5. The application of gold grain geochemistry to study lode-placer relationships in the study area has revealed the importance of the epithermal vein systems as sources of placer gold. Consideration of the geographical relationship of the major placer (Nansen Creek) with the Cyprus porphyry would suggest that most placer gold has been derived from this source. However the relative abundance of gold grains which exhibit a high Ag/low Cu signature indicates that the overall contribution from vein hosted gold is more important.

Table 5 Summary of lode-placer relationships in the study area

label	locality	Sources
KP1	Discovery Ck	Cyprus Porphyry
KP2	Victoria Ck	Multiple Au-Ag-Pb-Zn veins , locality unknown., but one source very close to the sampling site
KP3	Klaza R.	Klaza zone veins
KP5	East Fork Nansen	Cyprus porphyry, Kelly zone, Etzel occurrence, Klaza zone
KP6	Nansen Ck	Vein hosted gold comprises around 70% of the placer inventory with the balance derived from porphyry mineralization.

There are two caveats that must be applied to this interpretation. Firstly current mining operations on Nansen Creek mine down to a clay layer at a depth of around 10m which acts as false bedrock. Drilling has indicated that a further 40m of material overlaid bedrock. Consequently the amount of gold in the deeply buried channels is

unknown, but the placer was established in a previous fluvial regime, which could have derived gold from a different source, or indeed it may contain no gold at all. Consequently the approach of using placer production figures to interpret the size of the eroded mineralization is not appropriate in this case. Inference of the economic potential of vein systems from the placer occurrences is also problematic, as the amount of gold in the placer is dependent upon the spatial relationship of the veins to the drainage. The amount of gold from the Klaza veins which reports to the Nansen Creek placer is unclear, because gold with a similar signature is probably present in other sources such as Etzel. The placers in the Klaza River which are currently mined appear relatively modest, and give no strong indication of the potential of the adjacent vein system.
It seems likely that there are Au – bearing veins which remain to be discovered. The lode – placer relationships in Back Creek are unclear, but the variation in gold fineness reported previously is a clear indication of at least two sources, which is consistent with the location of the creek with respect to the vein and porphyry mineralization. The presence of coarse, rough gold near the sampling site on Victoria Creek is strong evidence for a local source, probably to the NE of the creek.

This small study is the first to consider variation of gold signatures in the porphyry-epithermal transition, and has highlighted some interesting relationships that have important implications both for the study area and wider investigations. The current data set do not include any lode samples from the transitional zone, some of which are reported as mineralogically distinctive from the vein systems. Study of this mineralizing environment would add to our understanding of metal transport and partitioning, within such systems and recommendations for further studies will be forthcoming.

Conclusions

The mineralogy of the hypogene ore was emplaced in three major stages with the paragenesis of the major minerals conforming to i. pyrite, ii. /sphalerite/arsenopyrite, iii. galena. Native Au was identified both in early stage pyrite and with later stage galena. The mineralogy of the vein material is reflected accurately in the inclusion suite of gold grains collected from elluvial and placer environments. The limited amount of alloy data relating to hypogene gold currently available shows a clear compatibility of the gold the Klaza Zone and the placer gold in the Klaza River.

Alloy signatures of placer gold comprise two end members, one relating to a porphyry origin and the other to the widespread Au-Ag-Pb-Zn veins. These signatures have been ascribed through study of two placer samples whose geographical position limits the influx of gold to a specific source and may be distinguished by considering both Cu and Ag contents of gold grains. The resulting signatures have been used to evaluate the contributions of the gold type to placers where both styles of mineralization are present within the drainage. In this way, previous assumptions that the majority of the placer gold inventory was derived from porphyry sources has been challenged, as the most common signature relates to the vein gold. However, given the number of vein occurrences in the study area it is not

always possible to identify the relative amounts of placer gold originating from specific veins.

References

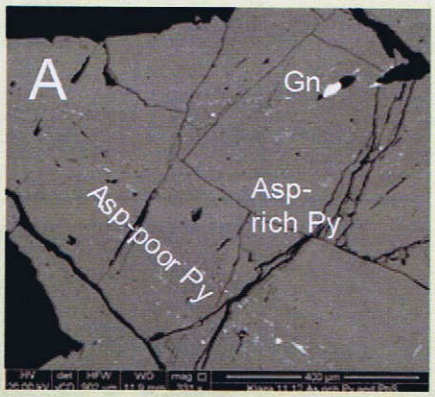
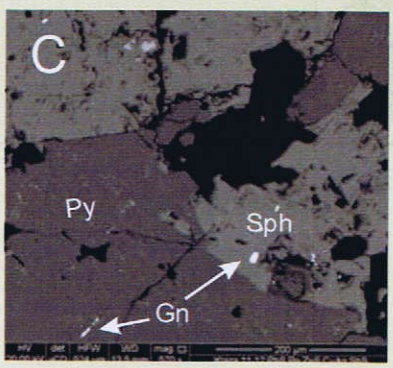
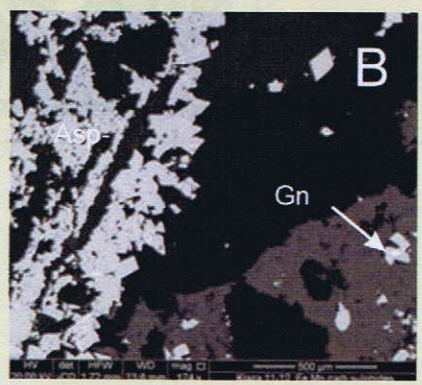
Chapman, R.J., Leake, R.C., Moles, N.R., Earls, G., Cooper, C., Harrington, K., and Berzins, R., 2000, The application of microchemical analysis of gold grains to the understanding of complex local and regional gold mineralization: a case study in Ireland and Scotland: ECONOMIC GEOLOGY, v. 95, p. 1753-1773.

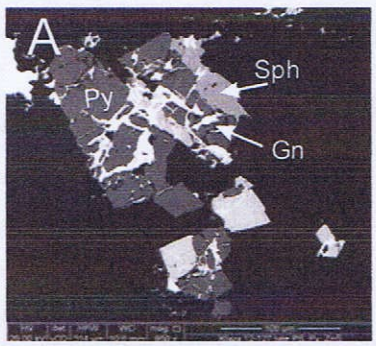
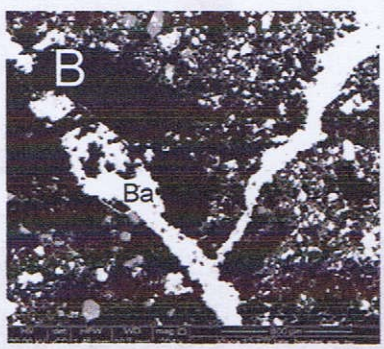
Hart, Craig J.R. and Langdon, Mark. Geology and mineral deposits of the Mount Nansen camp, Yukon. *In:*Yukon Exploration and Geology 1997, Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p.129-138.

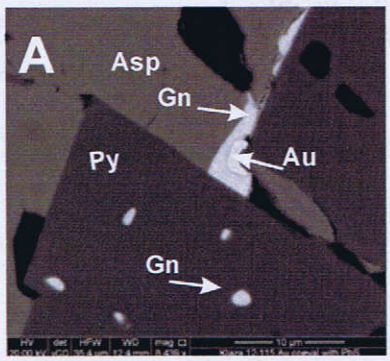
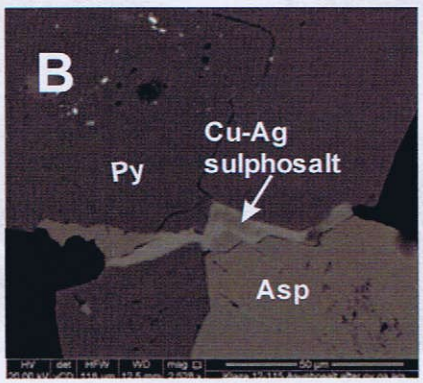
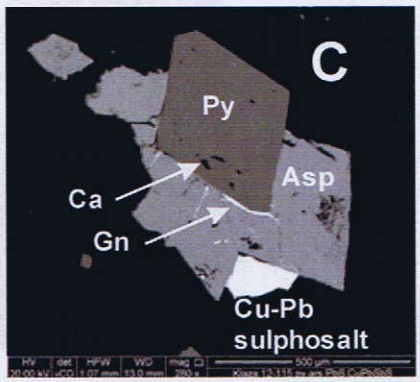
LeBarge, W.P. (compiler), 2007, Yukon Placer Database 2007 - geology and mining activity of placer occurrences; Yukon Geological Survey, CD-ROM.

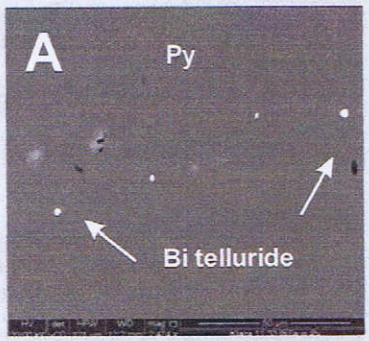
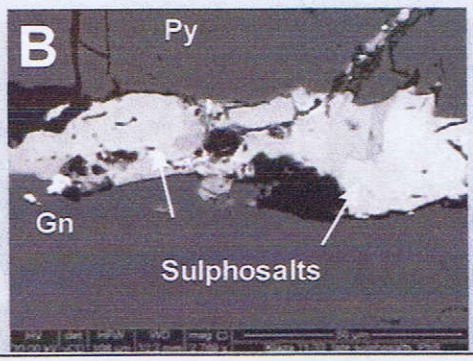
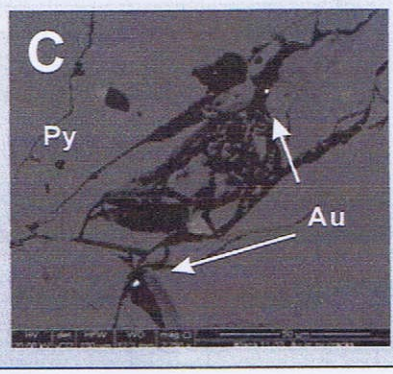
Tarswell, J, Turner, M. 2014. Assessment report describing excavator trenches, geophysical surveys and metallurgical tests at the Klaza property. Prepared by Archer, Cathro & Associates (1981) limited for Rockhaven Resources ltd.

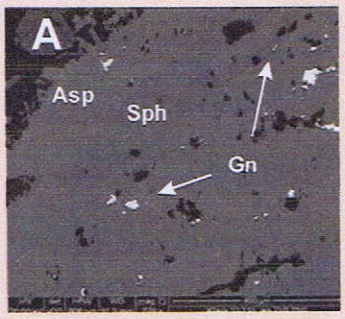
Appendix 1 4 Core mineralogy Abbreviations: Asp=arsenopyrite, Au= gold, En= enargite Ga= galena, Py= pyrite, Su= sulphosalts, Sph= sphalerite,

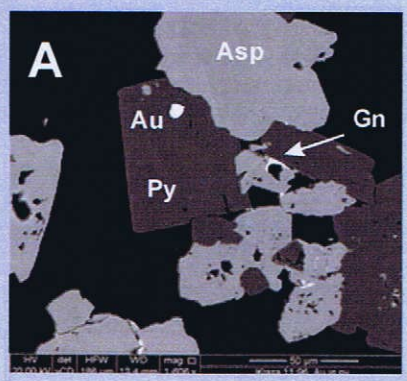
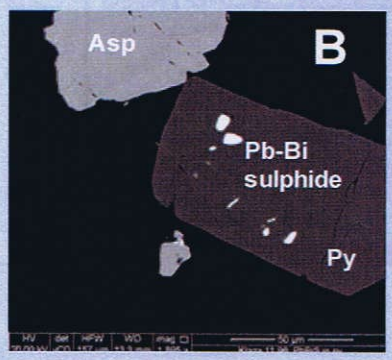
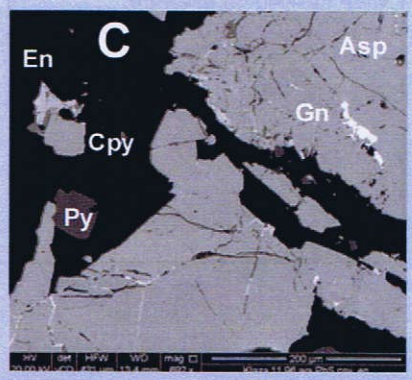
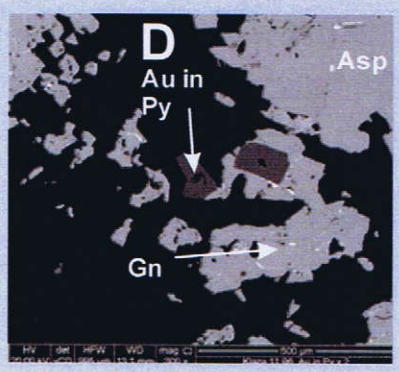
Hole _ID	Mineralogy	
KL-11-12 KZ1 ?	Cubic, subhedral Pyrite cubes to 1.5mm forms the majority of the block, Anhedral sphalerite with chalcopyrite disease Galena infills arsenopyrite and often follow linear trend (A), within As-poor pyrite. Galena blebs in Sphalerite and arsenopyrite (B) Quartz- carbonate gangue including Mn- bearing carbonate.(C) with arsenopyrite and galena	
		

Hole _ID	Mineralogy	
KL-12-127 KZ2	Galena postdates pyrite and sphalerite (A) Galena in bands of As- poor pyrite Late barytes cuts massive pyrite and arsenopyrite (B)	
		

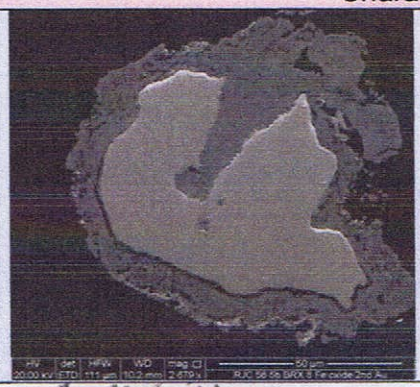
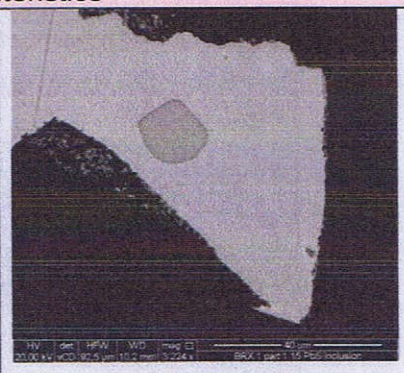
Hole _ID	Mineralogy	
KL-12-115	Arsenopyrite postdates pyrite (A) and galena postdates arsenopyrite Au coeval with galena (A) (CuAg) (SbAsS) postdates pyrite and arsenopyrite(B) Pyrite- arseno[pyrite –(galena/Cu-Pb sulphosalt) sequence in C. Euhedral pyrite with galena and calcite inclusions (C)	
		

Hole _ID	Mineralogy	
KL-11-33 BRX 1	Dominated by pyrite Tiny (3 µm) Bi telluride inclusions in pyrite (A) Galena mainly late stage fracture fill in pyrite sometimes together with Cu-Ag sulphide or Ag-Cu sulphosalts (B) Tiny Au grains n Pyrite (B)	
		

Hole _ID	Mineralogy	
KL-11-37 BRX 3	Spalerite, arsenopyrite and pyrite (stage 1) with later galena. Sphalerite predates arsenopyrite Galena postdates arsenopyrite	

Hole _ID	Mineralogy	
KL-12-96 BRX 2	Au coeval with Py.(A) Pb/Bi sulphide coeval with Py (B) Arsenopyrite postdates pyrite (A,D) Galena postdates arsenopyrite (A,D) Chalcopyrite, enargite and galena postdate arsenopyrite (C)	
		
		

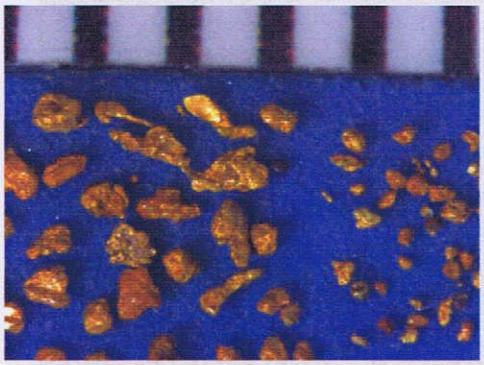
Appendix 2: Features of gold grains from elluvial localities

Sample	Characteristics	
BRX-1 Left: gold grain encapsulate by iron oxide. This film of gold, presumed remobilized on grain surface . Right: Galena inclusion in gold		
BRX-2 Bi telluride inclusions in gold, Dots =polishing medium		

Appendix 3 Samples of placer gold from the Klaza Environs

KP 1 Discovery Creek

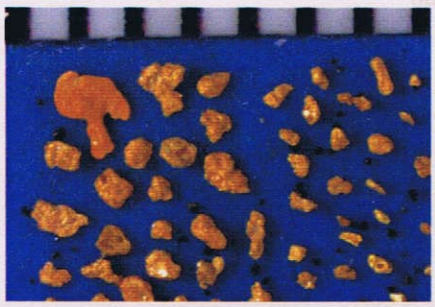
Small rough gold particles indicative of very limited fluvial transport



KP2: Victoria Creek

Top; larger rough grains collected in an area where larger, similar nuggets have been recovered by local placer miners.
Below: Smaller grains, exhibiting both very flaky and rough morphologies.





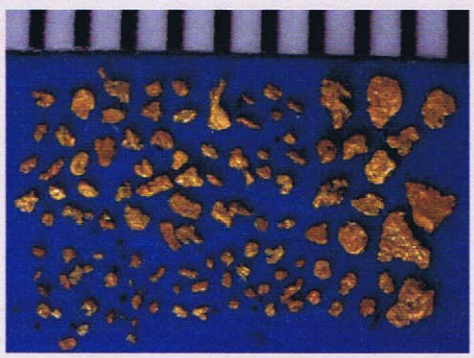
KP3, Klaza River

Mostly small<1mm grains, but all rough showing textures indicative of very limited transport

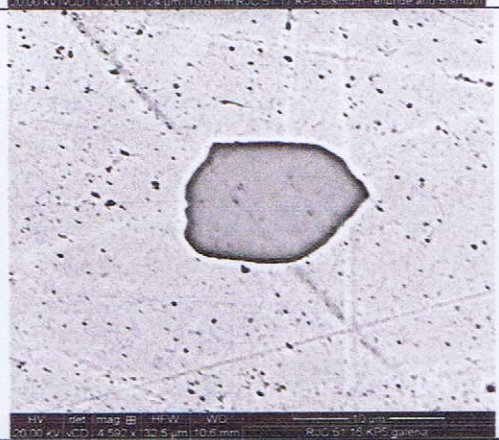
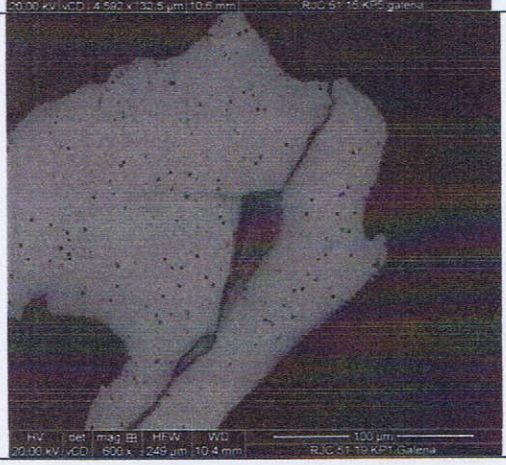


KP5 Nansen Creek

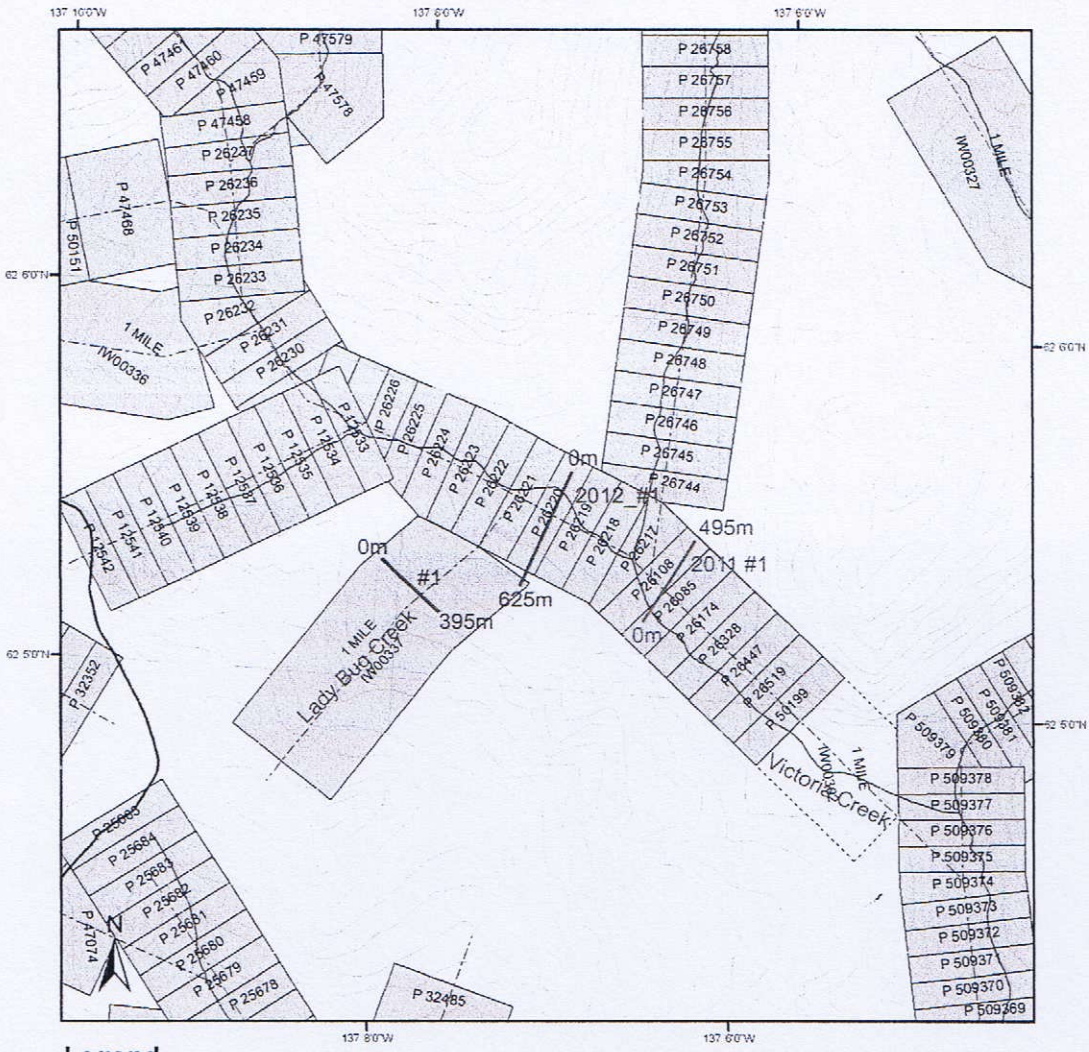
Mixed morphology, occasional rough grains, but many showing evidence of transportation



Appendix 4 Examples of internal features of placer gold grains

KP3 Bi Telluride (mid gray, and Bismuth sulphide (very dark gray) inclusions in gold from The Klaza river	
KP5 Large galena inclusion in gold from East Fork Nansen	
KP1 Galena postdating gold in a placer grain from the Klaza River	

10. Survey Map[7]



Legend

- mining road
- contour line
- watercourse
- water body
- measuring line 2012
- measuring line 2011
- placer baseline

placer claims

- Active
- Expired

prospecting lease

- Active
- Expired

Survey Map

115I03 (Mount Nansen)

Universal Transverse Mercator Zone 8
North American Datum 1983

scale 1:25,000

0 250 500 1,000 1,500 2,000 Meters

[7] Government of Canada, Natural Resources Canada, Centre for Topographic Information ftp://ftp.geomaticsyukon.ca/Mining

Early Pleistocene glaciation and implications for placer gold deposits in Back Creek, Mount Nansen area, Yukon

P.O. Englehardt[1], Brent C. Ward
Earth Sciences, Simon Fraser University

Jeffrey D. Bond
Yukon Geological Survey

Mark J. Coleman
Earth Sciences, Simon Fraser University

Englehardt, P.O., Ward, B.C., Bond, J.D. and Coleman, M.J., 2015. Early Pleistocene glaciation and implications for placer gold deposits in Back Creek, Mount Nansen area, Yukon. *In:* Yukon Exploration and Geology 2015, Yukon Geological Survey, p. 111-129.

ABSTRACT

Yukon has over a century of placer mining history, predominately in unglaciated regions. However, as these targets are exploited, focus turns to more complex landscapes where glaciation has buried, eroded and incorporated placer gold. This study examines how Early Pleistocene glaciation in the Mount Nansen area, central Yukon, has affected placer gold deposits. Detailed stratigraphic analysis and sample collection has focused on Back Creek, where placer mining has exposed a 22 m section with several gold bearing units. In the section, sediment from two glacial advances cap sporadically preserved pre-glacial gravel. The section is variably dissected by younger placer gold bearing fluvial gravel with enrichment related to intersection of inter-glacial or pre-glacial placer gold deposits. Analysis at Back Creek reveals the potential for deeply buried placer gold deposits in other glaciated regions of Yukon.

[1]*pengleha@sfu.ca*

INTRODUCTION

Beyond the influence of glaciation in Yukon, several lucrative placer deposits were exploited during the 1897 Gold Rush (LeBarge, 1995). As these prospects are exhausted exploration has shifted to more complex landscapes where glaciation may have obscured, eroded, and incorporated placer gold deposits (LeBarge, 1995). Several phases of Northern Cordilleran Ice Sheet (NCIS) glaciation, in Yukon, have modified the landscape (Duk-Rodkin, 1999; Duk-Rodkin *et al*., 2001; Jackson, 1993; 2000; Ward *et al*., 2007), producing the palimpsest landscape present today. The earliest phases of glaciation were the most extensive in central Yukon (Fig. 1) and likely had the largest effect on placer gold deposits. To understand the effect of early glaciation on placer gold development, the Mount Nansen Placer Mining District (NTS115/I) was investigated during the summer of 2015, to determine the stratigraphy at Back Creek, derive the geologic history, and to relate this to placer gold preservation and formation. Previous work in the Mount Nansen area is discussed and the current understanding of bedrock geology, glacial history, and placer gold development is summarized. This research is a synthesis of academic interest (early Pleistocene glacial behavior) and economic importance (placer gold development) that may be used as an analogue for future studies of placer gold in glaciated terrains.

BEDROCK GEOLOGY

Large gold deposits in Yukon formed during the repeated accretion of several terranes throughout the Mesozoic era (Colpron *et al*., 2007; Knight *et al.,* 2013; Monger *et al.,* 1972; Coney *et al.,* 1980). The Yukon Tanana terrane (YTT) formed as an island-arc back-arc basin with extensive porphyry/epithermal gold deposits, and the study area is underlain by these rocks (Colpron *et al*., 2007; Selby *et al.,* 1999). The Mount Nansen area is underlain by Proterozoic-Cenozoic bedrock, and major units are further described below (Fig. 2; Hart and Langdon, 1998; Saager and Bianconi, 1971; Tempelman-Kluit, 1984). The Proterozoic-Paleozoic metamorphic Yukon Group rocks consist of the following: chlorite schist, biotite schist, feldspathic quartzite, amphibolite, quartz-biotite gneiss and biotite-hornblende gneiss (Hart and Langdon, 1998; Mortensen *et al*., 2002; Saager and Bianconi, 1971). The metamorphic rocks host several intrusions including: the early Jurassic Long Lake Suite (hornblende-biotite granodiorite-monzogranite), mid-Cretaceous Dawson Range batholith (hornblende-biotite-quartz diorite, and granodiorite), late Cretaceous Prospector Mountain suite (quartz monzonite) and the Casino Plutonic suite (leucocratic granite, quartz monzonite and alaskite; Hart and Langdon, 1998; Johnston, 1996; Mortensen *et al*., 2002; Saager and Bianconi, 1971; Selby *et al.,* 1999; Wengzynowski *et al.,* 2015). Extensive volcanic deposits formed contemporaneously with the plutonic complexes and include the Mount Nansen Volcanic Group which comprises andesite, dacite, minor rhyolite and minor Cenozoic intrusions of quartz feldspar porphyries (Saager and Bianconi, 1971; Hart and Langdon, 1998; Mortensen *et al*., 2002). Mineralization in the Mount Nansen area is hosted within Paleozoic metamorphic rocks and Mesozoic intrusive rocks (Hart and Langdon, 1998; Mortensen *et al*., 2002). Late phase hypabyssal parts of the Mount Nansen volcanic rocks (quartz feldspars porphyries, dikes and minor pyroclastic flows) are related to significant mineralization (Hart and Langdon, 1998).

Several gold bearing porphyry-epithermal complexes are concentrated within a 3 by 12 km, northwest oriented, steeply dipping corridor called the Nansen trend (Hart and Langdon, 1998). These porphyry-epithermal complexes are the likely source for the placer gold deposits in the Mount Nansen area (Hart and Langdon, 1998; Jackson, 1993; LeBarge, 1995).

GLACIAL HISTORY

The NCIS first developed in Yukon during the late Pliocene (~2.6 Ma), and several advances produced the palimpsest surficial sedimentary record present today (Fig. 1; Barendregt *et al*., 2010; Duk-Rodkin *et al*., 2001; 2004 Hidy *et al.,* 2013). The development of the NCIS glaciation is related to complex atmospheric-oceanic interactions, Milankovitch Cycles, atmospheric composition and precipitation (Burn, 1994; Guthrie, 2001; Harris, 2005; Haug *et al*., 2005; Ward *et al*., 2008). Dawson (1889) first recognized evidence for glaciation in Yukon in 1887; however, multiple glacial advances were not recognized until Bostock (1936) worked in the Mount Nansen Area. Based on this early work there are three morphostratigraphic glacial surfaces widely recognized in Yukon: the pre-Reid, Reid/Gladstone, and McConnell (Fig. 1); each represents a discrete surface associated with a maximum extent, some of which represent two (Reid/Gladstone) or multiple (pre-Reid) NCIS advances (Bostock, 1966; Demuro *et al*., 2012; Duk-Rodkin *et al*., 1999; Hughes *et al.,* 1969; Jackson *et al.,* 1999; Jackson and Clague, 1991; Westgate *et al*., 2000; and Ward *et al*., 2007).

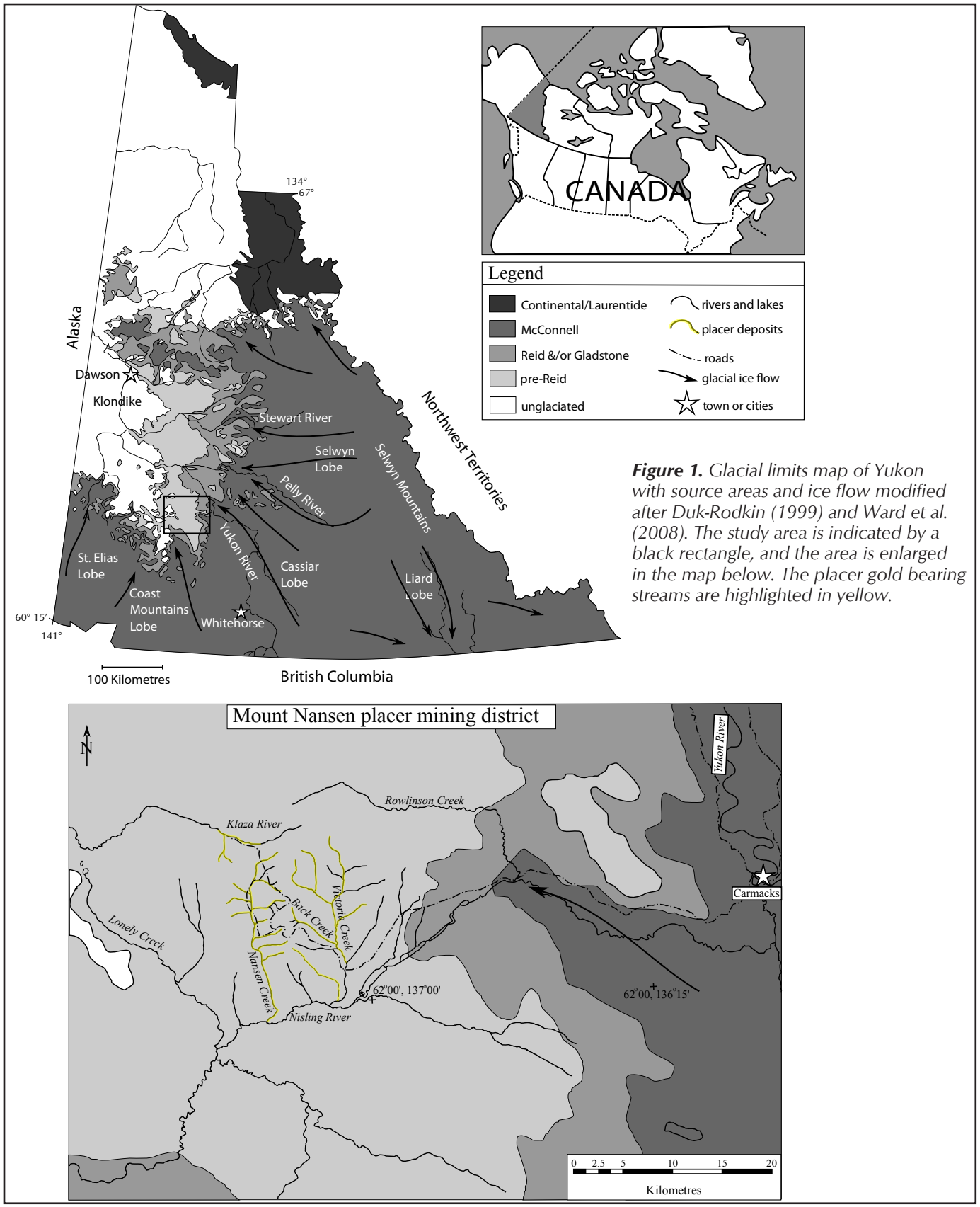


Figure 1. *Glacial limits map of Yukon with source areas and ice flow modified after Duk-Rodkin (1999) and Ward et al. (2008). The study area is indicated by a black rectangle, and the area is enlarged in the map below. The placer gold bearing streams are highlighted in yellow.*

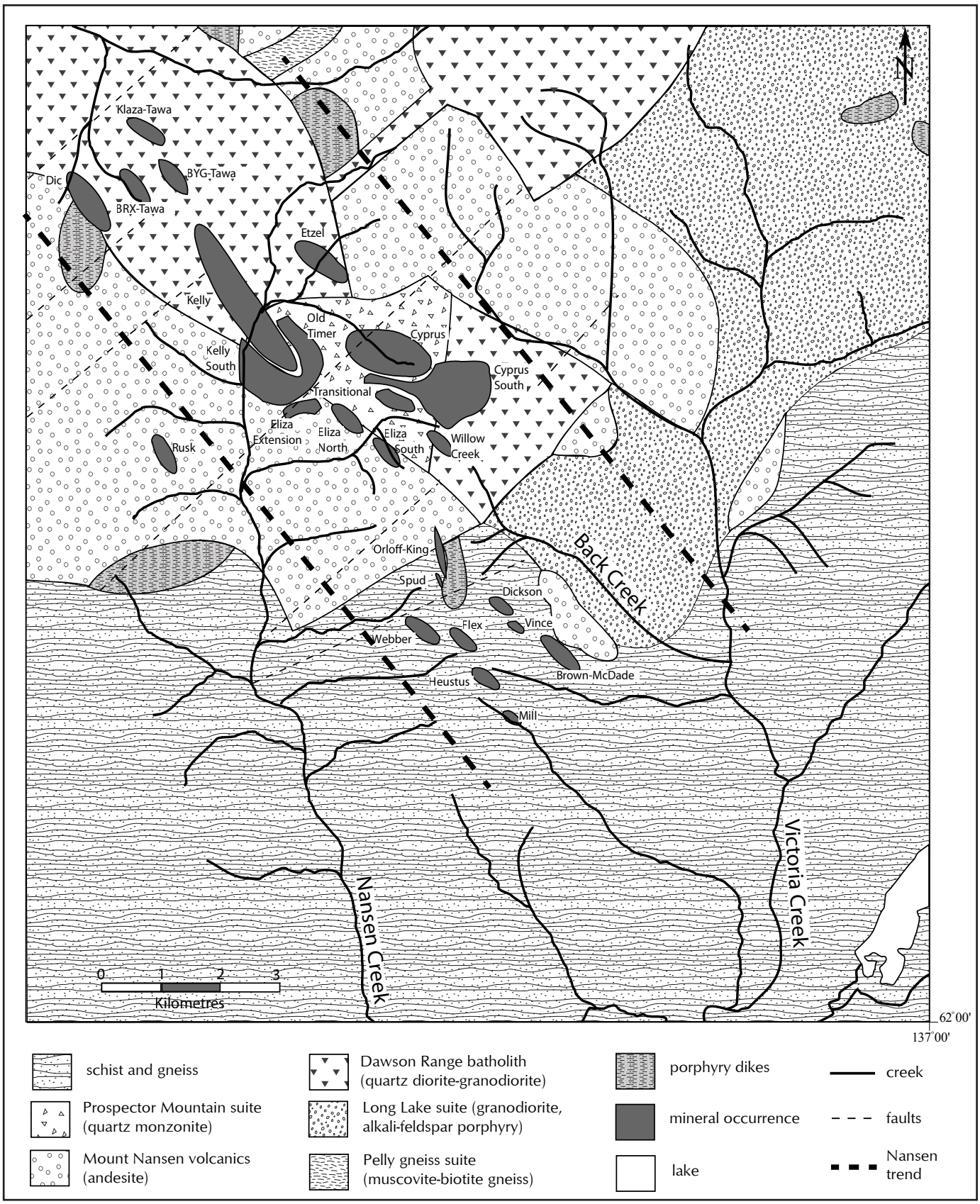


Figure 2. *Bedrock geology map of the Mount Nansen area modified after Hart and Langdon 1998.*

Glaciation in the Mount Nansen area has long been known (Cairnes, 1915), and placer mining occasionally provided insight that older glaciation had affected the area (Bostock 1966). Bostock (1966) assigned the two earliest phases of Yukon glaciation to be the Nansen (older) and the Klaza (younger) based on field observations in the 1930s. Subsequent work by Hughes *et al.* (1969), grouped the Nansen and the Klaza glacial events into the pre-Reid morphostratigraphic surface due to the challenge of separating the two advances in other areas. While several glacial periods are mapped in the Mount Nansen region only two pre-Reid glaciation events (the Nansen and Klaza) are known to have affected Back Creek (Fig. 1; Bostock, 1966; Jackson, 1993; 2000; LeBarge, 1995). The Nansen and Klaza glaciation likely advanced into the Mount Nansen area from the east and south and were part of the Cassiar and Coast Mountain ice lobes (Fig. 1; Bostock, 1966; Duk-Rodkin; 1999; Guerts and Dewes, 1993). The Nansen glaciation was extensive (affecting elevations below 1400 m), and landform evidence is restricted to meltwater channels and patchy till (Jackson, 2000; LeBarge, 1995). The antiquity of the Nansen till is reflected by the deeply weathered schist and granitic clasts contained in the till (Bostock, 1966). The timing of the Nansen glaciation is poorly constrained; however, it may be correlated to the most extensive NCIS *ca.* 2.64 Ma (Hidy *et al.*, 2013). The younger Klaza glaciation is thought to begin with local cirque glaciers developing in the Dawson Range and expanding into the valleys (Jackson, 1993; LeBarge, 1995). Further evidence of the Klaza glaciation was observed west of the study area in Lonely Creek where Bostock (1966) noted landscape modifications associated with glaciation. The Klaza glaciation may correlate to an advance in the Fort Selkirk region where basalt overlying till has been dated to greater than 1 Ma (Jackson, 2000; Jackson *et al.,* 1991; Naeser *et al.,* 1982). During subsequent mid-late Pleistocene glaciation (Reid, Gladstone and McConnell) the area was unglaciated and subjected to intense periglacial conditions (Fig. 1; Jackson, 2000; LeBarge, 1995). During the Reid and Gladstone glaciation events the Coast Mountains ice lobe dammed the Nisling River causing a glacial lake to develop. This increased the base level of the Nisling River and its tributaries Victoria and Nansen creeks (Guerts and Dewes, 1993; LeBarge, 1995). Gravel terraces associated with this episode of sedimentation are common in these tributaries to the Nisling River and are a good example of the indirect effect of more recent glaciation. This research focuses on the earliest phases of glaciation (pre-Reid) that directly affected the landscape and the associated placer gold deposits in Back Creek.

PLACER GOLD DEVELOPMENT

Placer gold deposits require mineralized bedrock and a mechanical concentration mechanism, typically colluvial and fluvial; however, it can also be glacial, eolian, or lacustrine (Els and Eriksson, 2005). In Yukon, the warmer temperatures (>4°C of current Mean Annual Temperature, MAT) and increased precipitation (>550 mm of current Mean Annual Precipitation, MAP) of the Paleogene to Neogene (66 to 2.6 Ma) produced deeply weathered bedrock mantles (>75 m) that facilitated the development of placer deposits and where lode gold became available for concentration (Ager *et al.*, 1994; Anderson and Stroshein, 1997; Dampier *et al.*, 2011; Foscolos *et al.,* 1977; Jackson, 2000; LeBarge, 1995). Beyond the reach of glaciation, placer gold deposits remained relatively undisturbed and continued accumulating throughout the Quaternary; however, in glaciated areas placer gold deposits were significantly affected by erosional and/or depositional processes (Goldfarb *et al.,* 2015; Herail *et al.,* 1989; Jackson 1993; LeBarge 1995; Levson and Blyth, 2001; Lowey, 2006).

More than 27,000 crude ounces of placer gold have been mined from several creeks in the Mount Nansen area and from various sediment types (LeBarge, 1995). A likely cause of this placer gold concentration is the abundance of mineralized bedrock in the region (Hart and Langdon, 1998; Jackson, 1993) and stable Cenozoic tectonic history that allowed residual deposits to accumulate. There are several known porphyry/epithermal deposits that may be the source of placer gold in Back Creek (Fig. 2; Hart and Langdon, 1998). Most placer mining in the Mount Nansen area extracts gold concentrated on the pervasive 'false bedrock' (till) developed on early Pleistocene pre-Reid glacial deposits (Bostock, 1966; LeBarge, 1995). These placer deposits have formed from weathering of bedrock slopes subsequent to the last regional glaciation to affect the area, and therefore, are considered relatively young. Exploitation of pre-glacial placer deposits situated on bedrock is limited due to the depth of glacial sediment cover. Recently, placer mining has exposed deeply buried deposits, which provides an important opportunity to

document stratigraphic and sedimentological information regarding multiple zones of placer gold development. This study investigates one of these deeper excavations that exposes valley bottom bedrock, pre-glacial sediment, and overlying Quaternary deposits. Information presented here may provide an analogue for future placer gold exploration in neighboring drainages, such as Nansen and Victoria creeks, and in other in glaciated areas.

METHODS

During the 2015 field season several locations in the Mount Nansen Area were visited; however, this study focuses on the stratigraphy of Back Creek due to its exceptional exposure of potential pre-glacial gravel and pre-Reid glacial sediment (Figs. 3 and 4). To understand the stratigraphy at Back Creek, sediment descriptions, clast orientation measurements, and paleomagnetic samples were collected. Several units (2, 3, 4, 6 and 11) were also sampled for placer gold to characterize gold provenance.

Sedimentary analysis was completed in the field where estimates of clast character (size, shape, orientation and surface features), and matrix character (size, abundance, compaction and structures) aided in assigning separate units (Table 1 and Fig. 5). Samples from several of these units were collected for further analysis. The presence of unique features including: 'decomposed clasts', cryoturbation, iron/manganese staining and organics were noted. The term 'decomposed clasts' refers to clasts that are pervasively weathered and may be easily broken by hand; Bostock (1966) used similar terminology (rotten clasts) when describing clasts from the Mount Nansen area.

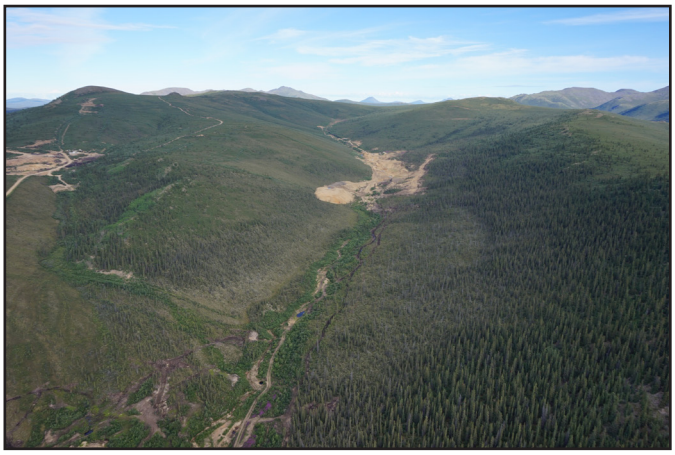


Figure 3. *A view of Back Creek looking northwest; current placer mining is in the centre of the valley.*



Figure 4. *A view of the deep (>22 m) placer mining exposure at Back Creek. The lowest unit visible is the deeply weathered bedrock (Unit 1). In the center of the section are two till units (Units 3 and 5) separated by interglacial sediments (Unit 4). Above this is cover sediment that includes various amounts of colluviated material (Unit 9), organics (Unit 8), tephra (Unit 9), and anthropogenic sediment (Unit 12).*

Table 1. *Unit interpretations and descriptions with respective landscape evolution phases.*

Unit	Interpretation	Description	Landscape Evolution Phase
12	Anthropogenic Sediment	All of the material that has been disturbed by mining. Characteristics, contacts and lateral extent all vary based on style of formation.	Cover Development (G)
11	Modern Gravel	Moderately stratified, poorly-consolidated, clast-supported gravel with ~70% clasts and a silty sand matrix. Clasts are subrounded to rounded and clast lithology is variable but local. Lower contact is sharp and erosive, and the unit forms the base of the modern creek.	
10	White River Tephra	Pale grey-white, finely laminated, fine-medium sand sized glass shards.	
9	Colluvium	Brown, poorly stratified to massive, organic-rich, matrix-supported, diamicton with ~30% clasts, variable lithologies. Lower contact is sharp and erosive, and the unit is laterally extensive.	
8	Colluviated Organics	Organic-rich, matrix-supported, poorly-consolidated, colluviated organics, with clay to fine sand, and abundant macrofossils. Lower contact is sharp and erosive, and this unit is laterally extensive.	
7	Fluvial Sand	Tan, sub-horizontally bedded silty-sand, with minor organics. Lower contact is erosive and unit is not laterally extensive.	
6	Fluvial Gravel (pay)	Variably Fe/Mn stained, stratified, poorly-consolidated, clast-supported gravel with ~80% boulder, cobble pebble clasts. Clasts are subrounded, imbricated with variable lithologies. Lower contact is erosive and unit is laterally extensive.	Pay Gravel Development (F)
5	Klaza Till	Dark grey, massive, over-consolidated, matrix-supported, diamicton with ~20% clasts, and a clayey silt matrix. Clasts were commonly decomposed, striated and or exotic.	Klaza Glaciation (E)
4	Paleosol/ inter-glacial gravel	Sediment present includes: i) an over-consolidated, matrix-supported diamicton with a clayey silt matrix ii) yellowish red disorganized pebbly gravel with Fe/Mn staining; iii) an organic bearing normal and reversely magnetized silt/clay (Fig. 8b,c).	Inter-Glaciation (D)
3	Nansen Till	Yellowish brown, massive, over-consolidated, matrix-supported, diamicton with ~20% clasts and a clay silt matrix (Fig. 7). Clasts are commonly decomposed, striated and/or exotic. Clast fabrics indicate a shift in ice flow direction from parallel to valley to orthogonal to valley which separates the two Nansen glacial phases (Landscape Evolution Phase B and C). Lower contact is sharp erosive and unit is laterally extensive.	Maximum Nansen Glaciation (C) Early Nansen Glaciation (B)
2	Pre-Glacial Gravel	Yellowish brown, weakly stratified, matrix/clast supported, poorly-consolidated gravel, with a ~50% clasts and a variably iron stained silty sand matrix (Fig. 6). The clasts are commonly decomposed and have variable but local lithologies. Within this unit a fine-grained magnetically reversed silty clay is also present (Fig. 8a). Lower contact is gradational and lateral extent is unknown.	Cenozoic Weathering (A)
1	Long Lake Suite	Buff coloured, variably weathered (highly fractured - completely decomposed), granitoid with some sulphide mineralization.	

Clast orientations were measured to reconstruct paleo-flow directions (Fig. 5). In diamictons only clasts with a greater than 2:1 length (A): width (B) were measured and utilized for trend analysis. Trend and plunge measurements were plotted using a Stereonet Program (version 9.3.3 by Dr. Allmendinger; website www.geo.cornell.edu/geology/faculty/RWA/programs.html). This technique is used to determine the direction of ice flow and the style of deposition (*cf*., Hicock *et al*., 1996). The A:B plane orientation was also measured in stratified gravel, to determine the approximate flow direction during deposition.

Paleomagnetic dating is very useful for late Pliocene-early Pleistocene glaciation (Duk-Rodkin *et al*., 1996), and several paleomagnetic samples collected from fine-grained units were analyzed by Dr. N. Roberts at the University of Lethbridge. The Earth's magnetic field can align magnetic minerals in sediment and rocks, recording polarity changes (Walker, 2005). Recognition of polarity changes can be used to assign ages to the sediment analyzed (Walker, 2005). Analysis first determined the bulk magnetic susceptibility, with a Sapphire Instruments Model SI-2B magnetic susceptibility and anisotropy meter. The natural remnant magnetism (NRM) was determined using an AGICO JR-6A spinner magnetometer and samples were incrementally demagnetized to determine their detrital remnant magnetism (DRM) acquired during deposition. Too few paleomagnetic samples were collected for a detailed determination of sediment age; however, analysis reveals the original polarity present during deposition which may indicate approximate ages.

Organic samples were collected for paleoenvironmental reconstructions and radiocarbon dating. Samples were sent to Alice Telka at Paleotec services for analysis. Organic material thought to be within the range of radiocarbon ages were dated while other samples were analyzed for macrofossil identification in an attempt to understand the environment at the time of deposition. Results from this analysis will be presented in a later publication.

Chemical characterization of gold grains is being completed from strategic placer-bearing facies in Back Creek. Sediment was sieved and panned to separate the heavy minerals and gold grains. The gold grains will be submitted for later laboratory analysis. At this time only the presence of placer gold grains in a unit are noted (Fig. 5).

RESULTS

Large exposures (>22 m) at Back Creek (Fig. 4) reveal a complex Quaternary history. During the 2015 field season twelve sections were analyzed at Back Creek, and these data were synthesized into an idealized stratigraphic column (Fig. 5) containing 12 units. The following is a brief synopsis of the stratigraphy and sedimentology present at Back Creek (Table 1 and Fig. 5).

The lowermost unit in the section is a variably weathered (minor jointing to highly decomposed) granite with sporadic sulphide mineralization (Unit 1). Based on previous mapping, Unit 1 is interpreted to be part of the Long Lake suite (Fig. 2) and is a potential source for gold mineralization in the drainage (Fig. 5 and Table 1).

Unit 2 is a matrix/clast-supported, poorly-consolidated gravel (Fig. 6). Unit 2 is less than 1 m thick with a gradational lower contact with Unit 1. This unit is locally exposed and lateral extent is unknown. The matrix is silty sand with variable iron staining and the colour is yellowish brown (10YR 5/6). There are ~50% clasts that are dominantly rounded to subrounded. The clasts are commonly decomposed and have variable, but local lithologies. The unit is crudely stratified in some exposures and a fine-grained clayey silt layer ~15 cm thick was sampled for paleomagnetic dating. Unit 2 contains placer gold, but due to the limited volume exposed it was not the main target for placer development.

Unit 3 is an over-consolidated, matrix-supported diamicton (Fig. 7). The lower contact is sharp and erosive with Units 1 or 2. Unit 3 is 5 to 10 m thick and laterally extensive across the valley bottom of Back Creek. The unit is thickest towards the valley margins and thinnest towards the valley center. The matrix is clayey-silt with minor sand, and yellowish brown (10YR 5/4) at the base and brown (7.5YR 5/4) at the top (7.5YR 5/4; brown). It contains 20-25% subrounded clasts that range from pebbles to boulders and many are striated or decomposed. Diverse clast lithologies are present in this diamict, including some not found within the Back Creek basin (sedimentary). Clast orientation changes upsection from parallel to orthogonal to the valley (Fig. 5). Based on the consolidation, extent, striated clasts, erosional lower contact, diverse clasts lithologies and fabric orientation, Unit 3 is interpreted as a regionally extensive glacial diamict. Since this represents the oldest known glaciation in the Mount Nansen area it is assigned to the Nansen glaciation.

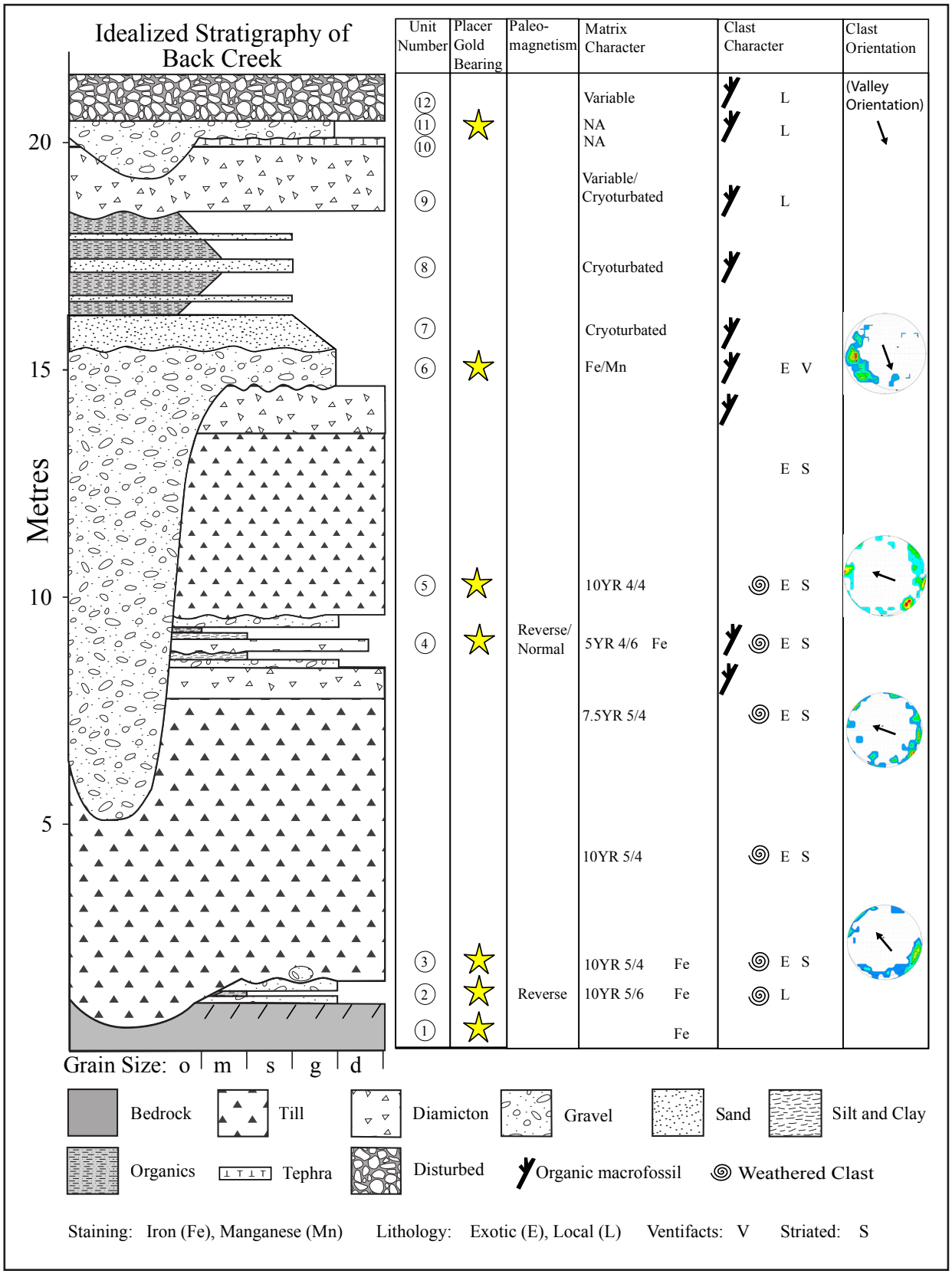


Figure 5. *Idealized stratigraphy of Back Creek. Each unit is numbered (1-12) and is further described in the results.*

Unit 4 is less than 2 m thick, laterally extensive and has a sharp, erosional lower contact. The materials and stratigraphic relationships of the sediment in Unit 4 are variable and include diamict, gravel, silt/clay and organic material (Fig. 8b,c). One sediment type is an over-consolidated, matrix-supported diamict with an erosional lower contact. The diamict has a clayey silt matrix, with 20-30% pebble-boulder sized, and subrounded to subangular clasts (Fig. 8c). Two clast-supported gravel beds are variably present in Unit 4 (Fig. 8b,c). The gravel has a silty sand matrix that is variably iron and manganese-stained. Clasts are greater than 55% pebble-cobble sized and subrounded to subangular. Furthermore, some of the clasts in the gravel are decomposed. Bedded silt/clay sediment is variably present in Unit 4 (Fig. 8b,c). Two sets of paleomagnetic samples were collected from this Unit 4 and normal (N) and reversely (R) magnetized sediment is present. Due to the small number of paleomagnetic samples collected and stratigraphic complexity it is unknown whether sediment records an N-R or an R-N-R sequence. There is an organic rich layer interstratified with silty clay. This layer was sampled for macrofossil analysis. Based on the presence of several sediment types, weathering representing potential paleosol processes and organics, Unit 4 is interpreted as inter-glacial sediment.

Unit 5 is an over-consolidated, matrix supported diamict. The lower contact is sharp and erosional. It is 3 to 6 m thick, and laterally extensive. The matrix is a clayey-silt with minor sand. It contains 15-20% subrounded clasts that range from pebbles to boulders, and have diverse lithologies. Striated and decomposed clasts are abundant, and several exotic lithologies are present. The clast fabric measured in this unit indicates ice flow orthogonal to the valley (Fig. 5). Based on the exotic lithologies, extent and striated clasts, Unit 5 is interpreted as a regionally extensive till. Since this represents the second oldest known glaciation in the Mount Nansen area, and it is beyond the Reid limit, it is assigned to the Klaza Glaciation.

Unit 6 is a poorly-consolidated, clast-supported gravel. The bottom contact is sharp and erosive, and this unit incises the pre-existing stratigraphy to Nansen till (Unit 3). Unit 6 is approximately 20 m wide and is presumed to



***Figure 6**. Pre-glacial gravel (Unit 2) exposed in lower Back Creek. Gravel is pervasively weathered and iron-stained. Clasts are variable in lithology but local in source.*



***Figure 7.** Nansen Till (Unit 3), containing striated and weathered clasts. Clasts can be quite large and several exotic clast lithologies are present indicative of regional glaciation.*



Figure 8. *Paleomagnetic sample locations. (a) Paleomagnetic samples of the pre-glacial gravel (Unit 2). Pervasive iron staining is visible in this photo. (b) Paleomagnetic samples of the interglacial sediment (Unit 4) right below an organic rich horizon. (c) Several inter-glacial sediments (Unit 4) and paleomagnetic sample locations are shown.*

extend down valley for some distance. The matrix is predominately sand with minor silt, and it is variably iron and manganese stained. It contains 60 to 70% subrounded to subangular clasts that range in size from boulder to pebble. Fabric measurements in Unit 6 indicate paleo-flow direction is approximately parallel to the modern creek valley (Fig. 5). This unit is the target of current placer mining and the gold character will be analyzed and presented in a later publication.

Unit 7 is a poorly-consolidated, with sub-horizontal bedded silty sand with minor organics. It is ~1 m thick and has a sharp erosive contact. This unit is not laterally extensive. Based on the sub-horizontal bedding, organics and sharp erosive lower contact Unit 7 is interpreted to be fluvial sand.

Unit 8 is matrix-supported, poorly-consolidated clay to fine sand colluviated organics. This unit is 2 to 3 m thick and laterally extensive. The unit has interstratified sand and it contains well-preserved macrofossils. Unit 8 contains several cryoturbation features (cryoturbated sediment and ice wedges) and the unit is predominately frozen. Based on the presence of organics and the interstratification of silt/clay, and sand Unit 8 is interpreted as a valley bottom floodplain deposit.

Unit 9 is a variably thick (1-4 m), matrix/clast-supported, moderately-consolidated diamicton. Unit 9 has an erosive lower contact and is laterally extensive. This unit contains organics and it has crude stratification. Based on these features it is interpreted to be a colluvium.

Unit 10 is a variably thick (5-50 cm), pale grey, silty sand, composed of tephra. This unit has a sharp non-erosive lower contact and it is laterally extensive. Based on the sediment location and previous work in the Mount Nansen area (LeBarge, 1995), Unit 10 is interpreted as the White River Tephra (WRT).

Unit 11 is a clast-supported, poorly-consolidated gravel. The gravel has a sharp erosive lower contact, and it is variably thick (0.5-2 m). The unit has a silty sand matrix with ~70% clasts. Clasts are cobble to pebble sized, and subrounded. The unit forms the base of the modern stream and this unit contains a minor amount of placer gold; however, it is not the current target of exploration. Based on these features, Unit 11 is interpreted as the modern/recent fluvial gravel.

Unit 12 includes all material that has been disturbed during mining. This includes a variety of sediment types such as diamictons or bedded silt and sand, depending on how the material was affected. Furthermore the thickness and lateral variability of this unit is highly variable.

LANDSCAPE EVOLUTION

By synthesizing the stratigraphy of Back Creek a seven phase landscape evolution model was created (Table 1 and Fig. 10). The following interpretations relate to the model, and explain the concentration mechanisms, preservation potential, and timing of placer gold development in relation to the landscape evolution of Back Creek.

CENOZOIC WEATHERING

The first phase of development was dominated by deep weathering and fluvial concentration of placer gold (Fig. 10a). The bedrock exposed at Back Creek is highly oxidized suggesting pervasive weathering occurred over a significant time period. The pre-glacial development of placer gold is theoretically the period of greatest gold accumulation in Back Creek due to long periods of weathering and tectonic stability. The presence of highly weathered bedrock (>2 m thick) suggests that it was sub-aerially exposed for a significant amount of time. Weathering is so intense that many of the feldspar grains have become pervasively stained and decomposed in the bedrock. Pre-glacial gold concentration developed as mineralized bedrock present at the surface, weathered, and incorporated in fluvial deposits of paleo-Back Creek.

The mineralized bedrock that supplied gold in Back Creek may be from several mineral occurrences (*eg.,* Willow Creek, Orloff-King and Dickson; *see* Fig. 2), and further analysis is required to determine its origin. Weathered bedrock is commonly in contact with, and incorporated into the Nansen till (Unit 3). Unit 2 (pre-glacial gravel) is only exposed in the deepest part of the valley and has a very limited lateral extent, likely related to variable paleo-bedrock topography. The valley bottom may have once had more extensive pre-glacial fluvial deposits; however, erosion during the first glaciation effectively removed most of these deposits.

NANSEN GLACIATION

The second phase of landscape evolution is during the Nansen glaciation (Fig. 10b,c). Reversely magnetized sediment sampled from overlying Unit 4 indicate the Nansen till is >780 ka, and normally magnetized sediment is interpreted to have formed during the Jaramillo (0.90-1.06 Ma) or Olduvai (1.78-2.00 Ma) subchron (Fig. 9). There are two phases during the Nansen glaciation, the advance phase (Fig 10b) and the maximum phase (Fig. 10c); these phases are based on changes in till characteristics and ice flow reconstruction from till fabric data. During the advance phase, ice flowed up-valley and likely produced a glacial lake (Fig. 10b). The ice was significantly erosive to incorporate highly weathered bedrock and pre-glacial gravel. The incorporation of oxidized bedrock produced a visible colour change from the base (10YR 5/4; yellowish brown) to the top (7.5YR 5/4; brown) of the Nansen till. As glaciation continued, ice thickened and flow became orthogonal to the valley unconstrained by underlying topography (Fig. 10c). During Nansen glacial maximum it is likely that large parts of the region were covered in ice. Both advance and maximum phases were likely significantly erosive depending on the topographic position. The glacial advance was parallel with the valley and therefore eroded the valley bottom, whereas at glacial maximum, ridge tops were likely eroded and the valley bottom remained protected.

INTER-GLACIATION

The next phase of landscape evolution occurred during a non-glacial or inter-glacial period (Fig. 10d). Unit 4 contains organic material, and a zone of weathering resembles a paleosol. These attributes suggest a period of stability following the Nansen glaciation. Two sets of paleomagnetic samples were collected from this unit

and normal and reversely magnetized sediment are present. The reversely magnetized sediment suggests a minimum age of deposition >780 ka, forming when the Earth's magnetic field last had a reversed polarity. Due to the number of samples collected and the complex stratigraphic relationships between samples, the exact age of the sediment remains unresolved (Fig. 9). It is likely however, that the paleomagnetic results record the Jaramillo or Olduvai subchron (Fig 9), due to suggested age (>1 Ma) of the overlying sediment from the Klaza glaciation (Jackson, 2000). The gravel from the inter-glacial unit has pervasive staining and several weathered clasts that represent fluvial activity over a significant period of time. This inter-glacial gravel may be another target for placer exploration, although its volume is limited particularly near the valley sides where it is exposed. It is possible this gravel sub-unit is larger towards the valley center; however, it was only seen in the left limit.

KLAZA GLACIATION

The Klaza glaciation (Fig. 10e) produced till with similar sedimentological characteristics to the Nansen till; however, clast orientations have a larger range in value that may be related to post-glacial disturbance or to the primary depositional environment. This unit is laterally extensive on the side of the valley, but placer excavation in the center of the valley effectively removed most of this unit. The preserved paleosol (Unit 4) below the Klaza till suggests that ice was largely non-erosive, which is encouraging for preserving inter-glacial placer gold deposits. The Klaza till is likely the 'false bedrock' that is pervasive throughout the Mount Nansen area and is known to have placer gold concentrated on it or in it.

PAY GRAVEL DEVELOPMENT

The next phase of landscape evolution (Fig. 10f) is the formation of post-glacial fluvial gravel. Fluvial incision following the Klaza glaciation eroded into the Nansen till, and potentially into the pre-glacial gravel. Currently, this gravel is the main placer gold target at Back Creek. Placer gold has four potential sources in the area i) bedrock; ii) till enriched with placer gold; iii) inter-glacial fluvial gravel; or iv) pre-glacial gravel. Additional studies into gold character may highlight the amount of reworked gold that is contributing to the placer deposit.

COVER DEVELOPMENT

The final phase of landscape evolution is the formation of cover (Fig. 10g). Hillslope colluviation, periglacial weathering and eolian processes were all dominant after glaciation. These processes produced thick cover (>5 m)

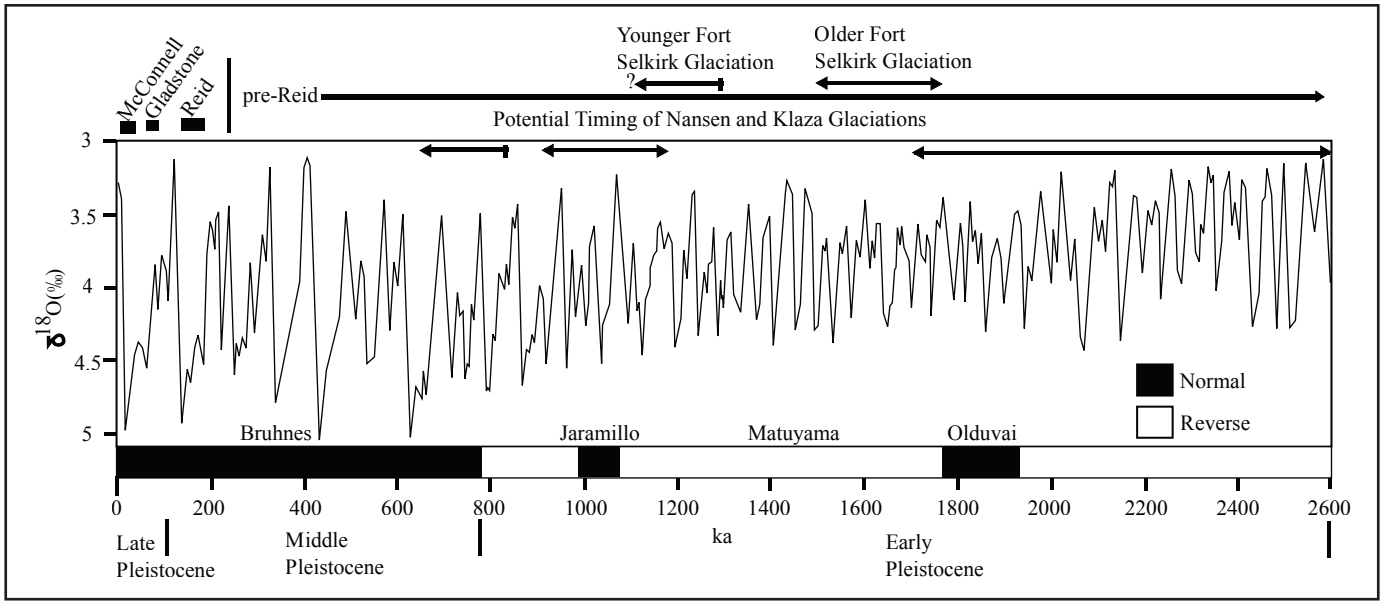


Figure 9. *Paleomagnetic timescale and the oxygen isotope ($\delta^{18}O$) curve modified from Lisieki and Raymo, 2005. The ($\delta^{18}O$) curve fluctuations indicate climate changes, where troughs denote glacial stages and the peaks are non-glacial. The timing of local glaciation is summarized for reference (after Nelson et al., 2009; Bond and Lipovsky, 2010), and the potential timing of the glaciation of Nansen and Klaza are highlighted*

with a variety of characteristics. The cover sediment is generally depositional in nature and therefore has not removed the underlying units. The presence of marker horizons such as the White River tephra (Unit 10) deposited ~1200 years ago (*cf.*, Clague *et al.,* 1995), indicate sediment has remained undisturbed since deposition. Most cover sediment contains little placer gold (Unit 11) and is not a placer mining target.

PLACER POTENTIAL

Two distinct tills are present at Back Creek and based on their extent, striated clasts, diverse clasts lithologies, and an intercalated paleosol, they are interpreted to represent Nansen and Klaza glaciation. This assignment is consistent with earlier glacial stratigraphy work in the region (Bostock, 1966; LeBarge, 1995). Nansen and Klaza glaciation has significantly impacted placer gold deposits in Back Creek. To understand the evolution of placer gold deposits at Back Creek, concentration mechanisms, preservation potential and a timing of placer gold deposits were synthesized into a model (Fig. 10) which highlighted three main placer gold targets (pre-glacial, inter-glacial, and post-glacial fluvial sediment). The influences of the Nansen and Klaza glaciation on these deposits are examined below.

PRE-GLACIAL DEPOSITS

Pre-glacial placer deposits should contain the highest gold concentrations because these deposits formed over a sustained period during the Paleogene and Neogene when climate was warmer, resulting in significant weathering of mineralized bedrock and fluvial concentration of gold (Ager *et al*., 1994; Anderson and Stroshein, 1997; Dampier *et al*., 2011; Foscolos *et al.,* 1977; Jackson, 2000; LeBarge, 1995). Channel avulsion may have resulted in laterally extensive pre-glacial placer deposits across Back Creek valley. Significant erosion likely occurred during the Nansen glaciation because Nansen till is in direct contact with bedrock near the valley side and incorporates weathered bedrock. Therefore, extensive removal of pre-glacial placer deposits likely occurred during this glaciation. Variable bedrock topography would decrease the efficiency of glacial erosion and this may preserve placer gold deposits. In Back Creek, gold-bearing pre-glacial placer deposits are most likely preserved in valleys oriented at a high angle to ice flow and where local bedrock topographic features like paleo-canyons or bedrock highs provide protection from glacial erosion. For exploration, preserved pre-glacial placer gold deposits could be anticipated by identifying areas of undulatory bedrock (canyons or ledges) using geophysics. Highlighting these areas might increase the chance of successfully drilling into a pre-glacial gravel. The discontinuous nature of these pre-glacial placer deposits in valleys aligned with regional ice flow makes them a challenging exploration target.

INTER-GLACIAL DEPOSITS

Inter-glacial gold deposits are another target for placer gold exploration. In these deposits gold must be sourced from either mineralized bedrock or from the Nansen till. LeBarge (1995), found that till may contain large quantities of gold grains, so the Nansen till could be a significant source of placer gold. In addition the Nansen till provides a false-bedrock for placer gold deposits to accumulate on. The Klaza glaciation did not result in significant erosion of these inter-glacial placer gold deposits. The deposits may be extensive and represent a favorable exploration target due to their shallow depth relative to pre-glacial deposits. Drilling and geophysical surveys could be employed to identify these inter-glacial targets within the Mount Nansen area.

POST-GLACIAL DEPOSITS

Post-glacial placer gold deposits have historically been the primary exploration targets in the Mount Nansen area, and they are most continuous deposits present in Back Creek. Gold in the post-glacial deposits may be sourced from (i) bedrock; (ii) till enriched with placer gold; (iii) inter-glacial fluvial gravel; or (iv) pre-glacial gravel. The gold abundance in post-glacial deposits may reflect various sources. Significant increase in gold abundance likely reflects intersection of underlying placer gold deposits, and should warrant detailed study to determine if intersected deposit is an extensive target. Sand, organics, colluvium, tephra, gravel, and anthropogenic deposits cover the post-glacial placer gold deposits. The thickness of this overlying material dictates the economic viability of mining post-glacial placer deposits.

DISCUSSION

This research shows that the early Pleistocene Nansen and Klaza glaciation had a significant impact on placer gold concentration in Back Creek. Three placer gold targets exist in the Back Creek area including the pre, inter and post-glacial deposits. Although historical exploration

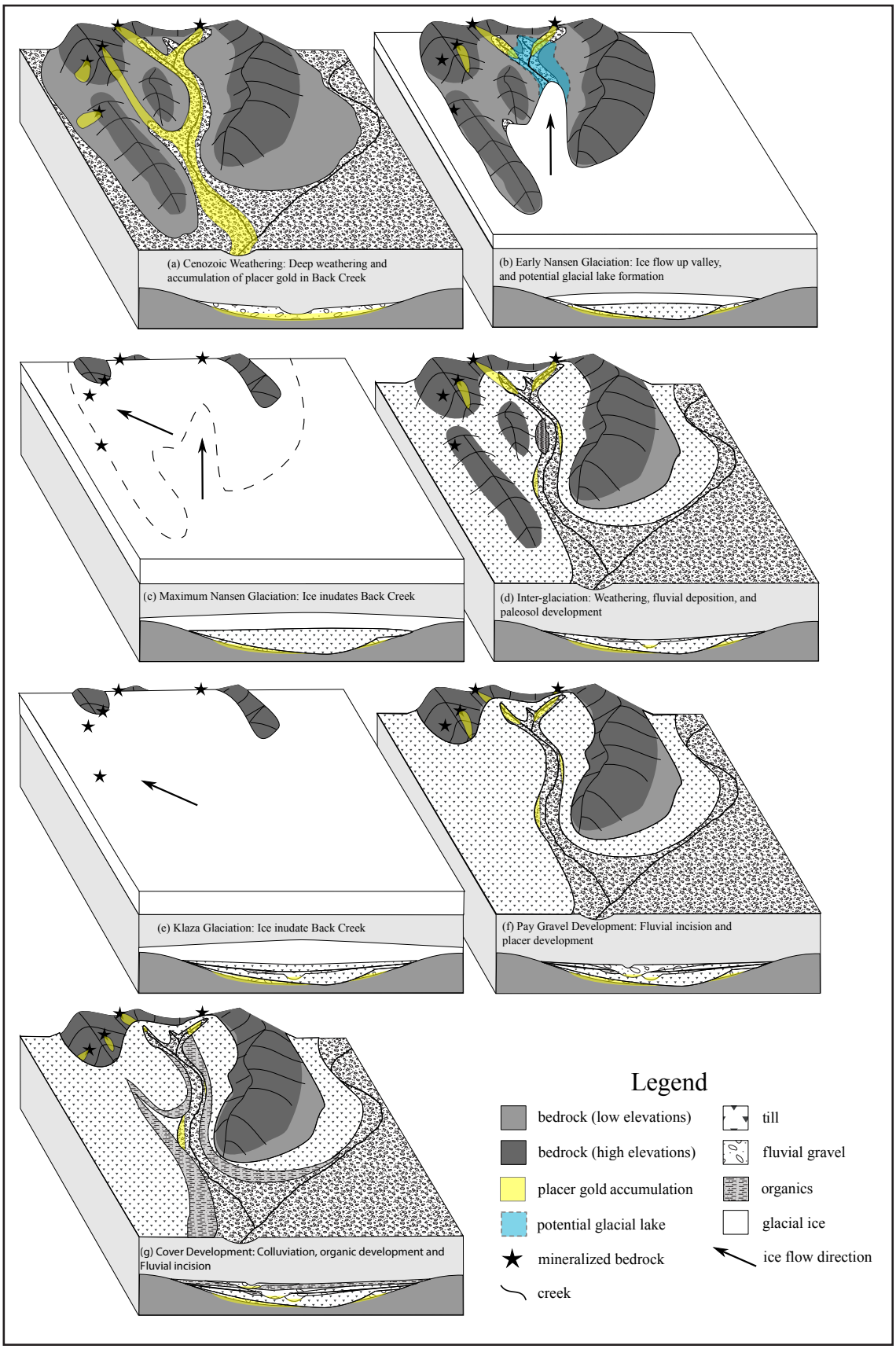


Figure 10.
The landscape evolution of Back Creek is described in these 7 block diagrams. This model illustrates both the spatial and stratigraphic distribution of placer gold from pre-glacial to modern time.

has focused on the post-glacial deposits, it is likely that lucrative pre-glacial and inter-glacial deposits exist at depth where glacial erosion was minimal. The landscape evolution model presented here is for Back Creek (Fig. 10); however, could be applied to other placer gold exploration targets in the Mount Nansen district and in early Pleistocene glaciated fringe of Yukon (Fig. 1).

CONCLUSION

Early Pleistocene glaciation had a significant effect on placer gold deposits in Back Creek. Two phases of glaciation are present and were separated by a period of weathering and pedogenesis. These two glacial events likely represent the Nansen and Klaza and are interpreted to have occurred before the Jaramillo or Olduvai subchron based on paleomagnetic results. The Nansen glaciation destroyed much of the earliest placer gold deposits leaving little evidence of pre-glacial gravels, only where bedrock topography permitted preservation. The Nansen glaciation was pervasive in the landscape and till fabrics recorded ice thickening and changing directions. Between periods of glaciation, a long period of pedogenesis occurred and inter-glacial placer gold deposits formed. The Klaza glaciation did not result in significant erosion of these inter-glacial placer gold deposits, and they may represent an important target for placer exploration. Post-glacial fluvial gravels are the main target for placer gold mining in Back Creek and variable gold abundance is likely related to incision of previous concentrations of placer gold. The thickness of sediment covering the post, inter or pre-glacial placer gold deposits has a significant impact on the economics of the deposit and should be considered during exploration. In conclusion, analysis at Back Creek reveals the potential for deeply buried placer gold deposits in other glaciated regions of Yukon.

ACKNOWLEDGEMENTS

First, I would like to thank the Canadian Northern Economic Development Agency for graciously providing the funding for this project. I would like to thank Ross Agnosti for access to the section and insightful information. I appreciate the Yukon Geological Survey for providing funding, training and guidance. I would also like to thank the Geological Survey of Canada, specifically Jim Ryan, for logistical support and guidance. I would also like to thank Nick Roberts for processing the paleomagnetic samples, and providing insight into Early Pleistocene glaciation. Furthermore, this research would not be possible without the countless hours of help from Mark Coleman and Kyle Orr. Further thanks go to Alice Telka for analysis of the macrofossil analysis and radio carbon dating. Finally, I want to thank my esteemed colleges Anna Haiblen and Gioachino Roberti who helped review my work and provided feedback on several ideas.

REFERENCES

Ager, T.A., Matthews, J.V. and Yeend, W., 1999. Pliocene terrace gravels of the ancestral Yukon River near Circle, Alaska: Palynology, paleobotany, paleoenvironmental reconstruction and regional correlation. Quaternary International, vol. 22/23, p. 185-206.

Anderson, F. and Stroshein, R., 1997. Geology of the gold-silver vein system, Mount Nansen area, Yukon. *In*: Yukon Exploration and Geology 1997, C.F. Roots and D.S. Emond (eds.), Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, p. 129-143.

Barendregt, R.W., Enkin, R.J., Duk-Rodkin, A. and Baker, J., 2010. Paleomagnetic evidence for multiple late Cenozoic glaciations in the Tintina Trench, west-central Yukon, Canada. Canadian Journal of Earth Science, vol. 47, p. 987-1002.

Bond, J.D., Lipovsky, P.S., and Gaza, P., 2007. Surficial geology investigations in Wellesley basin and Nisling Range, southwestern Yukon. In: Yukon Exploration and Geology 2007, D.S. Emond, L.L. Lewis and G.D. Bradshaw (eds.), Yukon Geological Survey, p. 125-138.

Bostock, H.S., 1936. Carmacks District, Yukon. Geological Survey of Canada, Memoir 189.

Bostock, H.S., 1966. Notes on glaciation in central Yukon Territory. Geological Survey of Canada, Paper 65-36, p. 18.

Burn, C.R., 1994. Permafrost, tectonics, and past and future regional climate change, Yukon and adjacent Northwest Territories. Canadian Journal of Earth Science, vol. 33, p. 182-191.

Cairnes, D.D., 1915. Summary Report 1914, Part A. Geological Survey of Canada, Memoir 284, p. 25-30.

Clague, J.J., Evans, S.G., Rampton, V.N. and Woodsworth, G.J., 1995. Improved age estimates for the White River and Bridge River tephras, western Canada. Canadian Journal of Earth Science, vol. 32, p. 1172-1179.

Colpron, M., Nelson, J.L. and Murphy, D.C., 2007. Northern Cordilleran terranes and their interactions through time. GSA Today, vol. 17, p. 4-10.

Coney, P.J., Jones, D.L. and Monger, J.W.H., 1980. Cordilleran suspect terranes. Nature, vol. 288, p. 329-333.

Dawson, G.M., 1889. Report on an exploration in the Yukon District, N.W.T. and adjacent northern portion of British Columbia, 1887. Geological Survey of Canada, Annual Report, 1887-88.

Dampier, L., Sanborn, P., Smith, S., Bond, J. and Clague, J.J., 2011. Genesis of upland soils, Lewes Plateau, central Yukon. Part 2: Soils formed in weathered granitic bedrock. Canadian Journal of Soil Science, vol. 91, p. 579-594.

Demuro, M., Froese, D.G., Arnold, L.J. and Roberts, R.G., 2012. Single-grain OSL dating of glaciofluvial quartz constrains Reid glaciation in NW Canada to MIS 6. Quaternary Research, vol. 77, p. 305-316.

Duk-Rodkin, A., 1999. Glacial limits map of Yukon Territory. Geological Survey of Canada, Open File 3694, Indian and Northern Affairs Canada Geoscience Map 1999-2, scale 1:1 000 000.

Duk-Rodkin, A., Barendregt, R.W., Froese, D.G., Weber, F., Enkin, R., Smith, I.R., Zazula, G.D., Waters, P. and Klassen, R., 2004. Timing and extent of Plio-Pleistocene glaciations in north-western Canada and east-central Alaska. Quaternary Glaciations-Extent and Chronology, Part II, p. 313-342.

Duk-Rodkin, A., Barendregt, R.W., Tarnocai, C., and Phillips, F.M., 1996. Late Tertiary to late Quaternary record in the Mackenzie Mountains, Northwest Territories, Canada: stratigraphy, paleosols, paleomagnetism, and chlorine-36. Canadian Journal of Earth Science, vol. 33, p. 875-895.

Duk-Rodkin, A., Barendregt, R.W., White, J.M. and Singhroy, V.H., 2001. Geologic evolution of the Yukon River: implications for placer gold. Quaternary International, vol. 82, p. 5-31.

Els, G. and Eriksson, P., 2005. Placer formation and placer minerals. Ore Geology Review, vol. 28, p. 373-375.

Foscolos, A.E., Rutter, N.W. and Hughes, O.L., 1977. The use of pedological studies in interpreting the Quaternary history of central Yukon Territory, Geological Survey of Canada, Bulletin 271.

Geurts, M. and Dewez, V., 1993. Le lac glaciaire Nisling et le Pleistocene dans le basin superieur de la Nisling River, au Yukon. Geographie physique et Quaternaire, vol. 47, no. 1, p. 81-92.

Guthrie, R.D., 2001. Origin and causes of the mammoth steppe: a story of cloud cover, wolly mammal tooth pits, buckles and inside-out Beringia. Quaternary Science Reviews, vol. 20, p. 549-574.

Goldfarb, Y.I., Petrov, A.N., Preis, V.K. and Skurida, D.A., 2015. Geological prerequisites for differentiated approach to prospecting and exploration of alluvial gold placers: an example from the northeast of Russia. Russian Journal of Pacific Geology, vol. 9, p. 166-177.

Harris, S.A., 2005. Thermal history of the Arctic Ocean environs adjacent to North America during the last 3.5 Ma and a possible mechanism for the cause of the cold events (major glaciations and permafrost events). Progress in Physical Geography, vol. 29, p. 218-237.

Hart, C.J.R. and Langdon, M., 1998. Geology and mineral deposits of the Mount Nansen camp, Yukon. *In:* Yukon Geology and Exploration 1997, Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, p. 129-138.

Haug, G.H., Ganopolski, A., Sigman, D.M., Rosell-Mele, A., Swann, G.E.A., Tiedemann, R., Jaccard, S.L., Bollmann, J., Maslin, M.A., Leng, M.J. and Eglinton, G., 2005. North Pacific seasonality and the glaciation of North America 2.7 million years ago. Nature, vol. 433, p. 821-825.

Herail, G., Fornari, M., Viscarra, G., Laubacher, G., Argollo, J. and Miranda, V., 1989. Geodynamic and Gold Distribution in the Tipuani-Mapiri Basin (Bolivia). International Symposium on Intermontane Basins: Geology and Resources, p. 342-352.

Hidy, A.J., Gosse, J.C., Froese, D.G., Bond, J.D. and Rood, D.H., 2013. A latest Pliocene age for the earliest and most extensive Cordilleran Ice Sheet in northwestern Canada. Quaternary Science Reviews, vol. 61, p. 77-84.

Hicock, S.R., Goff, J.R., Lian, O.B. and Little, E.C., 1996. On the Interpretation of Subglacial Till Fabric. Journal of Sedimentary Research, vol. 66, p. 928-934.

Hughes, O.L., Campbell, R.B., Muller, J.E. and Wheeler, J.O., 1969. Glacial limits and flow patterns, Yukon Territory, South of 65 Degrees North Latitude. Geological Survey of Canada, Paper 68-34, p. 1-9.

Jackson, L.E. Jr., 1993. Origin and stratigraphy of Pleistocene gravels in Dawson Range and suggestions for future exploration of gold placers, southwestern Carmacks map area, Yukon Territory. Current Research, part A; Geological Survey of Canada, paper 93-1A, p. 1-10.

Jackson, L.E. Jr., 2000. Quaternary geology of the Carmacks map area, Yukon Territory. Geological Survey of Canada, Bulletin 539, p. 1-74.

Jackson, L.E. Jr. and Clague, J.J., 1991. The Cordilleran Ice Sheet: one hundred and fifty years of exploration and discovery. Geographie physique et Quaternaire, vol. 45, p. 269-280.

Jackson, L.E. Jr., Tarnocai, C. and Mott, R, J., 1999. A middle Pleistocene paleosols sequence from Dawson Range, Central Yukon Territory. Geographie physique et Quaternaire, vol. 53, p. 313-322.

Johnston, S.T., Mortenson, J.K. and Erdmer, P., 1996. Igneous and metaigneous age constraints for the Aishihik metamorphic suite, southwest Yukon. Canadian Journal of Earth Sciences, vol. 33, p. 1543-1555.

Knight, J.B., Morison, S.R. and Mortensen, J.K., 1999. The relationship between placer gold particle shape, rimming, and distance of fluvial transport as exemplified by gold from the Klondike district, Yukon Territory, Canada. Economic Geology, vol. 94, p. 635-648.

Knight E., Schneider, D.A. and Ryan, J., 2013. Thermochronology of the Yukon-Tanana Terrane, west-central Yukon: Evidence for Jurassic extension and exhumation in the northern Canadian Cordillera. The Journal of Geology, vol. 121, p. 371-400.

LeBarge, W.P., 1995. Sedimentology of Placer Gravels near Mt. Nansen, Central Yukon Territory, Bulletin 4, Exploration and Geological Services Division, Indian and Northern Affairs Canada, Yukon Region, p. 155.

Levson, V.M. and Blyth, H., 2001. Formation and preservation of a Tertiary to Pleistocene fluvial gold placer in northwest British Columbia. Quaternary International, vol. 82, p. 33-50.

Lisiecki, L.E. and Raymo, M.E., 2005. A Pliocene-Pleistocene stack of 57 globally distributed benthic $\delta 18O$ records. Paleoceanography, vol. 20, PA 1003.

Loen, J.S., 1994. Origin of placer gold nuggets and history of formation of glacial gold placers, Gold Creek, Granite County, Montana. Economic Geology, vol. 89, p. 91-104.

Lowey, G.W., 2006. The origin and evolution of the Klondike goldfields, Yukon, Canada. Ore Geology Reviews, vol. 28, p. 431-450.

Monger, J.W.H., Souther, J.G. and Gabrielse, H., 1972. Evolution of the Canadian Cordillera: a plate-tectonic model. American Journal of Science, vol. 272, p. 577–602.

Mortensen, J.K., Appel, V.L. and Hart, C.J.R., 2002. Geological and U-Pb age constraints on base and precious metal vein systems in the Mount Nansen area, eastern Dawson Range, Yukon. *In:* Yukon Exploration and Geology 2002, D.S. Emond and L.L. Lewis (eds.), Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, p. 165-174.

Naeser, N.D., Westgate, J.A., Hughes, O.L. and Pewe, T.L., 1982. Fisson-track ages of late Cenozoic distal tephra beds in the Yukon Territory and Alaska. Canadian Journal of Earth Sciences, vol. 19, p. 2167-2178.

Nelson, F.E., Barendregt, R.W. and Villeneuve, M., 2009. Stratigraphy of the Fort Selkirk Volcanogenic Complex in central Yukon and its paleoclimatic significance: Ar/Ar and paleomagnetic data. Canadian Journal of Earth Science, vol. 46, p. 381-401.

Saager, R. and Bianconi, F., 1971. The Mount Nansen gold-silver deposit, Yukon Territory, Canada. Mineralium Deposita, vol. 6, p. 209-224.

Selby, D., Creaser, R.A. and Nesbitt, B.E., 1999. Major and trace element compositions and Sr-Nd-Pb systematics of crystalline rocks from the Dawson Range, Yukon, Canada. Canadian Journal of Earth Science, vol. 36, p. 1463-1481.

Tempelman-Kluit, D.J., 1984. Geology of the Laberge (105E) and Carmacks (115I) map areas. Geological Survey of Canada, Open File 1101, maps with legends, 1:250 000 scale.

Ward, B.C., Bond, J.D., Froese, D. and Jensen, B., 2008. Old Crow tephra (140±10 ka) constrains penultimate Reid glaciation in central Yukon Territory. Quaternary Science Reviews, vol. 27, p. 1909-1915.

Walker, M., 2005. Quaternary Dating Methods. John Wiley and Sons Ltd. London. p. 1-286.

Ward, B.C., Bond, J.D., Froese, D., Jensen, B., (2008). Old Crow tephra (140±10 ka) constrains penultimate Reid glaciation in central Yukon Territory. Quaternary Science Reviews 27, 1909-1915.

Ward, B.C., Bond, J.D. and Gosse, J.C., 2007. Evidence for a 55-50 ka (early Wisconsin) glaciation of the Cordilleran Ice Sheet, Yukon Territory, Canada. Quaternary Research, vol. 68, p. 141-150.

Wengzynowski, W.A., Giroux, G.H., and Martin, C.J., 2015. Geology mineralization, geochemical surveys, geophysical surveys, diamond and percussion drilling, metallurgical testing and mineral resources on the Klaza property Yukon, Canada. NI43-101 technical report. <http://www.rockhavenresources.com/projects/klaza-project> [accessed November 20, 2015].

Westgate, J.A., Preece, S.J., Froese, D.G., Walter, R.C., Sandhu, A.S. and Schweger, 2000. Dating early and middle (Reid) Pleistocene glaciations in central Yukon by tephrochronology. Quaternary Research, vol. 56, p. 335-348.


HAYWORTH
SALES SERVICE
PARTS & RENTALS


RAM
3500
HEAVY DUTY


Bonnyville
CHRYSLER • JEEP










PC400LC


PC400LC
ARCTIC CAT


ARCTIC CAT


OBILE
DRILL®




ARCTIC CAT








The Klondike
RGH41
Yukon

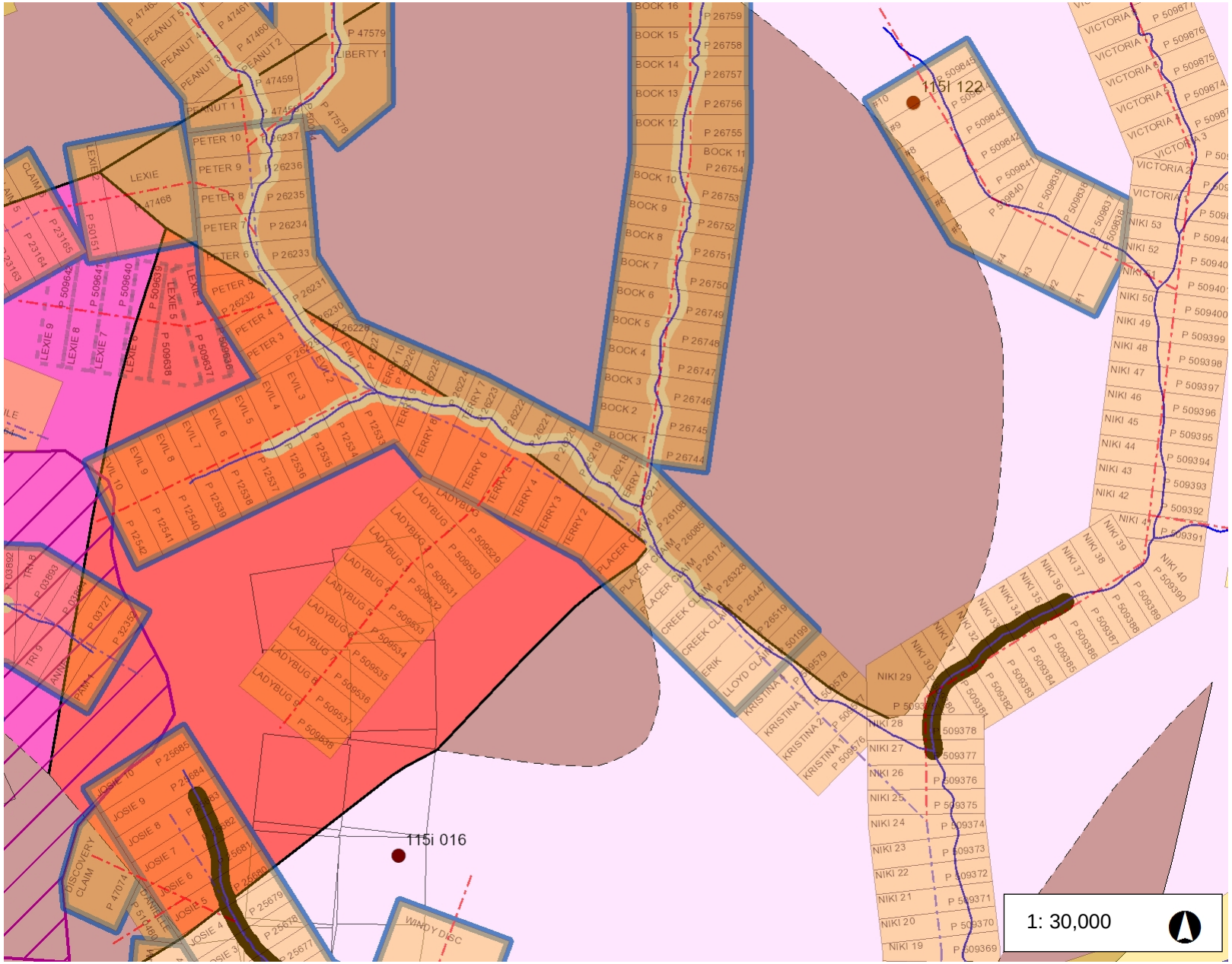

EXCEL
KING SIZE 25
DUTY PAID
CANADA
DROIT ACQUITTÉ





Yukon
Energy, Mines and Resources

2016 Victoria Creek Deep Placer Testing





Legend

- New Placer Claims
- Placer Baselines (unsurveyed)
- Placer Baselines (surveyed)
- Placer Claims (50K)
  - Active and Pending
  - Expired
- Prospecting Leases
  - Active and Pending
  - Expired
- Adjoin Placer
- Placer Mining Land Use Permi
  - Class 3
  - Class 4
- Coal Exploration License
  - Active and Pending
  - Expired
- Coal Mining Lease
  - Active and Pending
  - Expired
- Surveyed Mineral Claims
- Current Class 1 Notifications
  - Valid
  - In Review
  - Pending
  - Cancelled
  - Expired
  - Rejected

Notes

Bedrock overlaid on placer map.

1.5 0 0.76 1.5 Kilometers

Yukon Albers

Produced from: Yukon Mining Viewer

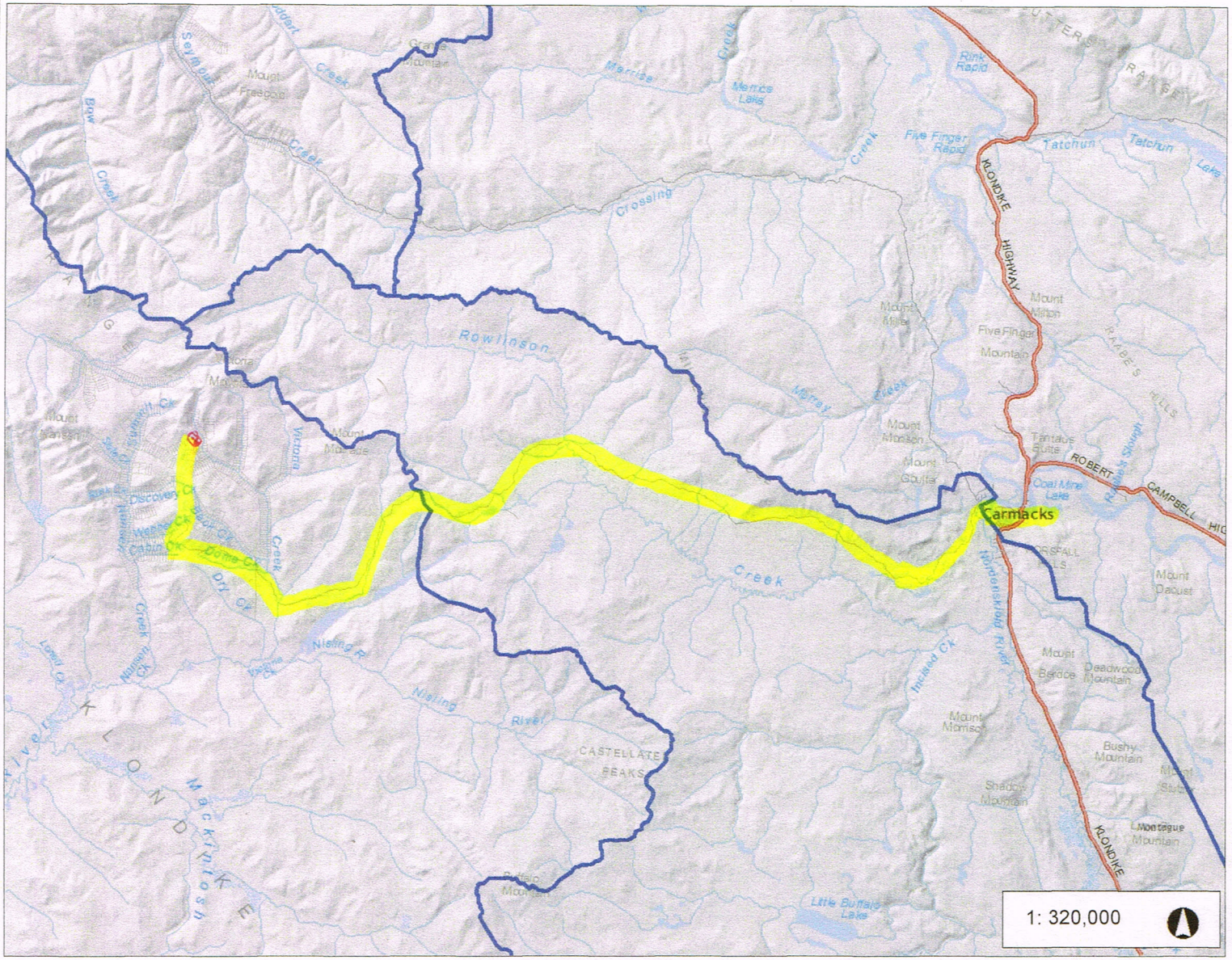
This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

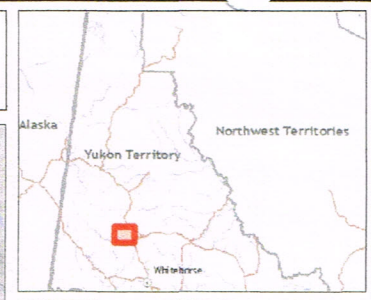
Date Printed: 13-Mar-2016

YUKON PLACER SECRETARIAT

Mt. Nansen Access Road

Yukon
Energy, Mines and Resources





Legend

- Placer Watershed Boundaries
- Placer Claims (50K)
  - Active and Pending
  - Expired

1: 320,000

16.3 0 8.13 16.3 Kilometers

NAD_1983_Yukon_Albers
Produced from: Yukon Placer Watershed Atlas Date Printed: 06-Jan-2013

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION. The habitat suitability classifications presented here only apply to licenced placer mining operations, and ARE NOT RELEVANT TO ANY OTHER ACTIVITY in or near watercourses.

Notes

60 km access road from Carmacks to Mt Nansen mining region. Additional 15 km all weather road to Victoria creek mine site.

TABLE 2 - LEGEND

Mt. Nansen area - Creeks and Roads

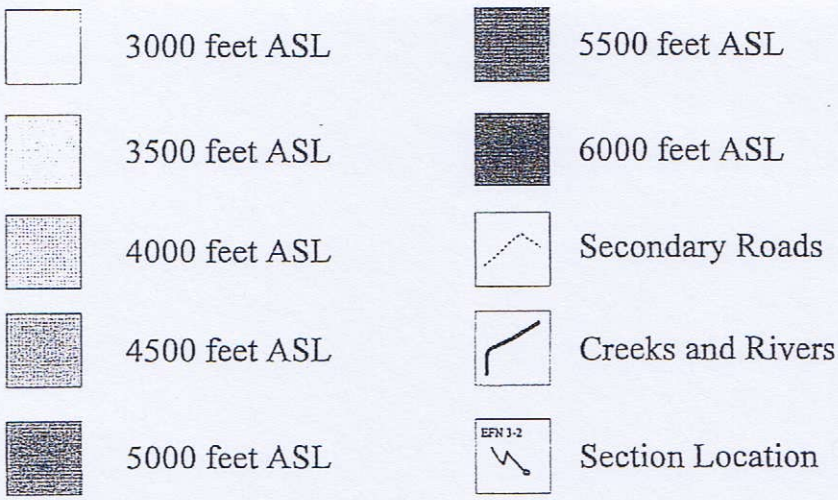




Figure 2 - Mt. Nansen Field Area - Creeks and Roads

Surficial Geology and Paleogeography

Introduction

Using airphoto interpretation and fieldwork, the surficial geology of the Nansen and Victoria creek areas was mapped at 1:50 000 scale. Figure 48 is a 1:100 000 scale map showing the main surficial features of the study area, while Figure 49 is a view of the surficial features of the northern tributaries of Nansen Creek. Table 19 is the legend for the surficial maps.

Discussion

Bedrock

Bedrock is exposed on most ridges at elevations of 4500 feet and above. In addition, scattered tors occur at lower elevations, mainly near an elevation of 4000 feet.

Recent deposits

Recent bar and channel deposits of stream gravels, low fluvial terraces and alluvial fans occur proximal to present stream courses in all drainages.

Colluvial veneer

Colluvium is ubiquitous in the field area, occupying the slopes between bedrock exposures and valley-side and valley-floor alluvial deposits. Older deposits of glaciofluvial gravels and till are overlain by colluvium on the East Fork and on Discovery Creek.

Reid and older deposits

Several levels of alluvial terraces occur along Nansen and Victoria creeks and their major tributaries.

Table 19
Legend for Surficial Geology Maps

Recent

Recent alluvium - recent alluvial fans, recent fluvial bar and channel deposits,adjacent terraces

Colluvial veneer - includes scattered occurrences of resedimented till and reworked glaciofluvial sediments

Pre-Reid

Kame terraces - north facing valley side, East Fork

Bedrock

Includes tors, felsenmeer

Reid

Alluvial terraces - includes at least three terrace levels

Secondary features

Glaciofluvial channels

Roads

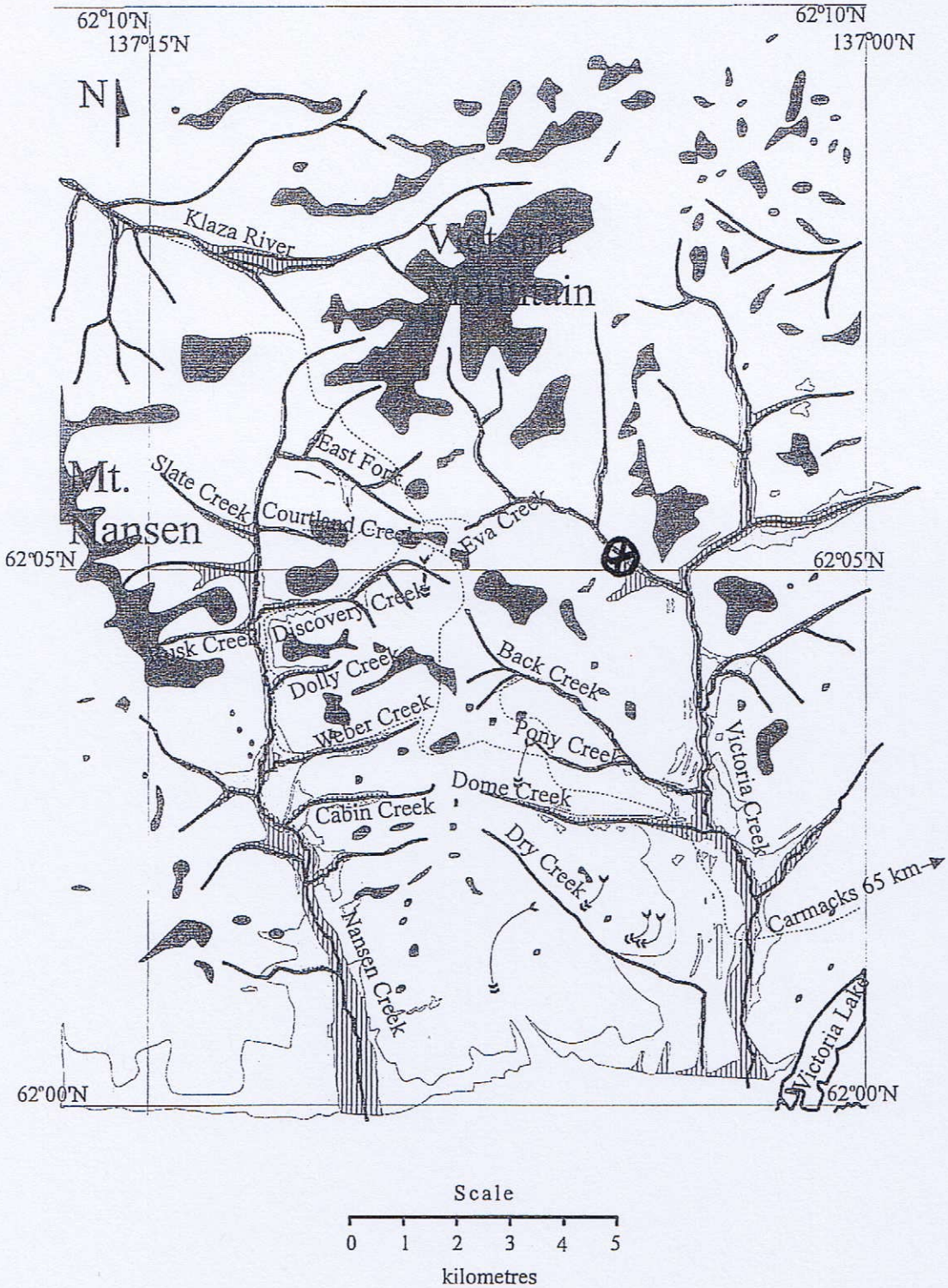


Figure 48 - Surficial Geology - Mt. Nansen Field Area

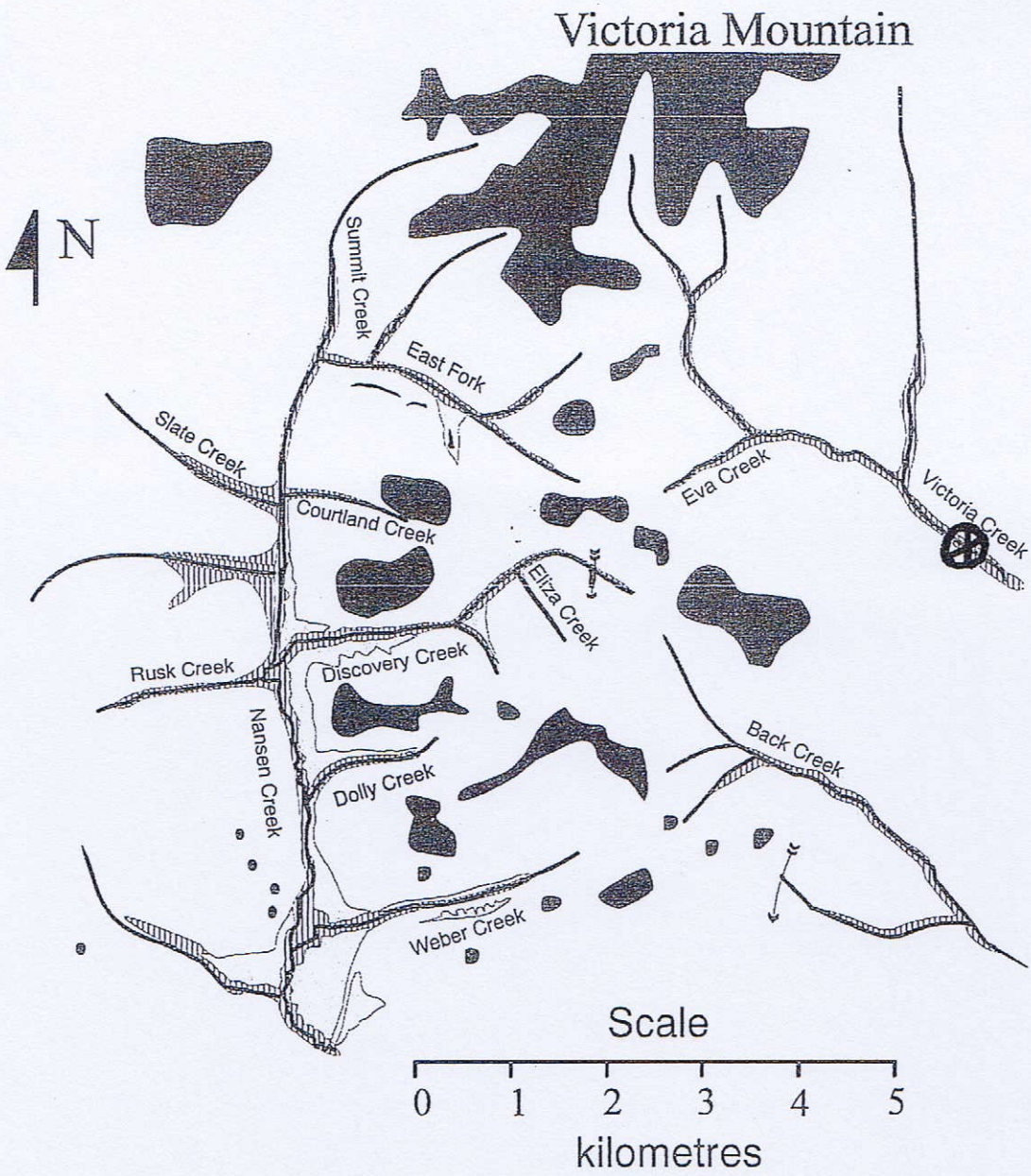


Figure 49 - Surficial Geology - Nansen Creek

Three major levels of terraces occupy the valley of Victoria Creek as far upstream as Back Creek, and along the valley of Nansen Creek as far north as Weber Creek. These generally range in elevation from 3100 to 3500 feet.

A second set of terraces occurs along major tributaries such as the northernmost and the next-to-northernmost left-limit tributaries of Victoria Creek, Victoria Creek tributary Dome Creek, and Nansen Creek tributaries Cabin, Weber, Dolly and Discovery creeks.

These terraces dominate the southern (north-facing) slopes of these tributary valleys, and have a fan-like morphology. They generally range in elevation from 3700 to 4000 feet.

Pre-Reid deposits

Kame terraces of pre-Reid glaciofluvial gravel occur along the southern (north-facing) valley wall of the East Fork of Nansen Creek, at an elevation of approximately 4200 feet. In addition, an ice-marginal channel of glaciofluvial gravel cuts bedrock at the 4270 foot elevation on Discovery Creek.

Scattered occurrences of pre-Reid till are mixed with colluvium on the south-facing slope of Discovery Creek , in occasional pockets on the north-facing slope of Discovery Creek (where it is sometimes overlain by thin glaciofluvial gravels), and on the upper reaches of Back Creek.

Facies Distribution

Facies 1

Facies 1, organic material, is present throughout the field area, mainly concentrated on valley slopes and valley bottoms. Except in areas of exposed bedrock or scattered active aeolian deposits, organic material occupies the present topographic surface. Thick deposits often occur with permafrost on the southern (north-facing) sides of valleys.

Facies 2

Facies 2, tephra, occurs on most valley slopes and in valley bottoms, where it is often thickened through reworking by fluvial and aeolian processes. Tephra occurs mainly within a few centimetres of the present topographic surface, mainly overlain by organic material.

Facies 3

Facies 3, diamicton, occurs scattered on valley slopes (where it is overlain by and mixed with colluvium) and deep within major valleys, where it is overlain by several metres of younger sediment.

Facies 4

Facies 4, massive and stratified silt and clay, occurs adjacent to present stream courses, on low fluvial terraces and in ponds and abandoned channels.

Facies 5

Facies 5, massive sand, occurs throughout the field area, however it is most often associated with proximal to medial alluvial fans which occur as terraces along major valleys and their tributaries.

Facies 6

Facies 6, stratified sand, occurs throughout the field area, but is most often associated with fluvial terraces and the distal portions of alluvial fans.

Facies 7

Facies 7, disorganized muddy gravel, occurs on valley slopes throughout the field area, where it is associated with the proximal regions of alluvial fans.

Facies 8

Facies 8, massive and stratified sandy gravel, occurs throughout the field area, however it is mainly associated with medial to distal portions of periglacial alluvial fans.

Facies 9

Facies 9, disorganized gravel, is associated with glaciofluvial terraces, medial periglacial alluvial fans and fluvial stream (gulch) gravels adjacent to present stream courses.

Facies 10

Facies 10, massive to crudely stratified gravel, occurs throughout the field area, in fluvial stream sediments, on fluvial terraces, as well as the medial to distal portions of alluvial fans, glaciofluvial terraces and channels, and periglacial alluvial fans and valley fills.

Valley Profile

Introduction

Figure 50 is a schematic valley profile of Nansen and Victoria Creeks. This profile was compiled from combined data including surficial geology, observed field relationships and facies data from measured sections. Vertical elevations are approximate, and no horizontal scale is implied.

Discussion

As the valley profile shows, a variety of facies associations and stratigraphic relationships occur in the valleys of Nansen and Victoria Creek and their major tributaries. A till interpreted to be deposited by the older of at least two pre-Reid glaciations is preserved only in patches and hummocks on the major valley floors. A younger pre-Reid till occurs intermittently along major valley walls and tributary valley walls where it is overlain by a variety of alluvial and colluvial deposits. Pre-Reid glaciofluvial gravels occupy terraces and cut bedrock on north-facing (southern) valley walls.

Two sets of alluvial terraces occur; 1) remnant tributary valley alluvial terraces, which occupy the (mainly southern) valley walls of major tributaries, and 2) remnant main valley alluvial terraces, which occupy the valleys of Victoria and Nansen creeks, where at least three levels can be discerned.

Along major tributary valleys, colluvium and recent alluvial fans overlie older glacial and glaciofluvial deposits. Recent gulch gravels have dissected and reworked older glacial, glaciofluvial and alluvial deposits.

Paleogeographic History

Introduction

Figures 51to 61 show the interpreted palegeographic history of the field area. These are based on field relationships, surficial geology and facies distribution data from measured sections.

Table 20 is the legend for the paleogeographic maps.

Discussion

Prior to the onset of periodic Pleistocene glaciations, a long period of humid tropical weathering occurred in the Tertiary. This left a thick mantle of highly-weathered and eroded bedrock (Figure 51).

The first of a minimum of two pre-Reid ice advances occurred at least 1 Ma B.P. (Hughes, 1987). This ice advance left only limited evidence, such as ice-marginal scours in bedrock along Mt. Nansen, and patchy occurrences of till along the valley floor of Nansen Creek. Only the highest points (above approximately 4500 feet ASL) of Mt. Nansen and Victoria Mountain were above the scouring effects of this ice sheet (Figure 52).

After deglaciation (Figure 53) and a lengthy ice-free period (Hughes, 1987) during which there was extensive weathering (Figure 54), a second pre-Reid glaciation occurred. As this Cordilleran ice sheet advanced, a local ice-centre probably originated in the Dawson Range (Jackson, 1993).

This likely began as cirque glaciers (Figure 55), progressed to valley glaciers (Figure 56) and eventually merged with the Cordilleran ice-sheet advancing from the south (Figure 57).

Following deglaciation, the climate returned at least once to warmer conditions than those of today, (Foscolos et al., 1977; Tarnocai, 1987) resulting in the extensive weathering of both bedrock and pre-Reid glacial and glaciofluvial deposits (Figure 58).

During McConnell glaciation, ice did not advance close to Nansen and Victoria creeks, however some aggradation probably occurred in Nansen and Victoria creeks, resulting in the formation of some alluvial fans. Glacially-derived deposits of loess blanketed the area and filled hollows in tributary valleys.

In the period from the end of McConnell glaciation to the present, streams have generally degraded, leaving low relief terraces adjacent to present stream courses and further dissecting older alluvial terraces where they are proximal to present streams. Colluvial processes remained active on tributary valley slopes.

Placer Gold

Limited bulk sampling and placer mining shows that glacigenic diamicton on Klaza River, Nansen Creek and Back Creek contains significant accumulations of placer gold, primarily at the diamicton/bedrock contact. Gold is also concentrated at the gravel/diamicton and gravel/bedrock interface, primarily in Facies 9 (disorganized gravel) and Facies 10 (massive to crudely stratified gravel).

The primary mechanism of concentration in these Facies 9 and 10 is likely to be selective entrainment of lighter mineral grains during major flood events, which results in an accumulation of heavy minerals (Slingerland, 1984). Continued reworking of gravels resulted in increased concentrations of heavy minerals at bedrock and other impermeable surfaces such as the clay-rich diamicton (Cheney and Patton, 1967).

Placer gold concentration in the diamicton is likely due to glacial erosion and incorporation of a mantle of extensively eroded bedrock material. This material consisted of pre-existing alluvium and supergene-enriched residual placers.

Previous workers (Cairnes, 1915a; Bostock, 1936a; 1966) suggested that significant placer gold concentrations occur only in alluvium that lies either upon bedrock or glacial till and no gold is present either in or below the till on bedrock. New data from this study suggests that significant amounts of placer gold also occur within the diamicton, principally at the diamicton/bedrock contact.

CONCLUSIONS AND RECOMMENDATIONS FOR EXPLORATION AND FUTURE STUDY

Conclusions

Figure 72 is an idealized stratigraphic section which illustrates the following generalized stratigraphic relationships:

1) pre-Reid glacial till (diamicton) rests on bedrock, and it in turn may or may not be overlain unconformably by glaciofluvial gravels;

2) alluvial fans of Reid to McConnell age may unconformably overlie the pre-Reid glacial till, or may lie directly upon bedrock; these complexes are in turn often unconformably overlain by colluvium;

3) McConnell to Holocene-age gulch gravels may unconformably overlie both alluvial fans and pre-Reid glacial deposits, or may rest directly upon bedrock, and are themselves often overlain by colluvium; and

4) capping the entire sequence are various Holocene-age buried organic horizons, silt/clay and at least two separate tephras.

Favorable Stratigraphic Settings for Gold

Favorable stratigraphic settings as noted in Figure 72 are as follows:

1) at the glacial till (diamicton)/bedrock contact;
2) within the glacial till (diamicton) itself and in intraglacial gravels within the till;
3) at the alluvial fan gravel/glacial till unconformity;
4) scattered within alluvial fan complexes, most favorably at the apex of the fan, and
5) at the gulch gravel/alluvial fan or bedrock unconformity.

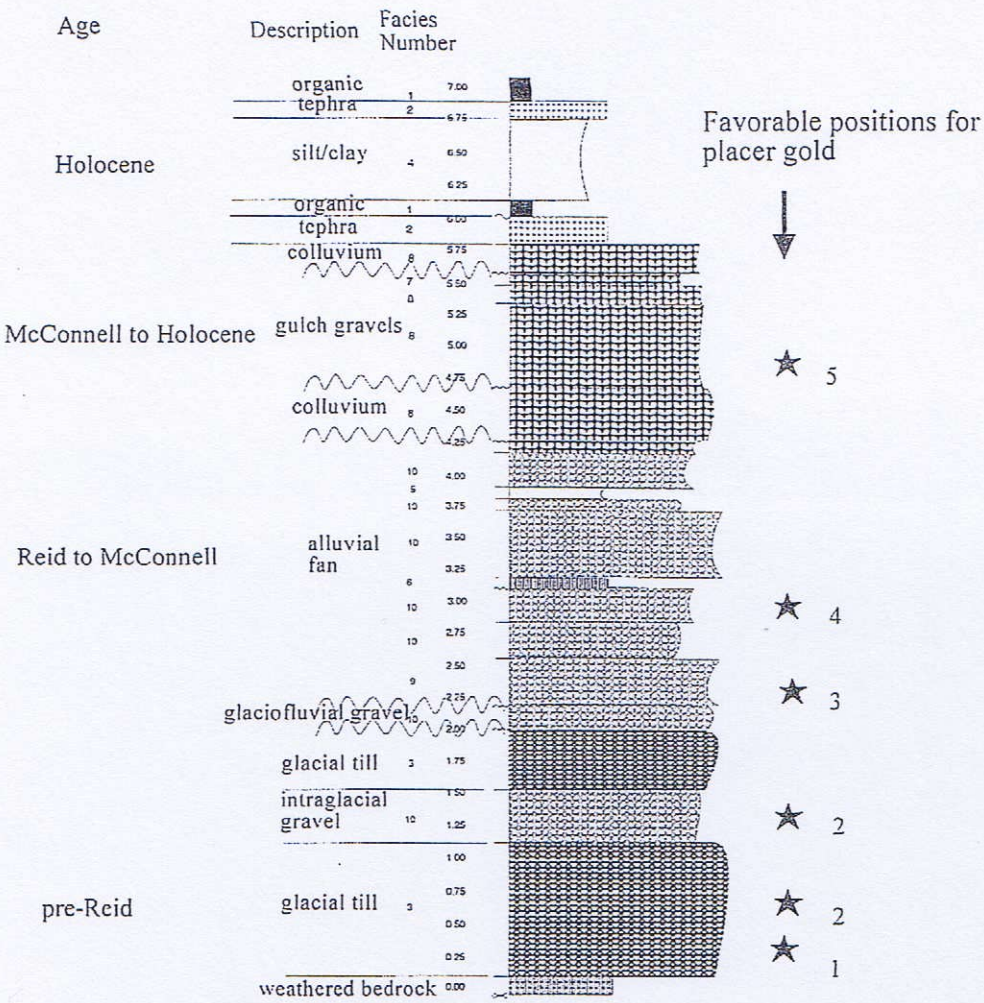


Figure 72 - Idealized Stratigraphic Section

Recommendations for Exploration and Future Study

Recommendations for Exploration

There are several possible exploration targets for placer gold in various geomorphic settings. These are shown in Figure 73 and are described as follows:

A) pre-Reid glacial till, high on valley sides, proximal to local bedrock sources of gold;

B) McConnell to Holocene gulch gravels, high in tributary valleys proximal to local bedrock sources of gold;

C) in alluvial fan complexes, most favorably near the apexes of the alluvial fans;

D) in pre-Reid till, deep in the valleys of Nansen Creek and Victoria Creek;

E) in point and channel bars of Recent gravels in the main valleys of Nansen and Victoria creeks;

F) in pre-Reid glaciofluvial deposits, generally proximal to local bedrock sources of gold; and

G) in pre-Reid till beneath Reid-age remnant alluvial terraces, and possibly within the remnant terraces themselves.

The concentration of placer gold in all of these stratigraphic and geomorphic settings can be highly variable, and depends upon a number of factors including proximity to local bedrock gold sources, amount of fluvial reworking of the gravels, and the age of the deposits. The economics of mining the placer gold in these various settings depends on a number of physical factors including the depth of overburden, the amount of frozen ground, the amount of water available for mining, and the various physical properties of the sediments themselves.

Recommendations for Future Study

A) Reid-age remnant alluvial terraces

The exact character and origin of these remnant alluvial terraces, both on tributary valleys such as Weber Creek and on the margins of the main valleys of Nansen and Victoria creeks, needs to be examined further. Exposure is typically poor as previous workers and placer miners have not generally worked these deposits.

Preliminary examinations of these deposits have shown them to have several unusual aspects including:

i) the sand matrix is unusually well-sorted, lacking in heavy minerals and sand grains are unusually well-rounded and quartz-rich;

ii) clasts within the deposits are unusually angular and are often ventifacts;

iii) the terraces comprise an unusually large volume of sediments in a relatively small basin.

B) Ages of pre-Reid sediments

It is still not possible to discern between deposits of the two pre-Reid glacial advances, except possibly in the case of the lithologically different "older till" found on Nansen Creek section NAN 1-1 and described in earlier chapters. Further work needs to be done in the Mt. Nansen area and areas adjacent to it if this distinction is to be possible.

C) Pre-Reid glacial limits - Carmacks and adjacent Aishihik and McQuesten map sheets

Due to the subdued nature of pre-Reid glacial features (Bostock, 1966), the exact limit of the pre-Reid ice advances is generally poorly-defined, in the Carmacks map area as well as in the adjacent Aishihik and McQuesten map areas. Further fieldwork must be done to identify pre-Reid deposits and map the limits of the pre-Reid glaciations.

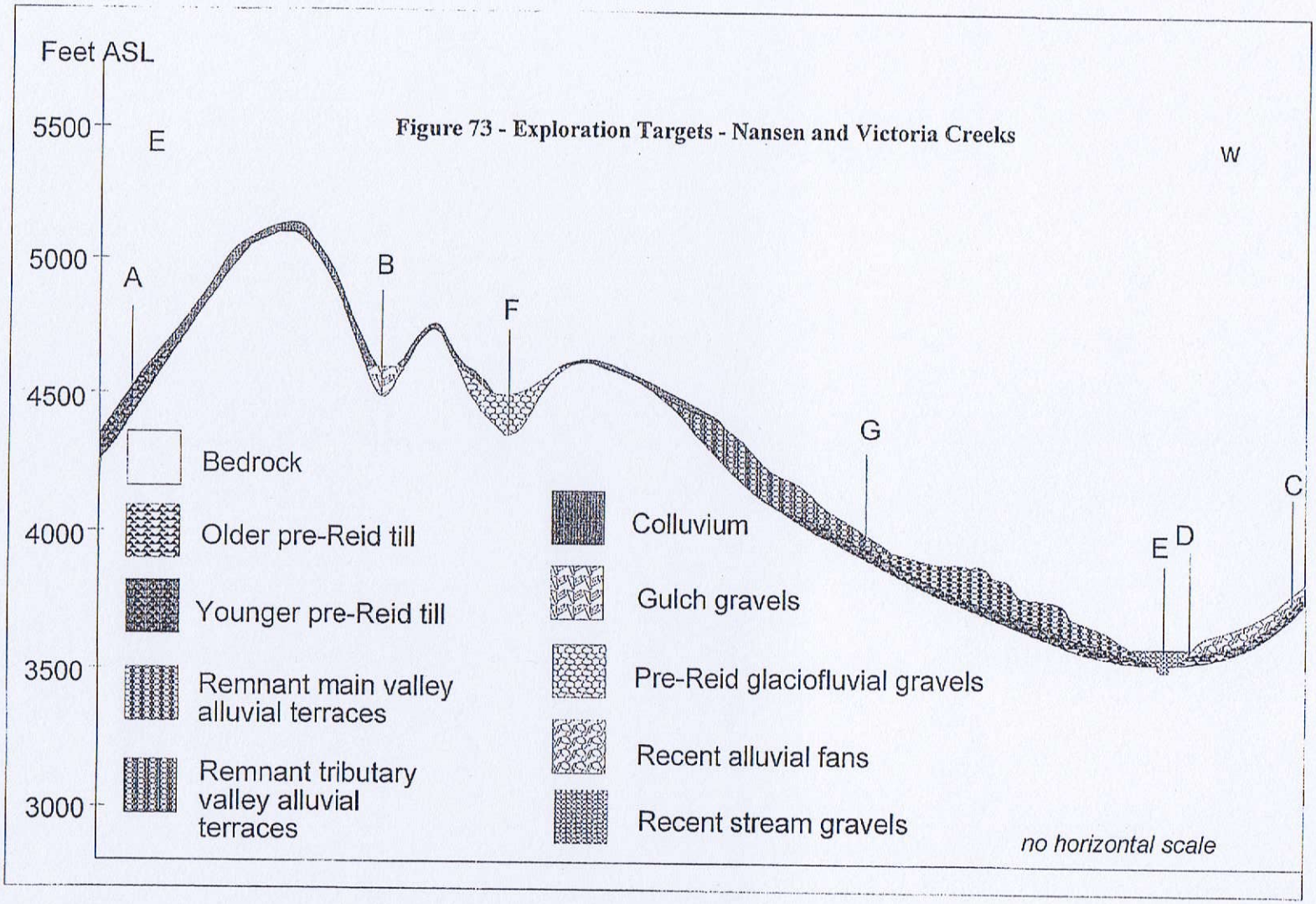


Figure 73 - Exploration Targets - Nansen and Victoria Creeks

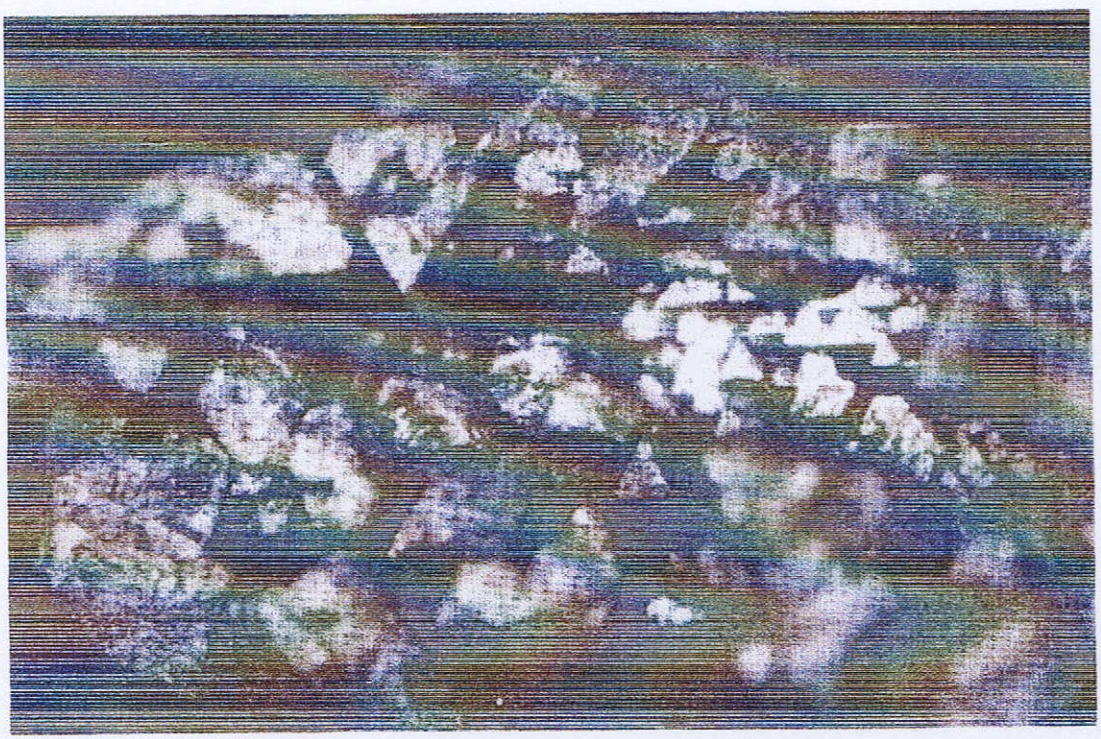
BULLETIN 4
(1)

Indian and Northern Affairs Canada | Affaires indiennes et du Nord Canada

Exploration and Geological Services Division, Yukon Region

BULLETIN 4

SEDIMENTOLOGY OF PLACER GRAVELS NEAR MT. NANSEN CENTRAL YUKON TERRITORY



W.P. LeBarge

1995

Canada

12-4
1500

FACIES SCHEME

Introduction

The term "facies" has generally been used by various authors as the classification of a body of rock or sediment based on a unique set of characteristics that set it apart from other bodies of rock or sediment. Modern usage originated with de Raaf et al., (1965) who used "lithological, structural and organic aspects detectable in the field" to subdivide a group of formations into facies. Walker (1984) noted that this subdivision is essentially a classification procedure which depends on the objectives of the study as well as the time available and the abundance of physical and biological structures in the rocks. Middleton (1978) noted that although facies will ultimately be given an environmental interpretation, the facies definition must be quite objective and based on the total field aspect of the rocks themselves.

The facies scheme utilized in the study area was designed with the above in mind. It was revised throughout the field season and adjusted as new lithologies were encountered. The objectives of the study were constantly kept in mind so that the facies scheme would be neither too simplistic nor too complex to achieve the goals of the study in the amount of time available. Although several facies occurred in widely varying genetic settings, care was taken not to add environmental interpretation into the facies descriptions.

The main characteristics of each bed which were described in the field were: lithology (percent of gravel, sand, silt and clay), maximum grain size (based on ten largest clasts), clast angularity, sedimentary structures, clast support, sorting, contacts, and accessories. Gravel and sand units were described according to the modified Wentworth scale (Wentworth, 1922) and classified according to the AGI (American Geological Institute) classification scheme (Detrich et al., 1982). Table 6 summarizes the main aspects of each facies described.

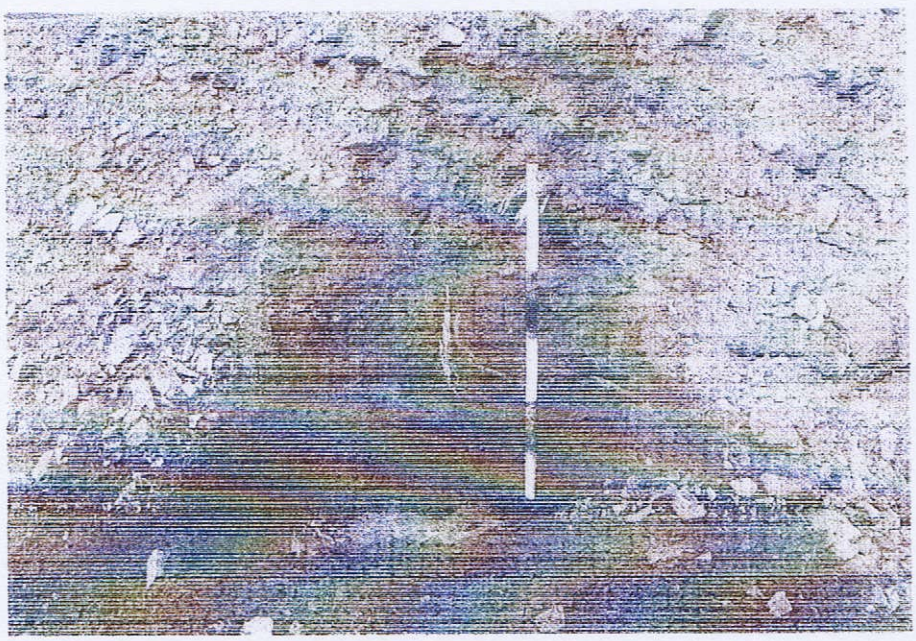


Figure 11 - Measured section K 1-3 shows one of several buried organic horizons (Facies 1) in the Klaza River locality. Note the stump in growth position, which has been radiocarbon dated at 4600a +/- 60 B.P.



Figure 12 - Facies 2, a convoluted, faulted tephra, lies beneath several feet of mud and fine sand at Eva Creek, measured section EVA 2-1. This unit is also exposed similarly in upper Discovery Creek. White River Ash caps the sequence near the present topographical surface.

General Facies Descriptions

Facies 1 - Organic

This facies (shown in Figure 11) includes recent and older organic material. Organic grade varies from present day and Holocene plant material to fibric peat material found lower in most sections. A total of 41 beds were encountered, comprising 15.24% of the total beds measured. The following sections contained Facies 1: LBAC 1-1, LBAC 2-2, UBAC 1-1, EFN 1-1, EFN 2-2, EFN 3-1, EFN 3-2, EFN 4-1, WEB 1-1, WEB 2-1, K 1-1, K 1-2, K 1-3, K 2-1, EVA 1-1, EVA 2-1, DIS 1-1, DIS 1-2, DIS 1-3, DIS 2-1, DIS 2-9, DIS 2-11, DIS 2-12, LDIS 1-1, VIC 1-1, VIC 1-2, VIC 1-3, NAN 1-1, DOL 1-1.

Facies 2 - Tephra

Two tephras are present. The most recent, found near the present day surface, is the White River Ash (Lerbekmo and Campbell, 1969; Lerbekmo et al., 1975). Its grain size is generally medium sand and it is overlain in most areas by only a few centimetres of organic material. The second tephra (Figure 12) is found associated with silts and fine sands within one metre of the present day surface. It is occasionally found in the same sections as the White River Ash. This ash has yet to be dated. A total of 18 beds were encountered, comprising 6.69% of total beds measured. The following sections contained Facies 2: LBAC 1-1, LBAC 2-2, EFN 1-1, EFN 2-2, WEB 2-1, K 2-1, 1-1, EVA 1-1, EVA 2-1, DIS 1-1, DIS 1-2, DIS 2-1, DIS 2-11, VIC 1-1, VIC 1-2, VIC 1-3.

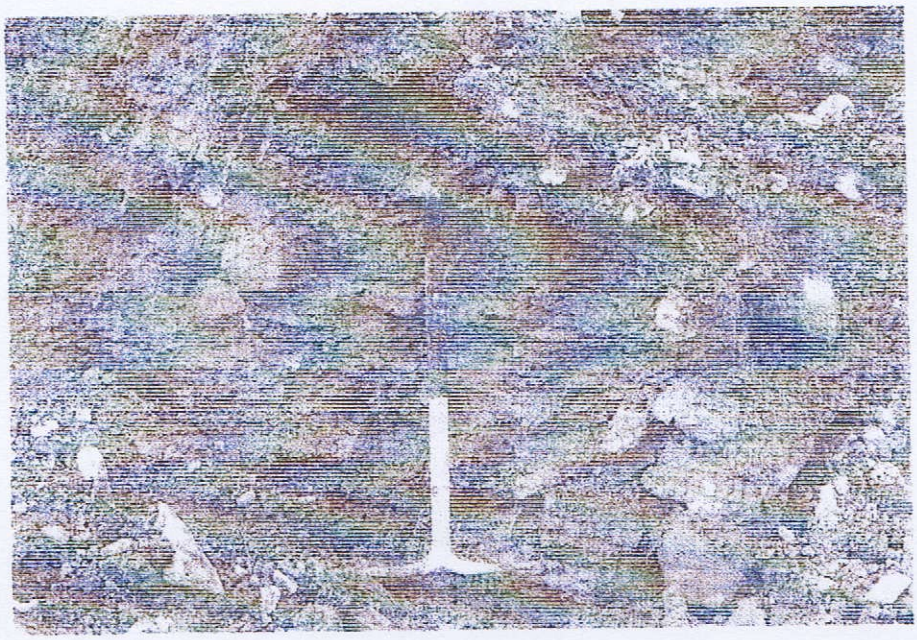


Figure 13 - Facies 3, disorganized cobble-boulder diamicton, occurs in the Klaza River locality, section K 2-1, unit A. Some placer gold has been mined from this unit. The pick is 65 cm long.

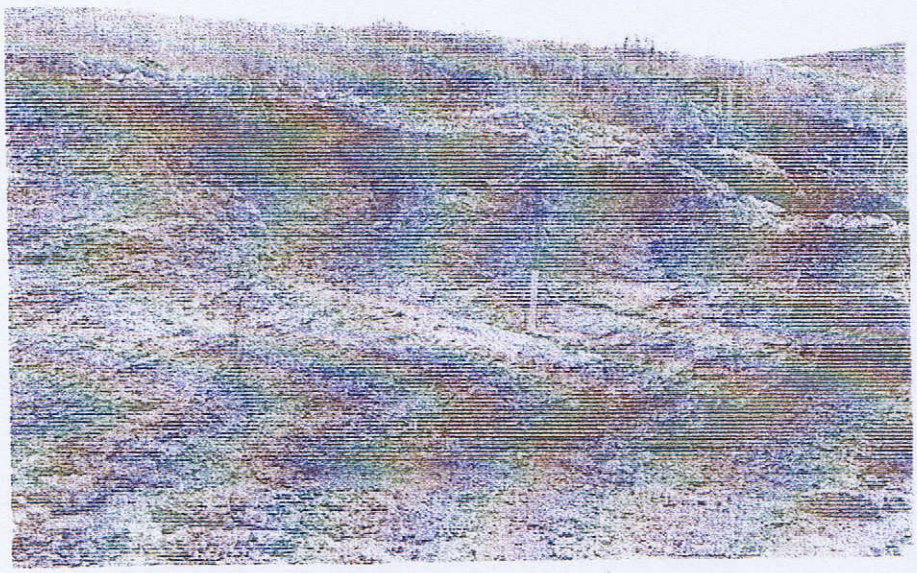


Figure 14 - An unusual stratified pebbly diamicton is overlain by colluvium on the East Fork of Nansen Creek. The unit is clay-rich, contains weathered granodiorite clasts and has strata that dip uphill.

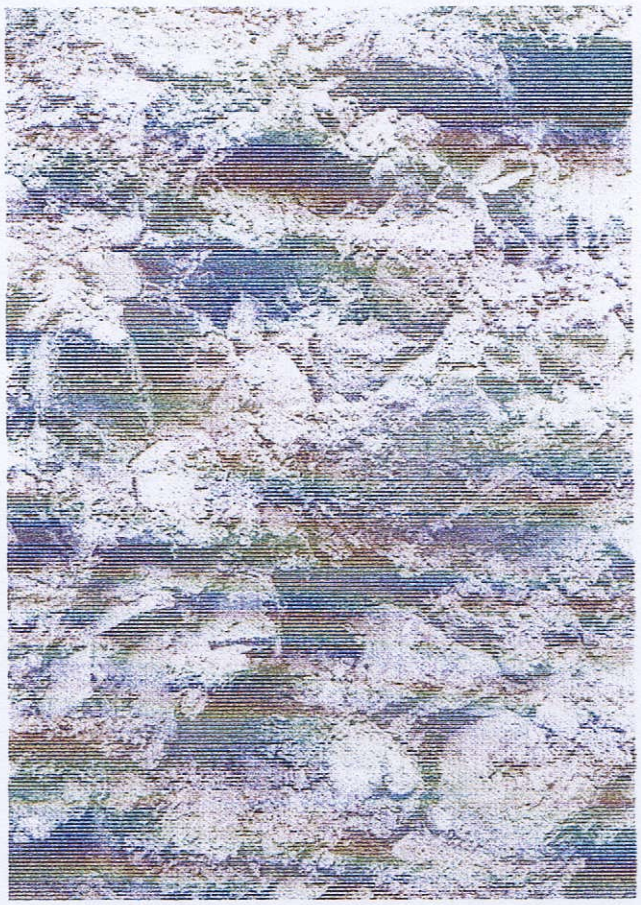


Figure 15 - Cobbly diamicton of Facies 3 occurs on Nansen Creek, measured section NAN 1-1. This clay-rich unit contains numerous weathered clasts and significant placer gold concentrations.

Facies 3 - Diamicton

This unit varies from clast- to matrix-supported, is disorganized and contains pebble to boulder size clasts in a matrix of clay, silt, and sand. Some units are mud-dominated and some are sand-dominated. It is very poorly sorted, and clasts are angular to subrounded. In many sections this facies is gold-bearing and is mined as the pay unit (Figures 13 and 15). A total of 19 beds were encountered, comprising 7.06% of total beds measured. The following sections contained Facies 3: EFN 3-1, EFN 3-2, WEB 1-1, K 2-1, NAN 1-1, UBAC 1-1.

Facies 4 - Massive and stratified silt and clay

This unit is composed of disorganized and massive to stratified silt and clay, with varying amounts of other minor components including sand and tephra (Figure 16). Pebbles and cobbles comprise less than 25%. A total of 14 beds were encountered, comprising 5.20% of total beds measured. The following sections contained Facies 4: K 1-1, K 1-2, K 1-3, K 2-1, EVA 1-1, EVA 2-1, DIS 1-1, DIS 1-2, DIS 2-1, DIS 2-11, LDIS 1-1.

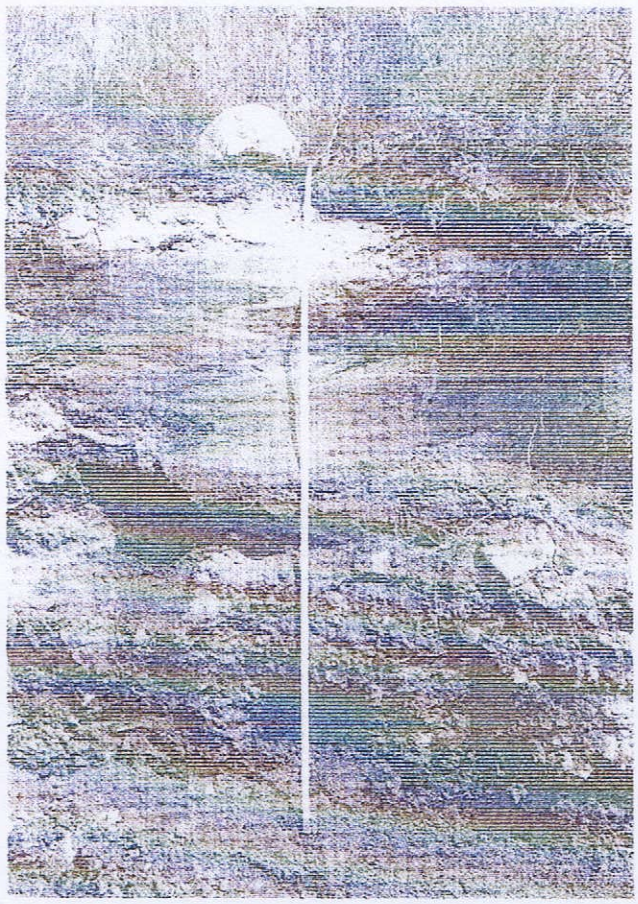


Figure 16 - Stratified silt and clay of Facies 4 overlies disorganized pebble-cobble gravel of Facies 9 at Eva Creek section EVA 1-1, and is in turn overlain by White River Ash. Traces of an older tephra are mixed with the silt and clay.

Facies 5 - Massive and disorganized pebbly sand and sand

This facies is composed of massive to disorganized, poorly- to well-sorted fine to coarse sand (Figure 19). Other fine sediments occur in minor amounts such as mud and tephra. Pebbles and cobbles occur in amounts of less than 25%. A total of 13 beds were encountered, comprising 4.83% of total beds measured. The following sections contained Facies 5: MBAC 1-1, EFN 2-2, WEB 1-1, WEB 2-1, EVA 2-1.

Facies 6 - Stratified pebbly sand and sand

This facies is composed of moderately to well-sorted fine to coarse granular sand with less than 25% pebbles and cobbles. Sedimentary structures include wavy and parallel stratification, planar tabular cross-beds (Figure 17), trough cross-beds, current ripples and convoluted bedding. A total of 34 beds were encountered, comprising 12.64% of total beds measured. The following sections contained Facies 6: LBAC 1-1, LBAC 2-2, MBAC 1-1, EFN 1-1, EFN 2-2, WEB 1-1, WEB 2-1, EVA 2-1, DIS 1-1, DIS 1-2, DIS 1-3, DIS 2-1, DIS 2-9, LDIS 1-1, VIC 1-1, VIC 1-2, VIC 1-3, K 1-2, NAN 1-1, DOL 1-1.

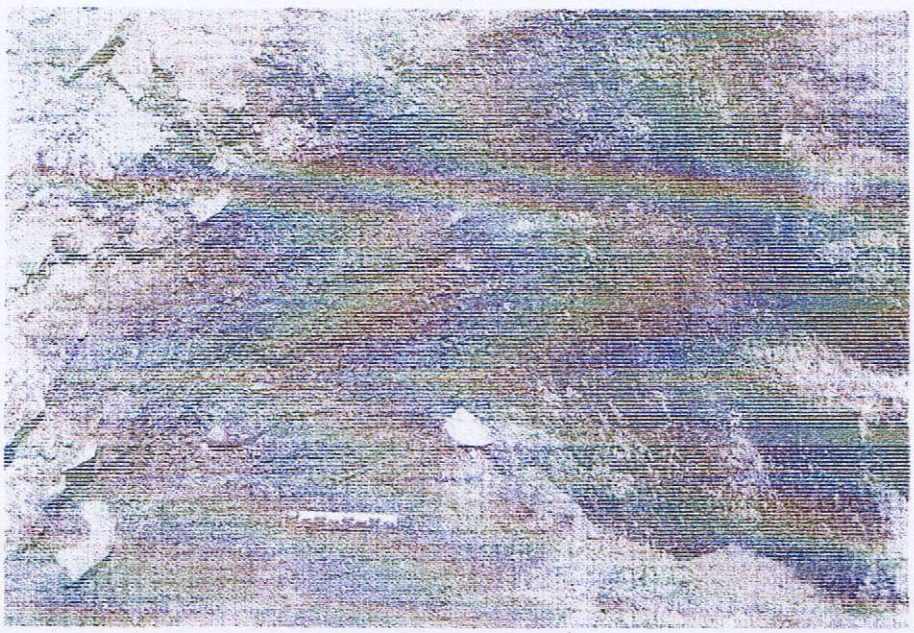


Figure 17 - Planar tabular cross-stratified pebbly sand (Facies 6) is truncated by pebble cobble gravel of Facies 10 on measured section DIS 1-3, upper Discovery Creek.

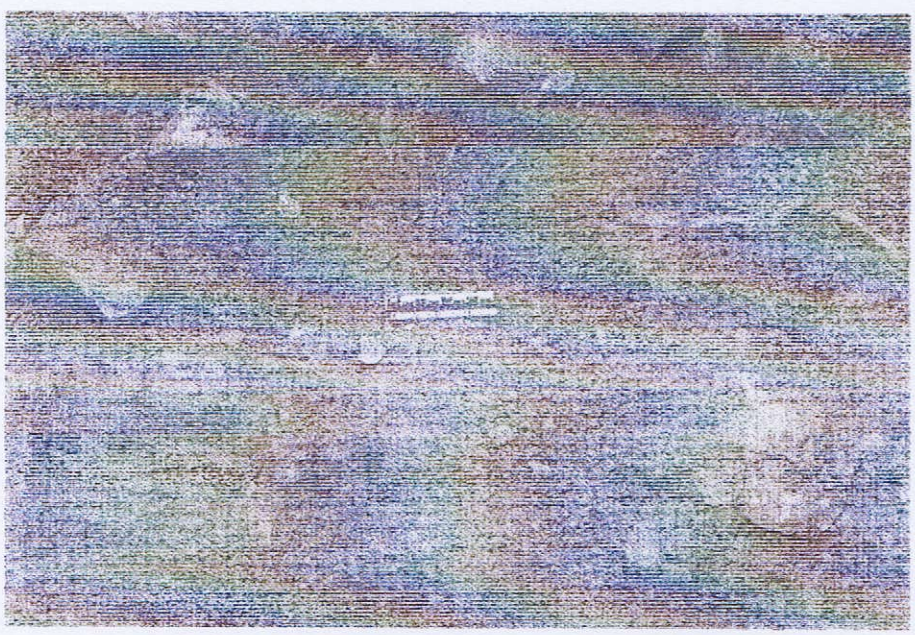


Figure 18 - Disorganized muddy pebble-cobble gravel of Facies 7 conformably overlies sandy pebble gravel of Facies 8 at measured section EVA 2-1, Eva Creek.

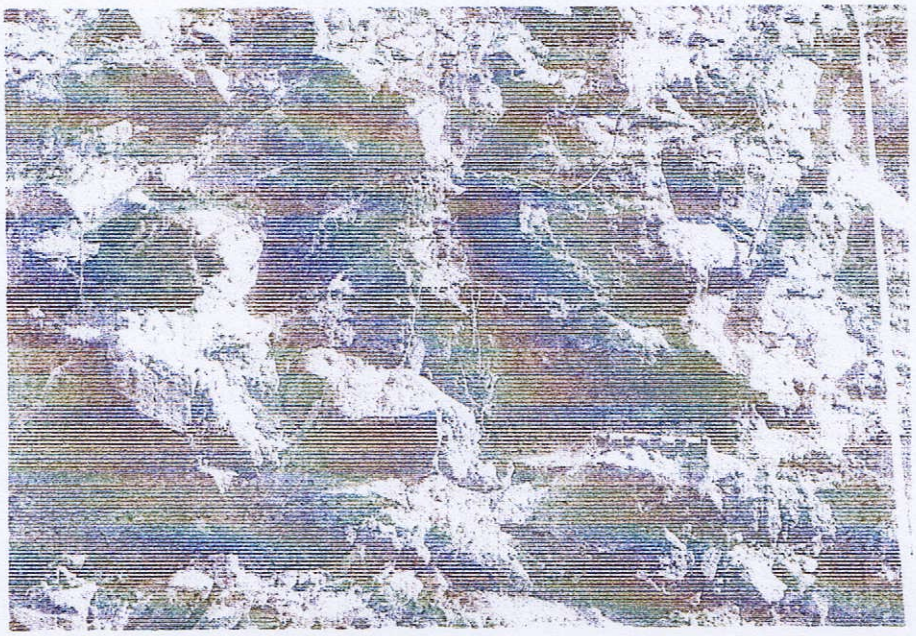


Figure 19 - Massive pebbly sand of Facies 5 and massive sandy pebble-cobble gravel of Facies 8 are intercalated on an alluvial fan in the mid-reaches of Discovery Creek, section LDIS 1-1.

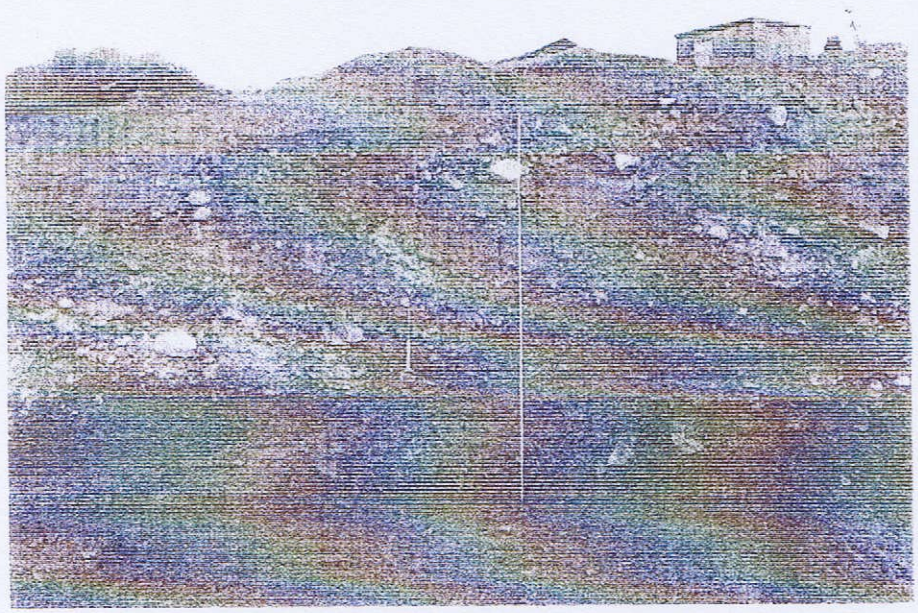


Figure 20 - Disorganized gravel of Facies 9 overlies stratified gravel of Facies 10 at measured section EFN 2-1, on the East Fork of Nansen Creek. This section is highly weathered and is interpreted as pre-Reid glaciofluvial outwash.

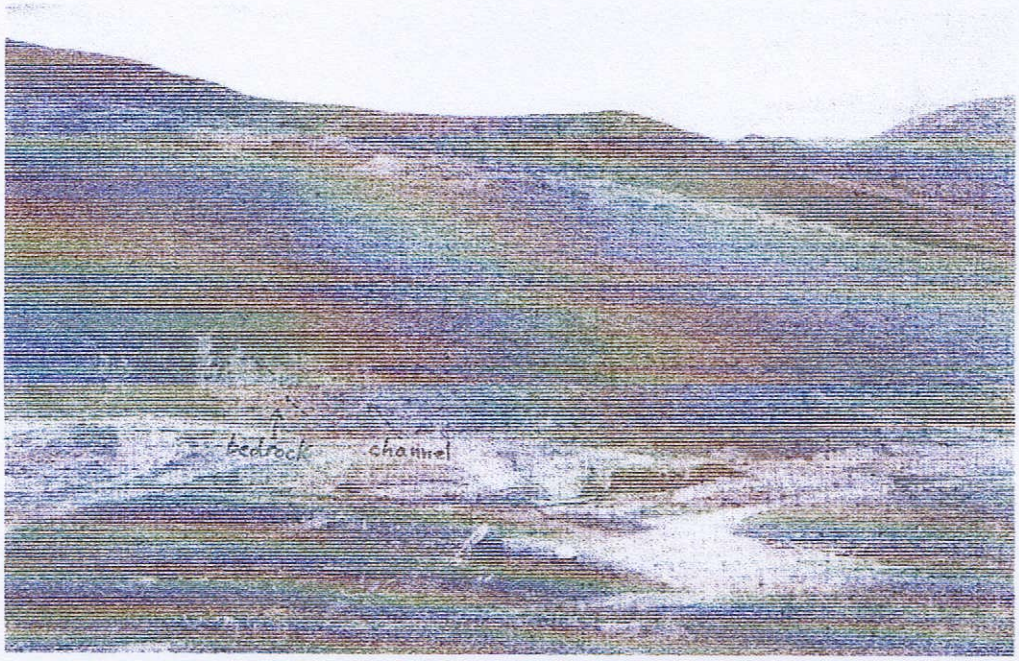


Figure 21 - A pre-Reid glaciofluvial channel (measured section DIS 2-9) cuts bedrock at an elevation of 4270 feet on upper Discovery Creek.

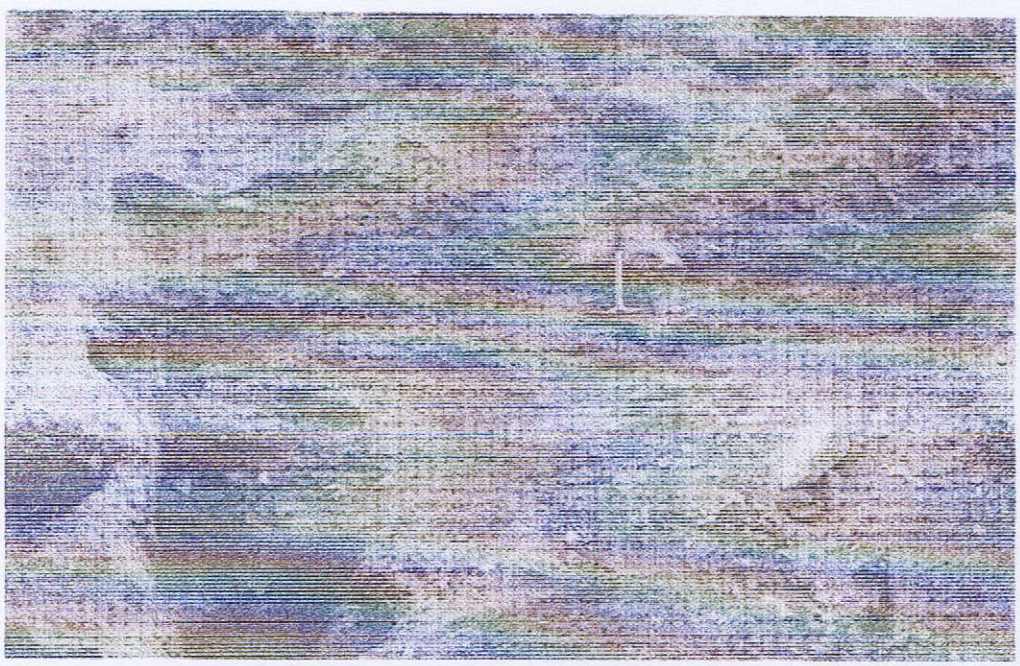


Figure 22 - A close-up of measured section DIS 2-9 shows massive to crudely stratified boulder-cobble gravel of Facies 10. Measured fabric in this highly weathered section shows a paleoflow direction which is transverse to the present valley.

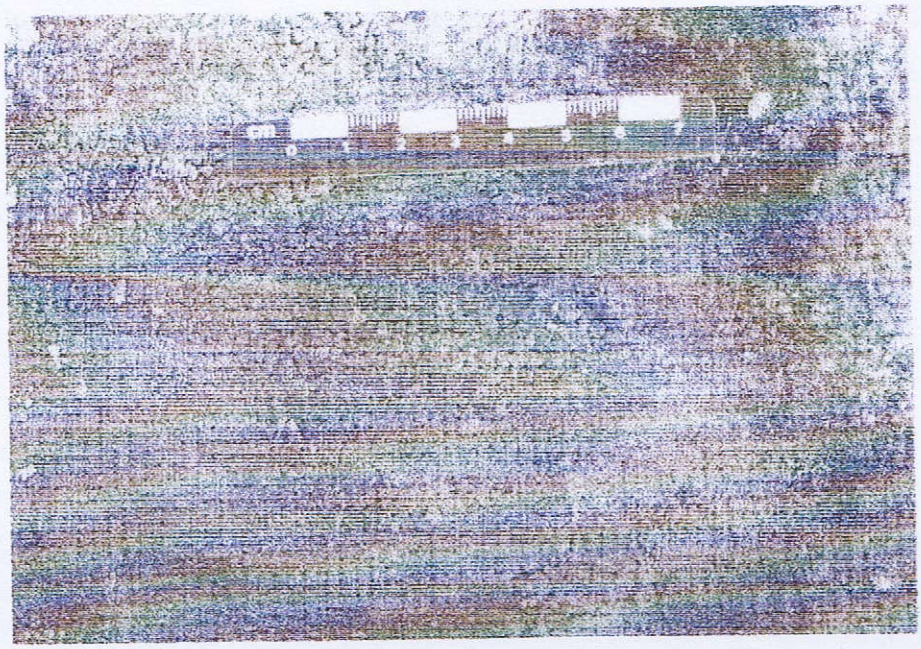


Figure 23 - Weathered arsenopyrite and pyrite occur in clay-altered pods in the bedrock near measured section DIS 2-9. Sulphides can be excavated as medium sand-sized grains.

Facies 7 - Disorganized muddy gravel

This facies is composed of gravels containing between 25% and 50% clasts and more clay and silt than sand. Strata are disorganized or crudely stratified and the units are mainly matrix-supported (Figure 18). Clasts vary from pebbles to cobbles and sorting is poor to moderate. A total of 7 beds were encountered, comprising 2.60% of total beds measured. The following sections contained Facies 7: K 2-1, EVA 1-1, EVA 2-1, EFN 2-1, EFN 2-2.

Facies 8 - Massive and stratified sandy gravel

This facies is composed of gravels containing between 25% and 50% clasts and more sand than clay and silt. Strata are massive, disorganized, or stratified and units are matrix- to clast-supported (Figures 18 and 19). Clasts vary from pebbles to boulders and sorting is poor to moderate. A total of 35 beds were encountered, comprising 13.01% of total beds measured. The following sections contained Facies 8: LBAC 2-2, MBAC 1-1, EFN 1-1, EFN 2-1, EFN 2-2, EFN 3-1, EFN 3-2, WEB 1-1, WEB 2-1, K 1-2, K 1-3, K 2-1, EVA 2-1, DIS 1-1, DIS 1-2, DIS 1-3, DIS 2-11, LDIS 1-1, DOL 1-1.

Facies 9 - Disorganized gravel

This facies is composed of gravels containing over 50% clasts. Units are disorganized and clast-to matrix-supported, and clast size includes pebbles, cobbles and boulders (Figure 20). Sorting is generally moderate. A total of 17 beds were encountered, comprising of 6.32% of total beds measured. The following sections contained Facies 9: EFN 1-1, EFN 2-1, EFN 2-2, K 2-1, EVA 1-1, DIS 1-1, DIS 1-3, VIC 1-3, NAN 1-1, DOL 1-1.

Facies 10 - Massive to crudely stratified gravel

This facies is composed of gravels containing over 50% clasts. Units are massive to crudely stratified and clast-supported, and clast size ranges from pebbles to boulders (Figures 20 to 23). Units are moderately to well-sorted. A total of 71 beds were encountered, comprising 26.39% of total beds measured. The following sections contained Facies 10: LBAC 1-1, 2-2, MBAC 1-1, UBAC 1-1, EFN 1-1, EFN 2-1, EFN 4-1, K 1-1, K 2-1, DIS 1-1, DIS 1-2, DIS 1-3, DIS 2-1, DIS 2-9, DIS 2-11, DIS 2-12, LDIS 1-1, VIC 1-1, VIC 1-2, VIC 1-3, NAN 1-1, WEB 1-1.



Figure 33 - A large bullet-shaped boulder was exposed by placer mining operations at an elevation of 4300 feet ASL on Back Creek. This streamlined boulder was derived from a diamicton which lay directly on bedrock. The diamicton in this location is interpreted as a glacial till.

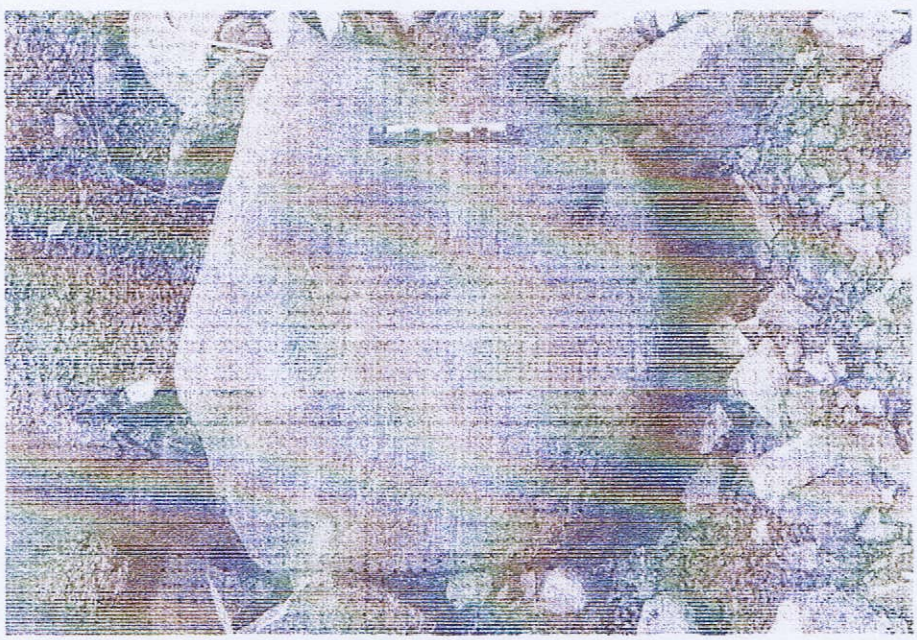


Figure 34 - Glacially-striated boulders also occur on the East Fork of Nansen Creek.

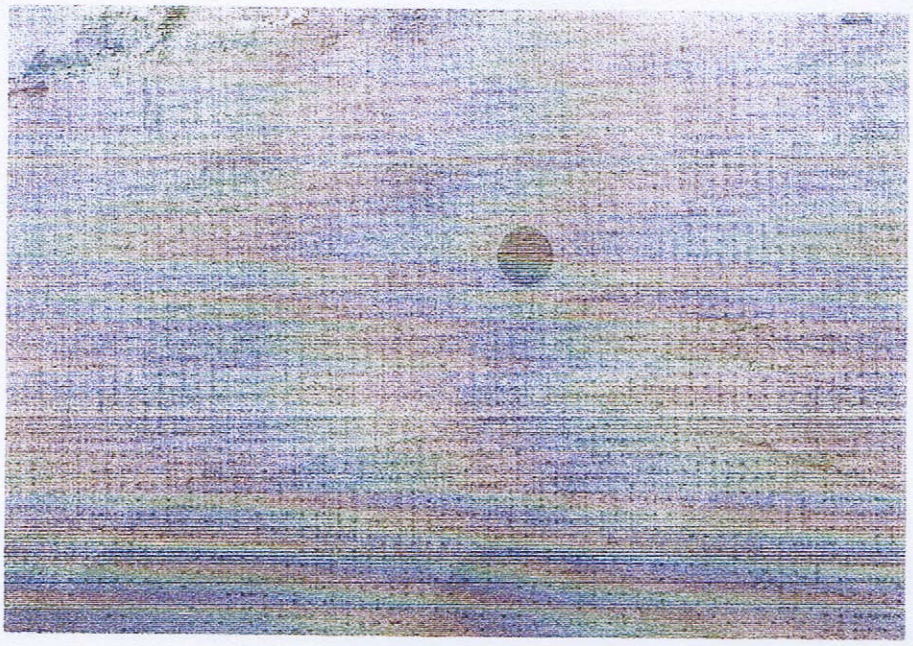


Figure 35 - Stratification consists of wavy parallel and ripple laminations in measured section WEB 2-1, located on a remnant alluvial terrace. An ice cast sand wedge can be discerned near the lens cap.

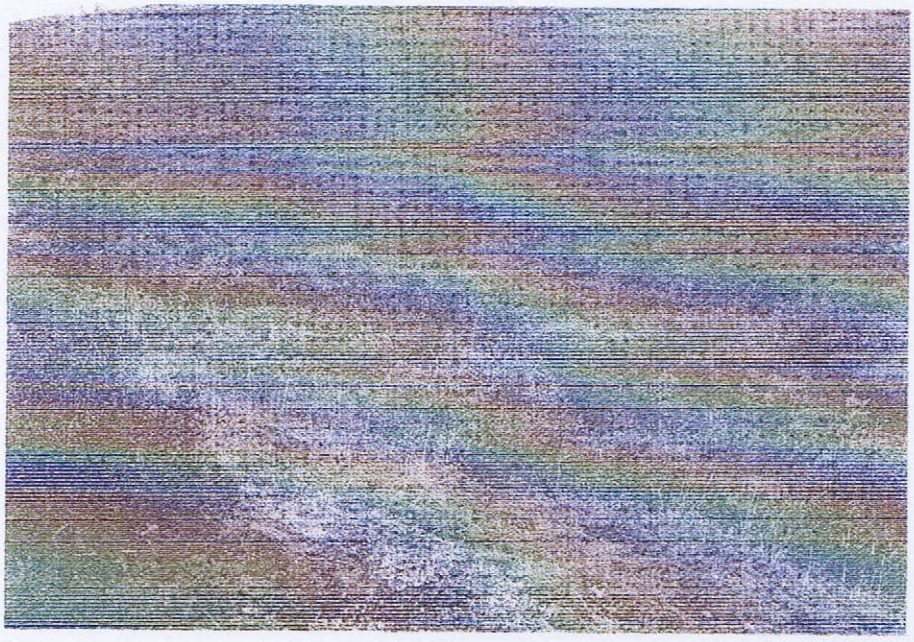


Figure 36 - A remnant alluvial terrace on the upper reach of Weber Creek has been dissected by the present stream, near the locality for measured section WEB 1-1.

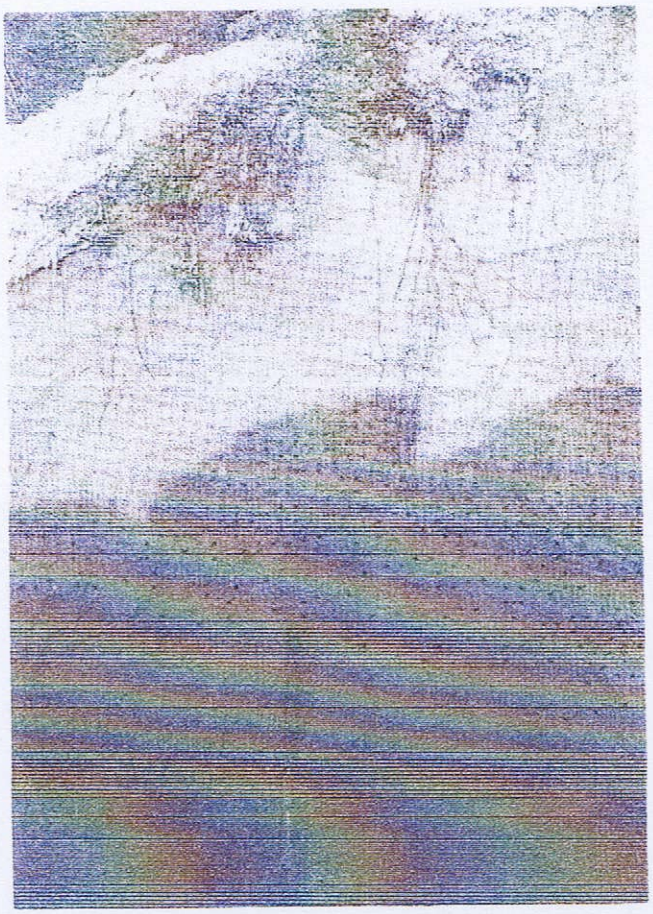


Figure 37 - Interbedded cross-stratified sand and gravel occur in a remnant alluvial terrace on Weber Creek. Gravel clasts are angular, ventifacts are common and fine to medium sand is well-sorted. Measured section WEB 2-1.

Schematic Profiles and Lateral Relationships

Introduction

Figures 38 to 47 show schematic profiles and general lateral relationships between measured sections for each drainage. Sections were correlated based on field relationships and facies trends. Table 18 is the legend for the schematic profiles and all of the measured sections.

Discussion

Discovery Creek

Discovery Creek is characterized by three types of sedimentation, glaciofluvial channels (DIS 2-9), gulch gravels (DIS 1-1, DIS 1-2 and DIS 1-3), and periglacial alluvial fans (LDIS 1-1). At elevations of 4200 feet ASL and above, the glaciofluvial channel cuts bedrock in a paleoflow direction perpendicular

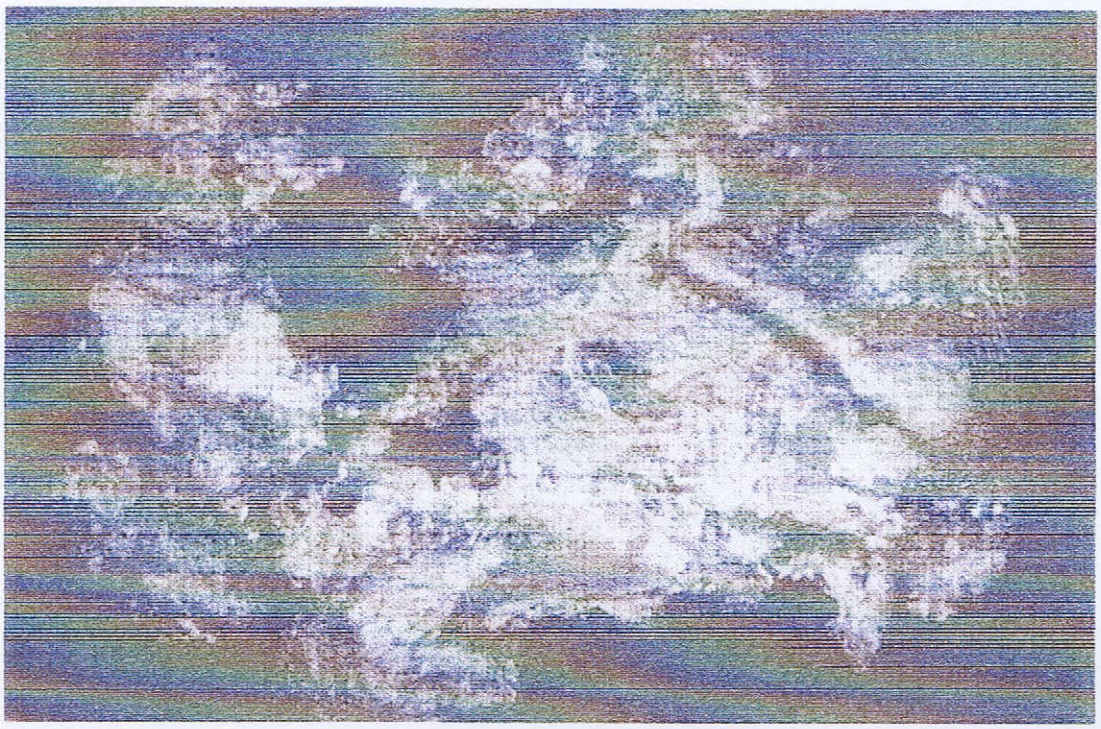


Figure 64 - Angular gold grain from alluvial fan gravels on Klaza River. Field of view approximately 1 cm.

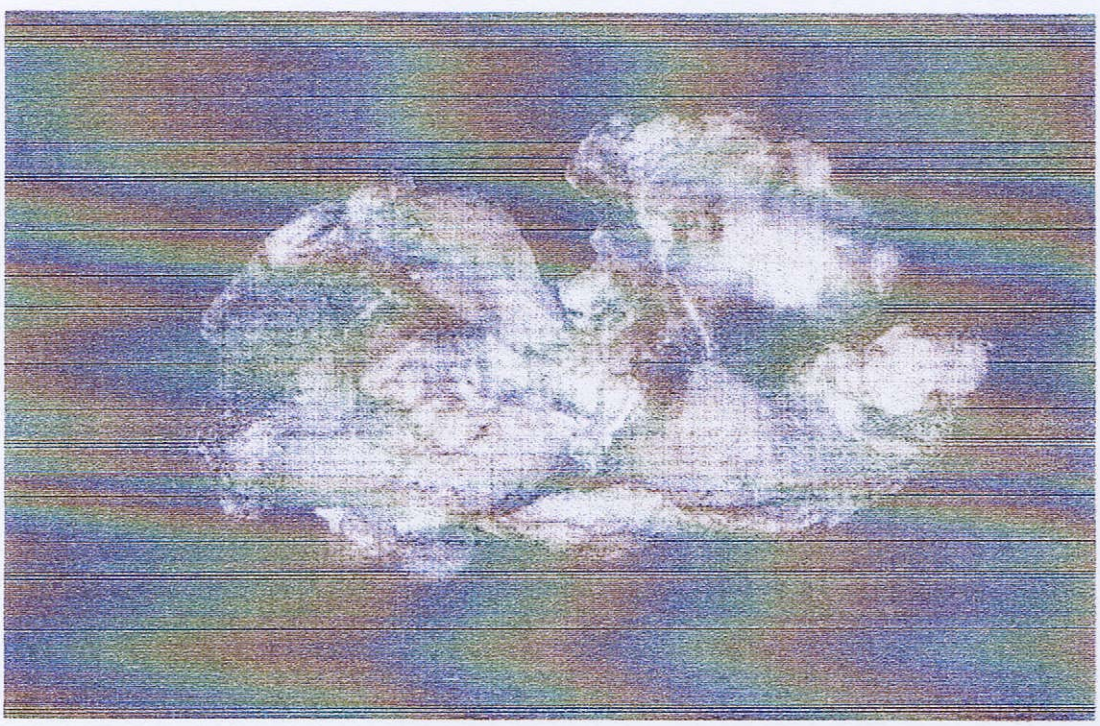


Figure 65 - Gold specimen from Back Creek with attached quartz. Field of view 1 cm.

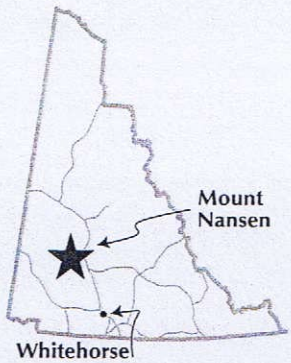
MOUNT NANSEN PROPERTY

Mount Nansen Mine Site

PROJECT STATUS

Site is under Receivership/Bankruptcy through PricewaterhouseCoopers.

Yukon government is maintaining and moving to final closure of the site.



Location
60 km west of Carmacks

Commodity
Gold, silver

Ore type
Sulphide

Mineral resource*

Brown-McDade zone
Underground resource: 193 706 tonnes grading 14.47 g/t Au and 100 g/t Ag

Flex zone
Indicated oxide resource: 69 977 tonnes grading 6 g/t Au and 234 g/t Ag
Inferred oxide resource: 38 615 tonnes grading 5.8 g/t Au and 333 g/t Ag

Webber zone
Historical resource of 58 524 tonnes grading 10.9 g/t Au and 611 g/t Ag

Huestis vein
Historical resource of 85 727 tonnes grading 14 g/t Au and 283 g/t Ag

*not NI 43-101 compliant

HISTORY

Placer gold was originally discovered on Nansen Creek in 1899. The first recorded lode gold discovery on the current Mount Nansen property was made by prospectors Brown and McDade in 1943.

The first underground work was conducted on the Brown-McDade zone in 1947 by the Spud Huestis Syndicate. After a few years of mine development, mapping, surface trenching and sampling, the property remained inactive until 1962 when the Mount Nansen Syndicate acquired the Brown-McDade, Webber and Huestis deposits and conducted additional exploration. Mount Nansen Mines Ltd. was acquired by Peso Silver Mines Ltd. which conducted exploration over the next three years on all three deposits. A 270-tonne/day flotation mill was constructed during 1967-68. A total of 14 500 tonnes of development muck produced during 1967-68 had an estimated average grade of 7.8 g/t Au and 162 g/t Ag, while mill feed of 5236 tonnes produced from stopes during 1969 had an estimated average grade of 11.7 g/t Au and 282 g/t Ag. Low gold recovery rates, estimated at 60% to 65%, led to the mine closure in April, 1969. In late 1975, a total of 5450 tonnes at an estimated grade of 16.8 g/t Au and 248.8 g/t Ag was produced from the Huestis deposit and processed during May, 1976, but the mine once again shut down shortly after. As of 1976, over 4572 m of underground development was completed on the three veins. Approximately 22 680 tonnes of ore were treated in the flotation mill in 1975 and 1976.

In 1984, BYG Natural Resources Inc. (BYG) acquired the properties and combined them with additional claims to form the current property. BYG and Chevron Minerals Ltd. carried out an exploration program from 1985 to 1987. Over $5 million was expended on geological mapping, geochemical and geophysical surveys, trenching, 2605 m of diamond drilling (41 holes) and 1283 m of rotary percussion drilling (17 holes). During 1988, BYG continued exploring on its own by carrying out surface trenching and 85 holes (5397 m) of diamond drilling. A previously unrecognized near-surface oxide zone was discovered and the underground sulphide reserves were

Reserves/resources are from a variety of sources and may not be compliant with National Instrument 43-101 Standards, unless specified.

expanded. Metallurgical testing, mill flow sheet designs, tailings disposal and environmental impacts were studied at this time, and commercial gold production began on January 1, 1997. Production continued intermittently until February, 1999, when all mining and operations ceased.

Between 1994 and 1997, BYG conducted exploration consisting of diamond drilling on the following zones: Brown-McDade and Flex (990 m, 12 holes in 1994), Flex and Huestis (1490 m, 21 holes in 1995), Webber and Flex (780 m, 10 holes in 1996) and Vince vein (745 m, 9 holes in 1997). During 1997, a program of overburden stripping and excavator trenching was completed on the Flex zone. During 1998, a further 16 holes (1092 m) were drilled on the Flex zone.

In May, 1999, BYG Natural Resources went into receivership (D. Manning and Associates) and was also convicted of violating its water licence. In July, 1999, the federal government took over mine-site maintenance.

In August 1999, the federal government formally declared the property abandoned and took over management of the mine site until 2003 when responsibilities devolved to Yukon government. In April 2004, the Supreme Court of Yukon appointed PricewaterhouseCoopers as interim receiver for the assets of BYG Natural Resources Inc. The Yukon government continues care and maintenance for the site and PricewaterhouseCoopers continues to manage the mine's assets.

In June 2007, PricewaterhouseCoopers, sold 199 mineral claims outside the disturbed mine site area to a Vancouver-based exploration company, 101073531 Saskatchewan Ltd. These claims included Webber Zone, portions of the Huestis vein and the Flex zone.

Yukon and federal government, together with the Little Salmon Carmacks First Nation are working towards a final closure plan.

PROJECT SUMMARY

The Mount Nansen mine is located 60 km west of the village of Carmacks, Yukon and is accessible by a gravel road from Carmacks to the minesite. The property consists of 257 mining claims and 30 mining leases covering an area of 53 km^2.

Geology, mineralogy and ore reserves

The Mount Nansen district is underlain by metamorphosed intrusive, sedimentary and volcanic rocks of the Yukon-Tanana Terrane. These rocks are intruded by Early Cretaceous felsic plutonic rocks and overlain by mid-Cretaceous Mount Nansen mafic to intermediate volcanic rocks and related sub-volcanic feldspar porphyry dykes and plugs.

The Mount Nansen property is host to four distinct gold deposits known as the Brown-McDade, Webber, Huestis and Flex zones. The zones are situated in a series of anastomosing veins in northwesterly trending faults or shear zones. The gold and silver mineralized structures consist of fault-shear-hosted veins and associated clay-rich and bleached alteration zones. The veins occur in a 2.5-km-wide corridor which has been traced over a strike length of 15 km. Clay-rich leach zones near the surface are underlain by blankets or lenses of gold-rich supergene ores.

Brown-McDade zone

The Brown-McDade zone lies at the southeasterly end of the belt. It is 55 m long by 200 m wide and consists of quartz veins and associated feldspar porphyry dykes. The oxide ore of the Brown-McDade was mined in a small open pit. A mineable open-pit reserve of 110 000 tonnes grading 12.33 g/t Au and 78 g/t Ag was outlined in the open pit, with an additional 80 000 tonnes of low-grade mineralized rock. Most of this was mined out by late 1998. Indicated and Inferred underground resources below the existing pit are estimated at approximately 150 000 tonnes grading 7 g/t Au and 50 g/t Ag.

In 2007, the claims containing the following zones were sold to Vancouver-based exploration company, 101073531 Saskatchewan Ltd.

Webber zone

A historical diluted oxide resource of 58 524 tonnes grading 10.9 g/t Au and 611 g/t Ag has been established in the Webber deposit from extensive trenching, drilling and underground development.

Huestis vein

A historical mineable sulphide resource of 85 727 tonnes grading 14 g/t Au and 283 g/t Ag has been defined on the Huestis vein by trenching, diamond drilling and detailed underground sampling. The ore is sulphide-rich and refractory.

Reserves/resources are from a variety of sources and may not be compliant with National Instrument 43-101 Standards, unless specified.

Flex zone

A preliminary, shallow open-pit design encloses a calculated mineable (Indicated) resource of 69 977 tonnes grading 6.0 g/t Au and 234 g/t Ag and a geological (Inferred) resource of 38 615 tonnes grading 5.8 g/t Au and 333 g/t Ag. This resource is not NI 43-101 compliant.

Production

The initial capacity of the mill was 700 tonnes/day.

Gold production from surface oxide ores commenced during the week of October 18, 1996 and the company poured the first bar of gold on November 23, 1996. Commercial production began on January 1, 1997. The mill was established to process 700 tonnes/day; intended yearly production was 50,000 oz. (1.5 million g) Au. The gold was sold through Gerald Metals Inc.

In January, 1997, the company produced 2700 oz. (84 000 g) Au and 13,000 oz. (400 000 g) Ag. Ore throughput increased to 450 tonnes/day, which was 64% of design capacity. Recoveries averaged 88% and the head grade averaged 0.235 oz./ton (8.06 g/t) Au equivalent.

The unanticipated presence of clay-alteration minerals in the ore forced the daily milling rate down to less than 325 tonnes during the first nine months of operations. The problem was solved by installing a semi-autogenous grinding mill (SAG). Also, record rainfall aggravated existing difficulties milling the gold-rich, clay-altered ores and restricted capacity to 36%. The SAG mill was operational by the end of August, 1997. During July and August, 1997, the mill operated largely on stockpiled ores leaving the high-grade open-pit clay-altered ores to be mined and processed when the SAG mill became operational.

Unseasonably heavy rainfall created a water imbalance problem in late 1997. There was inadequate provision for run-off of the rainfall, which led to an environmental discharge danger. BYG engineered a water treatment system in the spring of 1997 by transporting facilities from the Canamax mine controlled by YGC. The treatment facility enabled the company to meet water quality discharge levels.

The mine restarted production at the end of January, 1998 and delivered its first gold and silver for sale in April, 1998. At first, production was limited to 50% of the mill's 700 tonne/day capacity, then installation of new pumping facilities allowed the mill to operate at full capacity. BYG estimated that it would be able to produce gold at an operational cost of $160/oz.

The company downsized in 1998 and carried out exploration and drilling programs to delineate additional oxide ore reserves on the Mount Nansen mine property, particularly on the nearby Flex zone. The mine shut down in the spring of 1999.

Total production in 1998
472 kg (15,190 oz.) Au • 1208 kg (38,849 oz.) Ag

Total production in 1999
15 500 tonnes at a grade of 7.5 g/t Au and 50 g/t Ag, or 116.2 kg (3738 oz.) Au and 775 kg (24,917 oz.) Ag

Reserves/resources are from a variety of sources and may not be compliant with National Instrument 43-101 Standards, unless specified.

DISCOVERY CREEK	115 I/3
Bill Trerice	62°05'N 137°11'W
Water Licence: PM92-062	1993, 1994
Big Creek/Mt. Nansen Map	Site No. 178

Operation/Location: Bill Trerice was mining between the headwaters of Discovery Creek and its confluence with Eliza Pup. He worked a single shift each season with the help of one other miner.

Equipment/Function: A D355A Komatsu bulldozer was used for stripping, pushing up pay, and a 966 Caterpillar loader removed tailings. A UH07 Hitachi hoe fed the sluice box and dug ditches where required.



A view of Bill Trerice's mining operation on Discovery Creek, in the Mt. Nansen area.

Wash Plant: Pay material was fed at a rate of 40 loose cubic yards per hour into a 7 foot by 12 foot hopper/grizzly equipped with two monitors and four spray bars. A screen deck 4 feet wide by 8 feet long fed ¾ inch minus material into a single sluice run 4 feet wide by 20 feet long. The top four feet was lined with expanded metal with 1¼ inch by 3 inch openings, followed by two feet of slick plate, another four feet of expanded metal, more slick plate, and then 1¼ inch angle iron riffles to the bottom. The run was set to a 1½ inch to the foot grade.

Ground Description: The total depth exceeded 35 feet to bedrock. Six feet of black muck covered six feet of silty sand over a six foot layer of gravelly clay. Beneath this was 18 feet of silty gravel covering a thin layer of well washed gravel that contained very fine gold. Eighteen feet of the silty gravel was sluiced along with the washed gravel.

Mining Cuts: In 1993, the first year of operation, 15,000 cubic yards were processed. Another 15,000 yards were sluiced in 1994.

Water Supply and Treatment: Water was acquired at a rate of 1000 igpm from a recirculation pond, using a 6 by 6 inch Monarch pump powered by a 35B GMC engine. The effluent was treated in a series of out-of-stream settling pond on the left limit of Discovery Creek.

Gold: Most of the gold was fine, with the largest nugget weighing 20 grams. Fifty percent was smaller than 30 mesh, 25% was between 30 and 18 mesh, 20% fell between 18 and 10 mesh, and 5% was greater than 10 mesh. Fineness ranged from 820 to 850.

VICTORIA CREEK	115 I/3
John Trout	62°05'N 137°08'W
Water Licence: PM94-028	1994
Big Creek/Mt. Nansen Map	Site No. 179

Operation/Location: John Trout and Gordon Hagen worked single shifts in 1994. The mine was located on the right limit of Victoria Creek, at its confluence with Eva Creek.

Equipment/Function: A D8H Caterpillar bulldozer was used to strip and push up pay material. A 966C Caterpillar loader fed the sluice and removed coarse tailings.

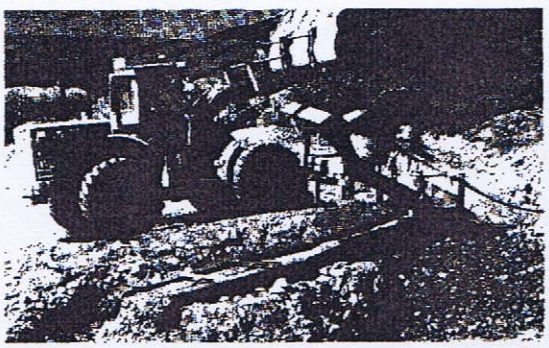
Wash Plant: A one horsepower Honda motor powered a small shaker wash plant. Pay material was fed into a hopper at a rate of 20 to 25 cubic yards per hour. It crossed a shaking table 30 inches wide by 8 feet long lined with one inch punch plate, before entering a sluice run 18 feet long. The first three feet was lined with two inch riffles, followed by three feet of one inch riffles. Four feet of slick plate widened the run from 2 to 4 feet, and was followed by eight feet of one inch expanded metal.

Ground Description: Four feet of black muck lay over a pay streak roughly three feet thick. This pay section contained brown clay and washed boulders. The material beneath this was not gold

bearing, and the operators did not probe to bedrock.

Mining Cuts: Information on the area and volume of cuts was not available.

Water Supply and Treatment: Water was acquired from an instream reservoir on Victoria Creek. It was pumped to the wash plant at the rate of 400 igpm by a Berkeley pump powered by a 4-cylinder Allis Chalmers gasoline engine. Waste water was treated in three out-of-stream settling ponds.



John Trout sluicing on upper Victoria Creek, near the confluence with Eva Creek.

Gold: Most of the gold was fine, although some 4 to 5 gram nuggets were recovered. Sixty percent was greater than 40 mesh, and 40% was 40 to 60 mesh. Fineness ranged from 790 to 810.

NANSEN CREEK 115 I/3
B. Johnson & L. Johnson 62°04'N 137°14'W
Water Licence: PM93-070 1994
Big Creek/Mt. Nansen Map Site No. 180

Operation/Location: Brian and Loren Johnson took over BYG Natural Resources Ltd.'s operation on the left limit of Nansen Creek in August 1994. Five miners worked a single shift for the remainder of the season.

Equipment/Function: A D9H Caterpillar bulldozer was used for stripping and pushing up pay. A 980C Caterpillar loader and a 966 loader were used to stockpile pay at the sluice box and remove tailings. The pay was fed into the box by a 225 Caterpillar excavator with a one cubic yard bucket.

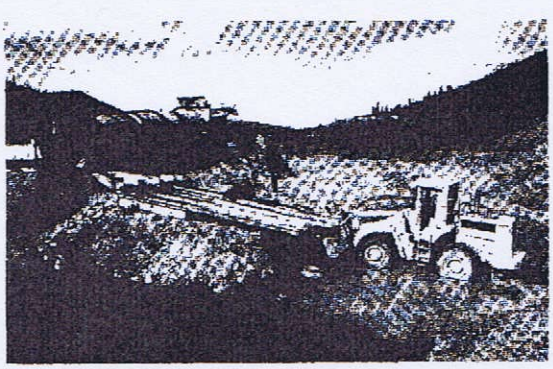
Wash Plant: Pay material was fed at a rate of 100 loose cubic yards per hour into a 6 foot by 10 foot hopper. The pay continued into a trommel 7 feet in diameter by 40 feet long, lined with large angle iron scrubbers. The classified pay entered four sluice runs three feet wide lined with Nomad carpet and two inch expanded metal. Two runs were 24 feet long and two were 26 feet long.

Ground Description: The total depth was unknown, but the average depth to the bottom of the pay zone was 30 feet. Ten feet of overburden was stripped off and 20 feet of homogenous pay gravels were sluiced. The ground was frozen.

Mining Cuts: A cut 200 feet wide by 500 feet long was started in 1994. The operators estimated that 50% of this cut would be completed by the end of the season.

Water Supply and Treatment: Water was acquired from Nansen Creek at a rate of 900 igpm using a 10 by 12 inch Cornel pump powered by a 3208 Caterpillar engine. The effluent was treated in a large out-of-stream settling pond before discharging by way of a long drain into Nansen Creek

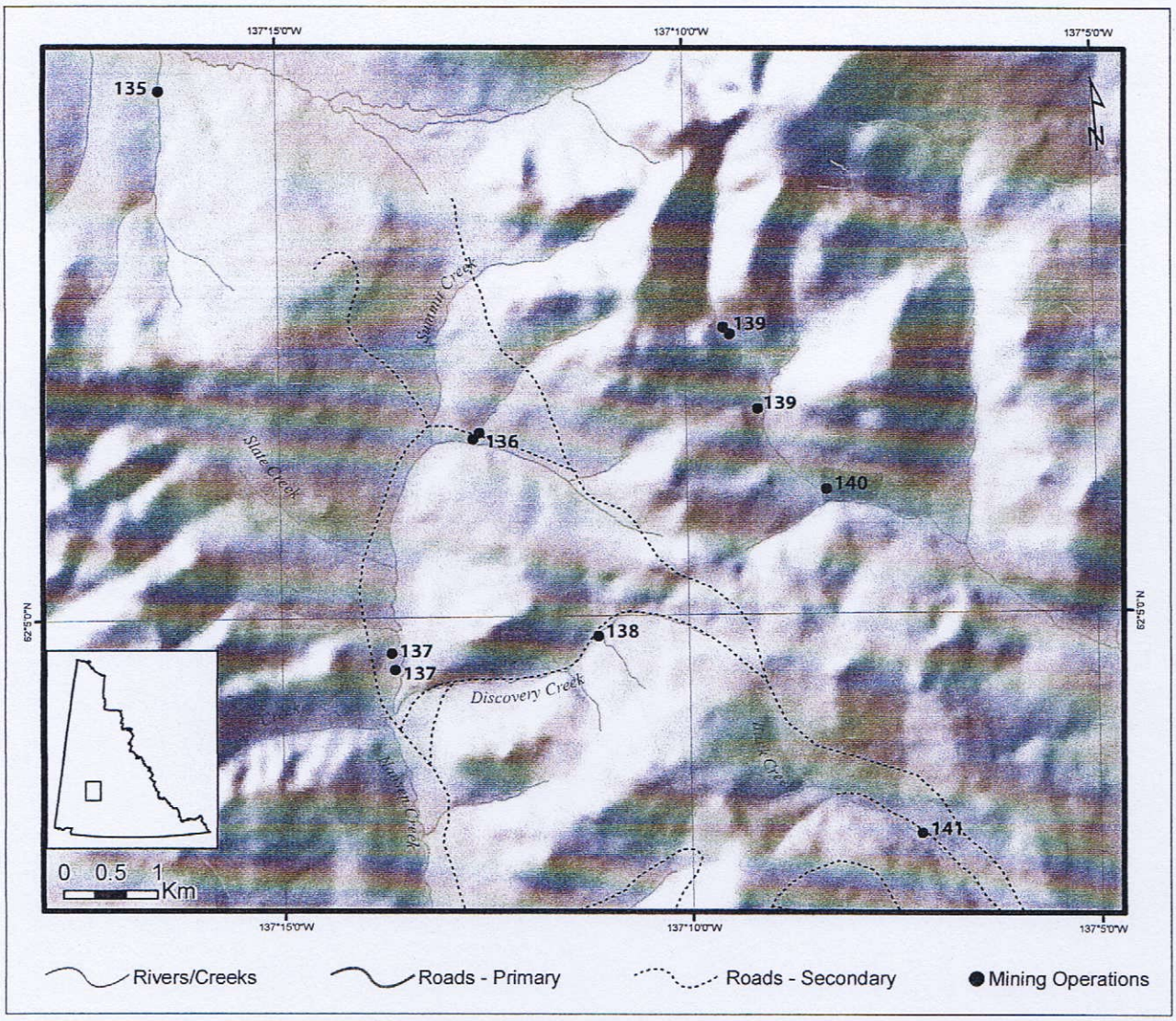
Gold: A clean up was conducted every 30 hours. Ninety percent of the gold was 40 mesh or finer. Fineness was 800.



Brian and Loren Johnson performing a clean-up on Nansen Creek.

DAWSON RANGE DRAINAGES:
NANSEN
PLACER AREA

SITES 135 - 141



LEGEND

135 ..... Canaan Gold Resources Inc.
136 ..... Nansen Gold Resources Inc.
137 ..... Johnson Exploration
138 ..... Frizzell
139 ..... La Tierra Resources Ltd.
140 ..... Spring Cove Enterprises Ltd.
141 ..... 38857 Yukon Inc.

Surficial Geology and Stratigraphy The stratigraphic section in 2008-2009 was composed of 2 feet (0.6 m) of overlying organic muck followed by 38 feet (12 m) of gravel on bedrock.

Bedrock Geology Bedrock is mapped as mid-Cretaceous intrusive and volcanic rocks.

Gold Characteristics Gold recovered in 2008-2009 was flat and fine-grained (less than 40 mesh) with a purity of 780.

Victoria, a tributary of Nisling

115I/3 2007: 62°05'44"N, 137°08'18"W

Spring Cove Enterprises Ltd., 2007-2009

Water License: PM06-524 (Closed 2017)
Water License: PM07-565 (Valid 2017)
Active Producer (2007-2009) **Operation no. 140**

Location The operation was located on Upper Victoria Creek, at the former Trout mine.

Work History and Mining Cuts Lloyd and Geoff Wade purchased the operation from the Trout estate in 2006. In 2007 and 2008, a cut was processed on the left limit in an old channel. Some testing was conducted on downstream claims and at the mouth of Eva Creek. In 2009, the operation moved upstream to conduct testing on La Tierra Resources Ltd. claims.

Equipment and Water Treatment Equipment included a Caterpillar 320C excavator a Caterpillar 235 excavator, Caterpillar D8H and D8K bulldozers, a Caterpillar 966 loader and a Kenworth 10 ton dump truck. The wash plant consisted of a trailer-mounted 48 inch by 8 foot shaker deck with a hopper, leading to a sluice run measuring 4 feet wide and 15 feet long, lined with Nomad matting, 3/8" expanded metal, 1" hydraulic riffles, and 1" angle iron riffles. Water



Spring Cove Enterprises wash plant at their upper West Victoria Creek operation in 2007.

was acquired from Victoria Creek and settled out-of-stream. Clean-ups were done with a pulsating jig, followed by classifying screens and pans.

Surficial Geology and Stratigraphy The section on the left limit consisted of 3 to 5 feet (0.9 to 1.5 m) of organics and cobbly silt overlying a rusty, highly-weathered, sandy boulder cobble gravel 15 to 30 feet (4.5 to 9 m) thick, increasing with distance into the hill. There were localized frozen lenses. The largest rocks were boulders 3 feet (0.9 m) across with the average size less than 1 foot (0.3 m) in diameter. The lowest 10 feet (3 m) of gravel plus 1 to 2 feet (0.3 to 0.6 m) of bedrock were sluiced.

Bedrock Geology Bedrock is mapped as a mid-Cretaceous granite in fault contact with a volcanic unit. The fault runs roughly parallel to the creek.

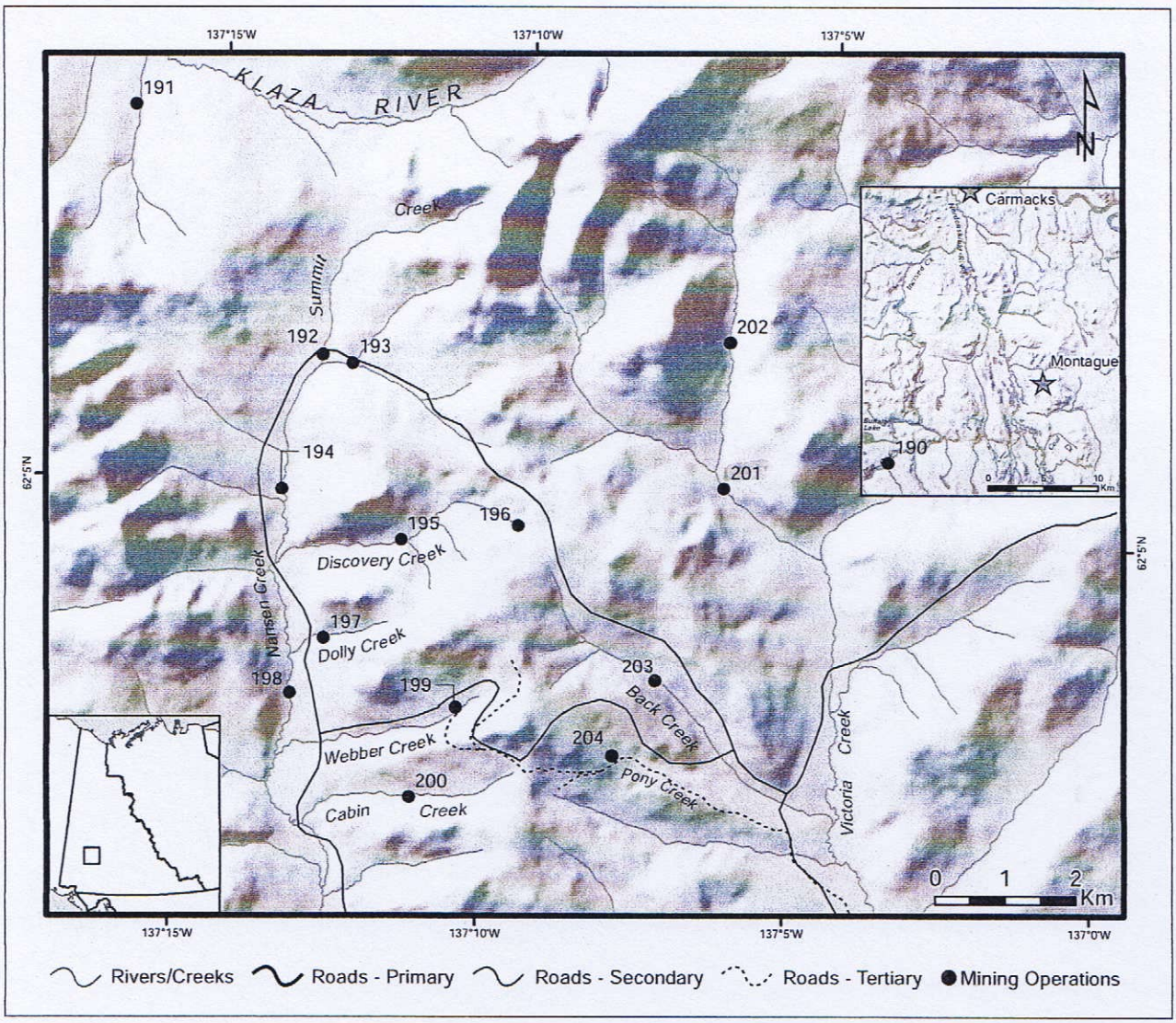
Gold Characteristics Gold from this location has been reported as flat and fine-grained, with some angular and wire pieces.



Aerial view of Spring Cove Enterprises mining operation on a left limit bench of upper West Victoria Creek in 2007.

NANSEN PLACER AREA

SITES 190 - 204



LEGEND

190 ..... Diamond Tooth Resources Inc.
191 ..... Canaan Gold Resources Inc.
192 ..... Pishon Gold Resources Inc.
193 ..... 38241 Yukon Inc.
194 ..... Johnson Exploration
195 ..... Smith, G.
196 ..... Marshall, C.
197 ..... Crawford and Marchand
198 ..... Chaschin, K
199 ..... Orotec International Ltd.
200 ..... Berdahl, R.
201 ..... Spring Cove Enterprises Ltd.
202 ..... Aley, R.
203 ..... 38857 Yukon Inc.
204 ..... Tulk, G.

CABIN, A TRIBUTARY OF NANSEN

115I/03 2013: 62°02'42"N, 137°11'11"W

Berdahl, R., 2014
Orotec International Ltd., 2009, 2010

Water License: PM07-590 (Active 2018)
Active Producer (2009-2010, 2014) **Operation no. 200**

LOCATION Cabin Creek

WORK HISTORY AND MINING CUTS No work history was reported for the 2010 mining season. In 2014, the property was transferred to Ron Berdahl. Mr. Berdahl completed a 2-D resistivity program under the Yukon Mineral Exploration Program (YMEP).

EQUIPMENT AND WATER TREATMENT Not reported.

SURFICIAL GEOLOGY AND STRATIGRAPHY The surficial geology of Cabin Creek is partially exposed in exploration cut lines in the headwaters of the drainage. Exposures indicate that near surface deposits consist of weathered bedrock colluvium. The drainage was glaciated by pre-Reid ice and erratics from this glaciation are present at the drainage divide at 1312 m (4300 ft) elevation. Erosion of valley bottom deposits from this glaciation was likely minimal because the drainage orientation is perpendicular to local ice flow up the Nansen Creek valley. Till deposits should be expected within the valley bottom stratigraphy along Cabin Creek and should overlie a pre-glacial gravel. Post-glacial aeolian sand deposits form significant accumulations in the lower part of the drainage, especially on the left-limit. These deposits will be a hindrance to placer development; however the upper reaches of the drainage and the right limit generally have less sand overburden.

BEDROCK GEOLOGY Bedrock is calcite-biotite-schist, amphibolite, gneiss, schist, phyllite, quartzite, and ultramafics (Templeman-Kluit, 1984). At the headwaters of the drainage is the Flex deposit with epithermal vein mineralization and gold grades averaging 5.9 g/t. The gold in the epithermal deposits typically occurs within quartz veins and up to 25% could be free gold or electrum (Hart and Langdon, 1998).

GOLD CHARACTERISTICS Not reported.

VICTORIA, A TRIBUTARY OF NISLING

115I/03 2014: 62°05'16"N, 137°06'26"W

Spring Cove Enterprises Ltd., 2007-2012; Harasimiuk, S., 2012-2014

Water License: PM06-524-1 (Active 2017)
Water License: PM07-565 (Active 2017)
Active Producer (2009-2010, 2014) **Operation no. 201**

LOCATION Upper left fork of Victoria Creek.

WORK HISTORY AND MINING CUTS Spring Cove Enterprises Ltd. (PM07-565) operated on Victoria Creek from 2010 to 2012. In 2010, they mined a cut on their lower claims located on the left limit of Victoria Creek. They also drilled the left limit with an impact drill to determine the location of the paleochannel. No activity was reported in 2011. In 2012 through 2014, Mr. Harasimiak (under PM06-524-1) leased the ground and initiated a program of testing a number of targets on the claim block. This work included test pitting, bulk sampling, drilling with an 8" auger, and resistivity geophysics. Approximately 44 test pits were dug on Victoria, Eva, and Lady Bug creeks.

EQUIPMENT AND WATER TREATMENT Equipment reported on site included a Caterpillar D11 and D8 bulldozers, a Komatsu 400 excavator, 400 Hitachi excavator, 450 and 500 Komatsu loaders, and Caterpillar 312B excavator for feeding the plant. Two wash plants were employed during the testing program. The smaller plant was a Goldfields Clay Buster trommel capable of handling 50 yd^3 per hour. It had a 6" grizzly dump that fed a 30 ft trommel with a double screen that classifies material into two size ranges for sluicing in separate runs: 1/4" to 3/8" and <1/4". The sluice runs have an initial 4 ft wide run that is split into two 3 ft wide runs for a total length of 18 ft. A variety of separation technologies are used in the runs including a nugget trap, hydraulic riffles, angle iron riffles, expanded metal, and 3M miners moss. The larger of the two plants, primarily used in the bulk sample testing, has an 8 ft wide shaker deck that screens to 1/2" and 1/4" and again has separate sluice runs for each fraction. The oscillating sluice runs are 4 ft wide by 16 ft long.

SURFICIAL GEOLOGY AND STRATIGRAPHY The primary target in Victoria Creek is a near surface modern gravel that was deposited on a false bedrock of clay and silt-rich glacial moraine (till). The modern gravel ranges in thickness from 3.6 to 6 m (12 to 20 ft) and the high grade channel is reported to meander within the valley bottom. Limited drill testing indicated that the till unit is 16 m (55 ft) thick near the mouth of the left fork of Victoria Creek. Gravel was reported below the till, similar to the stratigraphy documented on Back Creek.

Bedrock Geology Bedrock is granodiorite and quartz diorite (Templeman-Kluit, 1984).

Gold Characteristics The gold is generally fine with a few nuggets.

Unnamed, a tributary of Victoria

115I/03 2013: 62°06'24"N, 137°06'30"W

Aley, R., 2013

Water License: PM13-026 (2023)
Active Producer (2013) **Operation no. 202**

Location Unnamed left limit tributary of the left fork of Victoria Creek.

Work History and Mining Cuts Mr. Aley operated with one to three miners and one camp personnel in their first season (2013). They worked a 10 to 12 hour shift daily, primarily conducting exploration and some sluicing. Several test holes were dug throughout the season and materials were manually handled for testing, assessment, and sampling.

Equipment and Water Treatment Equipment included a Caterpillar D7 bulldozer with a 10 ft straight blade, a Komatsu WA350 wheel loader with 3.5 yd bucket, and a Caterpillar 330 excavator with 0.75 yd and 1.5 yd buckets. Water was acquired from the unnamed creek and supplied at 500 igpm by a 6" Detroit pump powered by a diesel engine. The trommel wash plant was 8 ft in diameter by 20 ft long with 1" punch plates. The sluice run sloped 1" per foot and was 8 by 20 ft with synthetic rubber matting. Clean-ups were conducted with a pan.

Surficial Geology and Stratigraphy Not reported.

Bedrock Geology Bedrock is calcite-biotite-schist, amphibolite, phyllite, and quartzite (Templeman-Kluit, 1984).

Gold Characteristics Gold is dull with rough edges and approximately 6 mesh in size.

Back, a tributary of Victoria

115I/03 2014: 62°03'44"N, 137°07'21"W

38857 Yukon Inc., 2006-2013; A-1 Cats, 2014

Water License: PM10-019 (2020)
Active Producer (2010-2014) **Operation no. 203**

Location Back Creek, approximately 3 km upstream of its confluence with Victoria Creek.



Wash plant on Victoria Creek at Mr. Harasimiuk's operation in 2012 (Photo credit: Steve Beaulieu).

Yukon
Water Board

Office des eaux
du Yukon

August 10, 2012

44280 Yukon Inc. c/o Michal Bidrman
164-108 Elliot Street
Whitehorse YT Y1A 6C4

Steve Harasionirk
Box 343
Ardmore AB T0A 0B0

RE: Application to assign Water Use Licence PM06-524 and Mining Land Use Operating Plan Approval AP06524

The Yukon Water Board has received your application to assign this water use licence and mining land use operating plan approval. Unfortunately, before we can proceed with your application, we require some additional information.

The following documents are required to complete your application:

1. Copies of all documents pertaining to the lease, sale, rental or other disposition of the property or the licence from one party to another. Since these documents are available to the public, you may choose to black-out dollar figures.
2. A claims status sheet that includes only those grant numbers included in licence PM06-524. The claims status report must be obtained from the Yukon Government Mining Recorders Office indicating the ownership of the active claims. If the claims are not in the name of the Assignee, a letter of agreement between the claim owner(s) and the Assignee must be provided allowing the Assignee to mine the claims for the remaining term of the licence.

Further to the above mentioned documents, both the application fee in the amount of $30.00 for the assignment of a placer water use licence and the application fee in the amount of $50.00 for the assignment of a placer mining land use approval are also required. Payment can be made payable to the Territorial Treasure.

Please remit payment in the amount to $80.00 at your earliest convenience. Our office will accept a VISA or MasterCard number over the phone. As well, we accept payments in person via cash, cheque, postal money order, credit card or debit card. If payment has already been sent, please disregard this request.

Your application will not be considered by the Board without these documents and applicable fees (if still outstanding). Your proposal for the effective date to be 45 dates after your application was submitted will not commence until you provide a completed application. Please provide copies of the relevant documents as soon as possible so that we can begin to process your application.

Sincerely,

Jennifer Logan
Licensing Officer

C: File PM06-524-AS-2

Suite 106, 419 Range Road, Whitehorse, Yukon Y1A 3V1 Ph: 867-456-3980 Fax: 867-456-3890
419, chemin Range, bureau 106, Whitehorse (Yukon) Y1A 3V1 Tél: 867-456-3980 Téléc: 867-456-3890
ywb@yukonwaterboard.ca www.yukonwaterboard.ca

RECEIVED
JUL 13 2012

APPLICATION FORM
ASSIGNMENT OF A PLACER WATER USE LICENCE AND CLASS 4 MINING LAND USE OPERATING PLAN

~~Amendment~~

Licence # : PM06524 MLU Operating Plan #: AP06524 Water Source : Victoria Creek

Name of Licensee : 44280 Yukon Inc c/o Michal Bidrman

Address : 164- 108 Elliott St

Whitehorse, Y.T. Y1A 6C4

Phone: (867) 336 4400

Water Use Fees pertaining to this licence must be paid in full.

DECLARATION OF LICENSEE

I, MICHAL BIDRMAN, representing 44280 Yukon Inc

_____, hereby declare that the sale or other disposition of any right, title or interest in the appurtenant undertaking will not result in any contravention of any provision or condition of water use licence number PM06524 or mining land use operating plan number AP06524, or of any provision of the *Waters Act* or the *Placer Mining Act*, or the *Regulations* under those Acts, and hereby request the assignment of the water use licence and the mining land use operating plan to:

Proposed Assignee : Steve Harasimuk

Address : Box 343

Carmacks Alberta, T0A 0C0 Phone: (780) 812-4525, 221-8585

Proposed date : 45 days after date of application (☐) or _____

Signature of Licensee: _____

Date: July 18, 2012

Application Fee for assignment of placer water use licence $30. Receipt # 738550
Application Fee for assignment of placer mining land use approval $50. Receipt# 738550

Suite 106, 419 Range Road, Whitehorse, Yukon Y1A 3V1 Ph: (867) 456-3980 Fax: (867) 456-3890

DECLARATION OF ASSIGNEE

I, (name - please print) Steve Hansen

representing _____
(If a Limited Company)

hereby declare that I am the signing authority for the Assignee and

THAT I request the Yukon Water Board to authorize the assignment of

Water Use Licence number PM 06527, and

Mining Land Use Operating Plan Approval number AP06527, and

THAT I have read the applications for water use licence and mining land use operating plan, and the water use licence and the mining land use operating plan approval and confirm that I am not proposing any variation,

THAT As of the effective date of the authorization, I accept all legal rights and obligations conferred by the Water Use Licence and the Mining Land Use Operating Plan Approval referred to in this application, including any obligations which may be outstanding with respect to compliance with the said Licence and Approval.

Dated this 18 day of July, 2012

in the City/Town of Whitehorse, in the Province/Territory of

Yukon, Canada.

Signature of Assignee

Suite 106, 419 Range Road, Whitehorse, Yukon Y1A 3V1 Ph: (867) 456-3980 Fax: (867) 456-3890

YUKON WATER BOARD
REASONS FOR DECISION
Water Use Application PM06-524, Spring Cove Enterprises Ltd.
and Mining Land Use Approval AP06524

The Yukon Water Board (the board) has made licensing decisions with respect to water use application PM06-524 for a type B licence for a placer mining undertaking and mining land use approval AP06524.

The purpose of the application is to obtain a water use licence to obtain and store water, deposit a waste and to obtain an approved placer mining land use operating plan.

Notice of the application was provided in accordance with the requirements of the *Waters Act* and the *Placer Mining Land Use Regulation*. In response, the board received interventions from the following parties:

Fisheries and Oceans Canada (DFO);
Government of Yukon (GY), Energy, Mines and Resources, Client Services and Inspections Branch; and
Government of Yukon (GY), Energy, Mines and Resources, Mineral Resources.

No party requested a public hearing. The applicant did not respond to the interventions.

This application required an environmental assessment under the *Yukon Environmental and Socio-economic Assessment Act* (YESAA).

Prior to making licensing decisions, the board reviewed the YESAA Decision Document (Decision Document) that is included in the water use register. The Decision Document included several terms and conditions pertaining to water use which restricted the board's jurisdiction under the *Waters Act*. As per section 86 of the YESAA, the board is satisfied that the licence and approval is not contrary to the Decision Document.

In making licensing decisions pertaining to this application, the board took into account the *Waters Act*, *Waters Regulation*, the application, the Decision Document, recommendations from the interveners, the board's standard licence requirements, Territorial Resources Base Map 115I/3 and Mining Map 115H/4, the Umbrella Final Agreement (UFA) and board policies.

Neither the applicant nor the Decision Document proposed alternative approaches to the operating conditions in the *Placer Mining Land Use Regulation*. These operating conditions have been incorporated into the Placer Land Use Approval For a Class 4 Operating Plan.

DFO

The effluent standard recommended by DFO is the same standard as referenced in the Yukon Placer Authorization (YPA). The YPA is an authorization under the *Fisheries Act* for the harmful alteration, disruption or destruction of fish and fish habitat in certain streams, or portions of streams, in the Yukon for placer mining works and undertakings, subject to compliance with the standards of allowable sediment discharge. The board has adopted the YPA as policy for the minimum allowable discharge standard. The effluent discharge standards and operating standards, which are stipulated in the YPA, have been incorporated in the licence.
DFO provided specific recommendations for the use of the creek as a conduit, diversions and instream settling; however, the applicant does not propose to use the creek as a conduit, build diversions or to instream settle. The licence only authorizes those undertakings described in the application, therefore, the licence does not permit either of these activities.

DFO provided standard recommendations for fuel, lubricants, cleansers, solvents and similar chemicals or substances to be transported, stored and disposed of in such a way as to ensure that they are not deposited in, or allowed to be deposited in, waters. The typical condition to transport, store and dispose of fuels, lubricants, cleansers, solvents and similar chemicals or substances in such a way as to ensure that they are not deposited in, or allowed to be deposited in, waters has been included in the licence.

DFO has provided standard recommendations that all diversions, ditches, drains, dams, or any structure built or otherwise effected is able to withstand seasonal floods. The typical condition that requires all diversions, ditches, drains, dams or any structure built or otherwise effected to withstand seasonal floods has been included in the licence. However, since the applicant is not proposing to build diversions the reference to diversions has not been included in the licence.

DFO has provided standard recommendations to ensure that spring freshet is not routed through work areas and where diversion channels around working areas are built or excavated they should be open in preparation for spring freshet. The typical conditions not to allow spring freshet to be routed through work area has been included in the licence. However, the applicant has not requested diversions, therefore the recommendation to open diversion channels has not been included in the licence

GY

GY recommended that the point of compliance should be at the point of entry to the stream. The board included the standard clause for the effluent and point of compliance to satisfy this concern. The point of compliance will be at the point of discharge from the final settling facility. The licence also requires all works to be maintained in good order and be of adequate capacity, including any works that are between the compliance point and the stream.

GY recommended that if a clay liner is used, that it should be approved by an engineer and the engineer should be present during the installation of the liner. GY further stated that although the applicant proposed the use of a clay liner in the application, he did later clarify that he would instead use an approved commercial liner. The typical condition that requires the provision of secondary containment that is impervious to petroleum products is included in the approval to satisfy this concern.

YESAA

The board reviewed the Decision Document for conditions that would be applicable to water related activities. The Decision Document included a requirement for the construction and restoration of all channels to be consistent with the *Guidelines for the Design and Construction of Stream Channels for Yukon Placer Mined Streams* or any other successor guidebook of mitigation for placer mining in the Yukon. However, since the applicant is not requesting diversions the board did not include this condition in the licence.

Chapter 14 of the Umbrella Final Agreement

The board examined the proposed use of water as it relates to Chapter 14 of the Umbrella Final Agreement, as to quantity, quality, or rate of flow of water flowing on, through or adjacent to settlement land, including seasonal rate of flow, as follows:

Territorial Resources Base Map 115I/3 and Mining Map 115H/14 are referenced in the Little Salmon/Carmacks First Nation Final Agreement. Map 115I/3 indicates the presence of settlement land parcel R-21B located approximately 10.2 km downstream of the proposed operation on Victoria Creek.

The applicant indicates that the amount of water available during the mining season is approximately 345,600 m^3/d for Victoria Creek and 86,400 m^3/d for Eva Creek. The applicant is proposing to obtain water at a combined maximum rate of 9,636 m^3/d. The applicant also indicates that he will be recycling about 90% of the water obtained from Eva Creek. Eva Creek flows into Victoria Creek. With 90% recycling occurring on Eva Creek and approximately 2.7% available flow being used on Victoria Creek the quantity and rate of flow of water flowing on, through or adjacent to settlement land will not be substantially altered.

The effluent standard recommended by DFO and stipulated in the YPA of 3.0 ml/L of settleable solids, being deposited into Victoria Creek and Eva Creek, will ensure that the quality of water flowing on, through or adjacent to settlement land is not substantially altered.

Original signed by Chair

_____

Chairperson
Yukon Water Board

Date

Jennifer.Logan

From:	Jennifer.Logan
Sent:	Tuesday, August 28, 2012 2:28 PM
To:	ymichalb@gmail.com
Subject:	Water Use Licence PM06-524, Assignment
Attachments:	PM07-565 amendment to PM06-524, licence.pdf; Map of grants included in PM06-524.pdf

Good Afternoon Michal,

I received your message this morning. I must apologize, the first grant listed in the email I sent to you yesterday should have been P 47573 and not P 47572.

Please see the attached amendment licence PM07-565 (amendment 1 of PM06-524), Appendix A. The grants which need to be removed by way of an amendment are the last four grants listed on Appendix A. As well, please see the map I attached which shows the former location of the expired grants. Both documents were attached in yesterday's email, but have been included with this email for your convenience.

I trust this email will provide further clarification. Please feel free to call if you require further assistance.

Jennifer

Jennifer Logan
Licensing Officer
Yukon Water Board Secretariat

Suite 106 – 419 Range Road, A-419
Whitehorse YT Y1A 3V1
(867) 456-3987
(867) 456-3890 (fax)
Jennifer.Logan@gov.yk.ca

Jennifer.Logan

From:	Jennifer.Logan
Sent:	Monday, August 27, 2012 1:30 PM
To:	'ymichalb@gmail.com'
Subject:	Water Use Licence PM06-524, Assignment
Attachments:	pm06_524_license.pdf; PM07-565 amendment to PM06-524, licence.pdf; schedule4.pdf; Map of grants included in PM06-524.pdf

Good Afternoon Michal,

In order to proceed with the assignment of PM06-524 to Steve Harasimiuk the four grants (P 47572, P 47574, P 47575 and P 47576) which are no longer active, but were still included in the water use licence, need to be removed. As I had indicated to you during our phone conversation last week, it would appear that these four grants expired and were never renewed with the Mining Recorders office, but remained in water licence PM06-524 and mining land use approval AP06-524.

I would encourage you to speak with an Inspector for your area, as any work done and any outstanding reclamation on these grants would be the responsibility of the yourself as the Licensee.

All amendments require the Water Board's Schedule 4 application, along with a letter from 44280 Yukon Inc., as the current licence holder, requesting the removal of the four inactive grants. Please specify the grant numbers in this letter and it would also be helpful to include a map showing the location of were these grants when they were active.

Amendments further require a $30 application fee and a $150 fee to amend the mining land use approval made payable to the Territorial Treasurer. Payments can be made in person or over the phone using VISA or MasterCard.

In my review of application PM07-565 (amendment 1 of PM06-524) to add the grants, it appears these grants do not have any of the water uses proposed in the mining plan which would require a further amendment beyond just their removal from the licence and approval. Their removal should not impact the mining plan the new Licensee has agreed to continue to follow under PM06-524 and approval AP06-524.

For your convenience, I have attached a copy of water licence PM06-524 showing the four grants in the attached Appendix A. As well, I have included a copy of the map which was included in the amendment application PM07-565.

If you require further assistance please do not hesitate to contact me to discuss this.

Jen

Jennifer Logan
Licensing Officer
Yukon Water Board Secretariat

Suite 106 - 419 Range Road, A-419
Whitehorse YT Y1A 3V1

21

Exhibit 10.2

MINING LEASE

THIS MINING LEASE ("Agreement") is made this 18th day of August 2012 by and between:

Lessor ("Owner");

44995 Yukon Inc.
164- 108 Elliott Street,
Whitehorse, Yukon,
Y1A 6C4

Represented by: Michal Bidrman

And
Lessee ("Operator");

Bonnyville Oilfield Service and Supply Ltd
P.O. Box 6409
Bonnyville, Alberta
T9N 2G9

Represented by: Steve Harasimiuk

RECITALS

A. Owner possesses (38) Placer mining claims located along Victoria Creek (and tributaries) at Mount Nansen, Yukon. The claims are more particularly described on Exhibit A attached hereto. These claims, together with all ores, minerals, surface and mineral rights, and the right to explore for, mine, and remove the same, and all water rights and improvements, easements, licenses, rights-of-way and other interests appurtenant thereto, legally assigned to the Owner by the Yukon Territorial Government, shall be referred to collectively as the "Property".
B. The parties now desire to enter into an agreement giving Lessee the exclusive right to explore, develop, and mine the Property pursuant to the terms and conditions of this Agreement.
THEREFORE, the parties have agreed as follows:

SECTION ONE

Lease Term and Royalties

1.1 Term of Lease. Owner hereby leases the Property to Lessee for an initial term of five (5) years, and renewable for additional five (5) year periods not to exceed 99 years. **The Effective Date of this Agreement will be August 18th, 2012,** and all rights and obligations shall be calculated on the basis of that date.

1.2 Area of Influence. A one mile area of influence, extending from the current boundaries of the Property, within which any claims located or acquired by Lessee will be considered part of the Property.

1.4 Annual Work Commitment. Lessee agrees to diligently pursue commercial production as contemplated by this agreement.

1.5 Production Royalties. Royalty shall be paid by Lessee to Owner for gold produced from mining claims within the area of influence. Lessee agrees to submit to Owner Ten percent (10%) of all raw gold produced. Lessee and Lessor will each be responsible to submit Yukon Government royalty payment for their quantity of gold produced.

a. Sales, use, gross receipts, severance, and other taxes, if any, payable with respect to severance, production, removal, sale or disposition of the minerals from the Property, but excluding any taxes on net income;

b. Actual charges and costs, if any, for transportation from the mine or mill to places where the minerals are smelted, refined and/or sold but specifically excluding costs of transportation of ores to a mill or other processing facility, that is not a smelter or refinery, where concentrates or ore are produced; and

c. Actual charges, costs (including assaying and sampling costs specifically related to smelting and/or refining), and all penalties, if any, for smelting and/or refining.

Payment of production royalties shall be made on or about the last day of each operating month.

1.6 Delivery of Data. Upon execution of this Agreement Owner shall deliver to Lessee copies of all maps, deeds, and other documents in his possession which pertain to the claim title and boundaries, prior workings and production history, and so forth.

SECTION TWO

Operations

2.1 Right to Explore, Develop and Mine. Upon execution of this Agreement, Lessee shall have the right to make geological investigations and surveys, to drill on the Property by any means, and to have all the rights and privileges incident to ownership of the Property, including

J.B MLL JM

without limitation the right to mine, extract by leaching in place or any other means, remove, save, mill, concentrate, treat, and sell or otherwise dispose of ores, concentrates, mineral-bearing earth and rock and other products therefrom.

2.2 Conduct of Work. Lessee shall perform its mining activities on the Property prudently, diligently and in accordance with good mining practice, and shall comply with all applicable laws and regulations.

2.3 Liability and Insurance. Lessee shall indemnify and hold Owner harmless from any claims, demands, liabilities or liens arising out of Lessee's activities on the Property or under this Agreement. To that end, Lessee shall protect Owner against any claims for injury to persons or damage to property of third parties resulting from Lessee's operations.

2.3.1 Environmental Liabilities. Lessee, its successors and assigns shall indemnify and hold Owner harmless from any environmental liabilities arising out of Lessee's activities on the property.

2.4 Liens. Lessee shall keep the Property free and clear from any and all liens and encumbrances, including mechanics' or laborers' liens arising from labor performed on or material furnished to the Property at Lessee's request. However, a lien on the Property shall not constitute a default if Lessee, in good faith, disputes the validity of the claim, in which event the existence of the lien shall constitute a default thirty (30) days after the validity of the lien has been adjudicated adversely to Lessee.

2.5 Installation and Removal of Equipment. Lessee may install, maintain, replace, and remove during the term of this Agreement any and all mining machinery, equipment, tools, and facilities which it may desire to use in connection with its mining activities on the Property. Upon termination of this Agreement for any reason, Lessee shall have a period of six (6) months following such termination during which it may remove all or part of the above items at its sole cost and expense. Owner may, at Owner's discretion, require Lessee to remove all of the above items from the Property upon termination. Any equipment remaining on the Property after six (6) months shall if and to the extent that Owner so elects by giving written notice of election to Lessee become the property of Owner.

2.6 Acquisition of Permits. Lessee shall acquire and comply with all federal, state and county permits required for its operations. Lessee shall be responsible for reclamation of only those areas disturbed by Lessee's activities. In the event that Lessee is required to post a reclamation bond, the bond if and to the extent provided for by applicable law, will revert to Lessee upon satisfactory completion of the reclamation program.

J.b MB.

Lesee agrees the reclamation of areas mined on the claims is to be completed to the written approval of the Mining Inspector for the area prior to abandonment and/or termination of this agreement.

2.7 Commingling of Ore. Lessee shall have the right to commingle ores from the Property with ores from other properties provided that Lessee weighs and samples Owner's ores in accordance with sound mining and metallurgical practices and fully and accurately accounts for Owner's share of production.

2.8 Drill Logs, Assays, and Maps. Upon request by Owner, copies of all drill logs, exploration information, assays, maps, metallurgical studies, and a summary report of all factual information shall be furnished by Lessee to Owner.

SECTION THREE

Inspection by Owner

3.1 Inspection of Property. Owner, or Owner's authorized agents or representatives, shall be permitted to enter upon the Property at all reasonable times for the purpose of inspection, but shall enter upon the Property at Owner's own risk and so as not to hinder unreasonably the operations of Lessee. Owner shall indemnify and hold Lessee harmless from any damage, claim, or demand by reason of injury to Owner or Owner's agents or representatives on the Property or the approaches thereto.

3.2 Inspection of Accounts. Lessee agrees to keep accurate books of account reflecting the mining operations on the Property, and Owner shall have the right, either personally or through a qualified accountant of Owner's choice and at Owner's cost, to examine and inspect the books and records of Lessee pertaining to the operations of Lessee and to materials produced from the Property.

SECTION FOUR

Taxes

Lessee shall pay all taxes levied or assessed upon the Property, existing improvements, and any improvements placed on the Property by Lessee. Upon termination of this Agreement for any reason, taxes shall be apportioned between the parties on a calendar year basis for the remaining portion of the calendar year. However, Owner shall not be liable for taxes on any tools, equipment, machinery, facilities, or improvements placed upon the Property unless Lessee fails to remove them within the time provided by this Agreement.

J.B SV

R.H.

SECTION FIVE

Maintenance of Claims

5.1 Rental Fees. So long as the annual assessment requirement is suspended, Owner shall pay all annual rental fees and filing costs required to maintain the Property in good standing. Owner is obliged to make any of the foregoing payments or filings in order to avoid forfeiture of the Claims. If Lessee terminates this Agreement before June 1 of any year, Lessee shall not be held responsible for rental payments or filings due in that calendar year.

5.2 Assessment Work. Lessee shall be responsible for the performance and filing of assessment work unless this Agreement is terminated as hereinafter provided. In the event of termination after June 1 of any calendar year, Lessee shall be responsible for the performance and filing of assessment work for that year.

Lessee agrees to recognize the existing claim's grouping and will file the maximum assessment work annually for the Property.

5.3 Relocation, Amendment, and Patent. At any time during which this Agreement is in effect, Lessee may, with the express written consent of Owner but at its own expense, relocate, amend or apply for patent on any of the unpatented mining claims included in the Property, and such relocated, amended, and patented claims shall be deemed to be covered by the provisions of this Agreement.

SECTION SIX

Termination and Default

6.1 Termination. Lessee shall have the right to terminate this Agreement at its sole discretion at any time by giving 30 (thirty) days written notice to Owner. Upon termination, Owner shall retain all payments previously made as liquidated damages and this Agreement shall cease and terminate. Lessee shall promptly upon termination provide Owner with all tests, samples, factual data, maps, assays, and reports pertaining to the Property.

6.2 Default. If Lessee fails to perform all of its obligations under this Agreement, including but not limited to the making of all payments due to Owner hereunder, Owner may declare Lessee in default by giving Lessee written notice of default which specifies the obligation(s) which Lessee has failed to perform. If Lessee fails to remedy a default within

J.B

ninety (90) days of receiving the notice of default, Owner may terminate this Agreement and Lessee shall peaceably surrender possession of the Property to Owner. Notice of termination shall be in writing and served in accordance with this Agreement. A copy of the written notice of termination shall be delivered to Lessee's legal consul who will promptly deliver to Owner.

6.3 Obligations Following Termination. In the event of voluntary or involuntary termination, Lessee shall peaceably surrender possession of the Property to Owner and shall have no further liability or obligation under this Agreement except for its obligation (1) to pay any advance and production royalties then owed to Owner; (2) to pay the cost of removal as stated in Section 2.5; (3) to fulfill its reclamation responsibilities as stated in Section 2.6; (4) to satisfy any accrued obligations or liabilities including but not limited to any relating to Lessee's obligations to indemnify and hold Owner harmless pursuant to Section 2.3; and (5) to satisfy any other obligation imposed by this Agreement or by law.

SECTION SEVEN

Notices and Payments

7.1 Notices. All notices to Lessee or Owner shall be in writing and shall be sent certified or registered mail, return receipt requested, to the addresses below. Notice of any change in address shall be given in the same manner.

TO OWNER: Represented by: Michal Bidrman

44995 Yukon Inc.
164- 108 Elliott Street,
Whitehorse, Yukon,
Y1A 6C4

TO LESSEE: Represented by: Steve Harasimiuk
Bonnyville Oilfield Service and Supply Ltd
P.O. Box 6409
Bonnyville, Alberta
T9N 2G9

J.B
MB.

7.2 Payments. All payments shall be in Canadian currency in the form of a bank draft or certified check payable to Owner at the address above or by wire transfer.

SECTION EIGHT

Assignment

Lessee may not assign this Agreement at any time, in whole or in part without Owner's consent, which shall not be unreasonably withheld. Owner will have 30 (thirty) days to object in writing with detailed valid reasons or the assignment will proceed.

SECTION NINE

Warranty of Title

9.1 Warranty. Owner represents, to the best of Owner's knowledge and belief at the execution of this Agreement, that Owner owns and possesses the mining claims described on Exhibit A and all lode mineral rights within the boundary of those claims. Owner further warrants that Owner is not aware of any claim disputes, legal actions, or environmental hazards affecting the Property.

9.2 Examination of Title Documents. Promptly after execution of this Agreement, Owner shall deliver to Lessee copies of all documents in Owner's possession bearing upon Owner's title, interest, or ownership in the Property. Lessee may then undertake such further investigation of the title and status of the claims as Lessee shall deem necessary. If that investigation should reveal defects in the title, Owner agrees to proceed forthwith to cure said title defects to the satisfaction of Lessee; and in the event Owner should not do so, Lessee may cure such title defects and deduct the expense incurred, including reasonable attorney's fees, from any payment to be made hereunder.

9.3 No Liability for Loss of Claims. Lessee shall not be held liable for the loss of any claims by virtue of invalid location by Owner. Lessee shall not be held liable for the loss of any claims due to any act of governmental agencies, provided that Lessee has promptly given Owner written notice of the initiation of any such act by a governmental agency and taken all reasonable and legal means to protect and maintain such claims.

SECTION TEN

Force Majeure

J.B

10.1 Suspension of Obligations. If Lessee is prevented by Force Majeure from timely performance of any of its obligations hereunder, except the payment of money, the failure of performance shall be excused and the period for performance shall be extended for an additional period equal to the duration of Force Majeure. Upon the occurrence and upon the termination of Force Majeure, Lessee shall promptly notify Owner in writing. Lessee shall use reasonable diligence to remedy Force Majeure, but shall not be required to contest the validity of any law or regulation or any action or inaction of civil or military authority.

10.2 Definition of Force Majeure. "Force Majeure" means any cause beyond a party's reasonable control that the party is unable to cure by the exercise of due diligence, including law or regulation; action or inaction of civil or military authority; inability to obtain any license, permit, or other authorization that may be required to conduct operations on or in connection with the Property; interference with mining operations by a lessee of quartz (hard rock) mining, oil, gas, or geothermal resources under the Property; unusually severe weather; mining casualty; unavoidable mill shutdown; damage to or destruction of mine plant or facility; fire; explosion; flood; insurrection; riot; labor disputes; inability after diligent effort to obtain workmen or material; delay in transportation; and acts of God (but excepting any obligation to pay money) and government decision reversal or permit withdrawl unrelated to Lessees work performance.

SECTION ELEVEN

Miscellaneous Provisions

11.1 Binding Effect. This Agreement shall inure to the benefit of and be binding upon the parties hereto, their respective heirs, executors, administrators, successors, and assigns.

11.2 44995 Yukon Inc agrees to assign Michal Bidrman as the only party of 44995 Yukon Inc with whom Lessee is to deal with regards to any and all dealings associated with this agreement.

11.3 Applicable Law. The terms and provisions of this Agreement and the rights and obligations of the parties shall be governed and interpreted in accordance with the laws of the Yukon Territory.

11.4 Entire Agreement. This Agreement terminates and replaces all prior agreements, either written, oral or implied, between the parties hereto, and constitutes the entire agreement between the parties. Lessee shall, at all times, act prudently, diligently and in good faith.

J-B
MB

11.5 Recording. The parties hereto agree to provide a copy of the agreement to the Yukon Water Board so as to give public record, pursuant to the laws of the Yukon Territory, of the existence of this Agreement.

11.6 Void or Invalid Provisions. If any term, provision, covenant or condition of this Agreement, or any application thereof, should be held by a court of competent jurisdiction to be invalid, void or unenforceable, all provisions, covenants and conditions of this Agreement, and all applications thereof not held invalid, void or unenforceable, shall continue in full force and effect and shall in no way be affected, impaired, or invalidated thereby.

11.7 Time of the Essence. Time is of the essence of this Agreement and each and every part thereof.

11.8 Confidentiality. Except as otherwise required by law, all reports and data provided by Lessee to Owner shall be held in strictest confidence, and Owner shall not disclose such information without Lessee's prior written consent.

11.9 No Partnership. Nothing in this Agreement shall create a partnership or other relationship between Owner and Lessee except that of lessor and lessee hereunder.

11.10 Counterparts and Facsimiles. This Agreement may be executed in counterparts. Facsimile signatures will be acceptable for a binding agreement among the parties.

11.11 Purchase Option. If the Property is to be sold, as part of this agreement the Owner agrees to offer the option to buy the Property to the Lessee. The price of the Property is $500,000 CDN on August 20th, 2012 and the price of the property is directly associated to the gold price on the day the sale would be completed. (for example: if the price of gold increases by 50% on the day of sale the price of the property will also be 50% higher). All other details of the sale are to be negotiated at the time of sale.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement on the day and year first above written.

OWNER

By: Michal Bidrman

Joe Barnes

44995 Yukon Inc.

44995 Yukon Inc

J-B

MB

LESSEE

By: Steve Harasimiuk

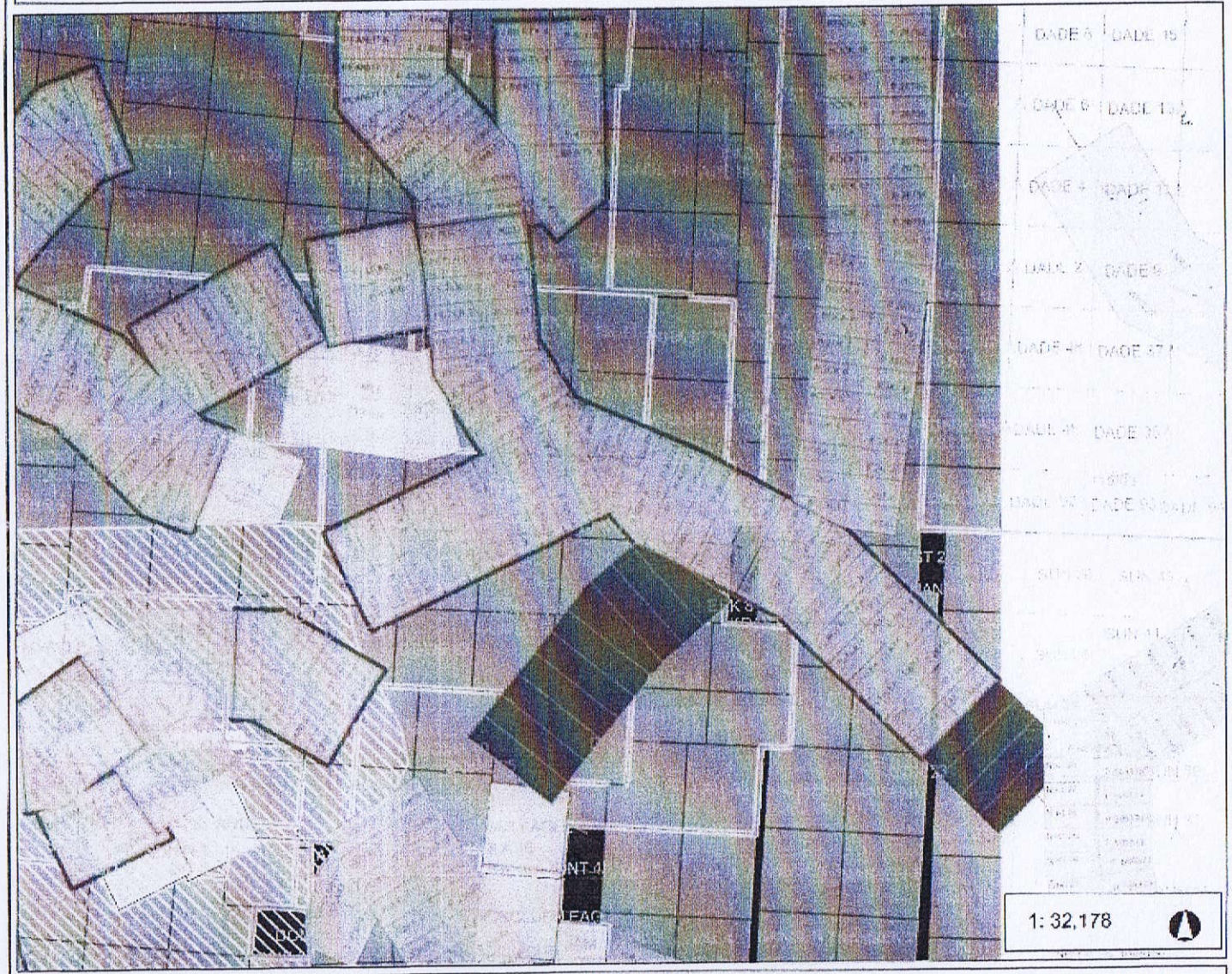
Bonnyville Oilfield Service and Supply Ltd

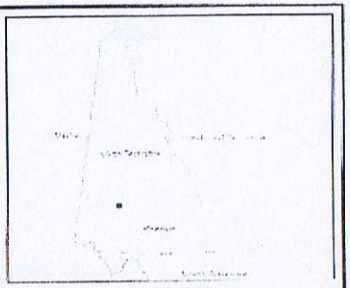
Aug 21

District	GrantNumber	RegType	ClaimName	ClaimNbr	Claim Owner	OperationRecor	StakingDate	ClaimExpiryDat
Whitehorse	P 12542	Placer	EVIL	10	44995 Yukon In	1981-06-09	1981-06-09	2012-11-01
Whitehorse	P 12534	Placer	EVIL	2	44995 Yukon In	1981-06-09	1981-06-09	2012-11-01
Whitehorse	P 12533	Placer	EVIL	1	44995 Yukon In	1981-06-09	1981-06-09	2012-11-01
Whitehorse	P 12535	Placer	EVIL	3	44995 Yukon In	1981-06-09	1981-06-09	2012-11-01
Whitehorse	P 12541	Placer	EVIL	9	44995 Yukon In	1981-06-09	1981-06-09	2012-11-01
Whitehorse	P 12537	Placer	EVIL	5	44995 Yukon In	1981-06-09	1981-06-09	2012-11-01
Whitehorse	P 12538	Placer	EVIL	6	44995 Yukon In	1981-06-09	1981-06-09	2012-11-01
Whitehorse	P 12539	Placer	EVIL	7	44995 Yukon In	1981-06-09	1981-06-09	2012-11-01
Whitehorse	P 12540	Placer	EVIL	8	44995 Yukon In	1981-06-09	1981-06-09	2012-11-01
Whitehorse	P 12536	Placer	EVIL	4	44995 Yukon In	1981-06-09	1981-06-09	2012-11-01
Whitehorse	P 26085	Placer	PLACER CLAIM		44995 Yukon In	1984-04-30	1984-04-28	2012-11-30
Whitehorse	P 26108	Placer	PLACER CLAIM		44995 Yukon In	1984-05-08	1984-04-28	2012-11-30
Whitehorse	P 26174	Placer	PLACER CLAIM		44995 Yukon In	1984-07-06	1984-07-03	2012-11-30
Whitehorse	P 26221	Placer	TERRY	5	44995 Yukon In	1984-08-01	1984-07-27	2012-11-01
Whitehorse	P 26222	Placer	TERRY	6	44995 Yukon In	1984-08-01	1984-07-27	2012-11-01
Whitehorse	P 26223	Placer	TERRY	7	44995 Yukon In	1984-08-01	1984-07-27	2012-11-01
Whitehorse	P 26224	Placer	TERRY	8	44995 Yukon In	1984-08-01	1984-07-27	2012-11-01
Whitehorse	P 26219	Placer	TERRY	3	44995 Yukon In	1984-08-01	1984-07-27	2012-11-01
Whitehorse	P 26226	Placer	TERRY	10	44995 Yukon In	1984-08-01	1984-07-27	2012-11-01
Whitehorse	P 26227	Placer	TERRY	11	44995 Yukon In	1984-08-01	1984-07-27	2012-11-01
Whitehorse	P 26217	Placer	TERRY	1	44995 Yukon In	1984-08-01	1984-07-27	2012-11-01
Whitehorse	P 26218	Placer	TERRY	2	44995 Yukon In	1984-08-01	1984-07-27	2012-11-01
Whitehorse	P 26220	Placer	TERRY	4	44995 Yukon In	1984-08-01	1984-07-27	2012-11-01
Whitehorse	P 26225	Placer	TERRY	9	44995 Yukon In	1984-08-01	1984-07-27	2012-11-01
Whitehorse	P 26237	Placer	PETER	10	44995 Yukon In	1984-08-01	1984-07-28	2012-11-01
Whitehorse	P 26229	Placer	PETER	2	44995 Yukon In	1984-08-01	1984-07-28	2012-11-01
Whitehorse	P 26230	Placer	PETER	3	44995 Yukon In	1984-08-01	1984-07-28	2012-11-01
Whitehorse	P 26231	Placer	PETER	4	44995 Yukon In	1984-08-01	1984-07-28	2012-11-01
Whitehorse	P 26232	Placer	PETER	5	44995 Yukon In	1984-08-01	1984-07-28	2012-11-01
Whitehorse	P 26233	Placer	PETER	6	44995 Yukon In	1984-08-01	1984-07-28	2012-11-01
Whitehorse	P 26234	Placer	PETER	7	44995 Yukon In	1984-08-01	1984-07-28	2012-11-01
Whitehorse	P 26235	Placer	PETER	8	44995 Yukon In	1984-08-01	1984-07-28	2012-11-01
Whitehorse	P 26236	Placer	PETER	9	44995 Yukon In	1984-08-01	1984-07-28	2012-11-01
Whitehorse	P 26228	Placer	PETER	1	44995 Yukon In	1984-08-01	1984-07-28	2012-11-01

Whitehorse	P 26328	Placer	Creek Claim	44995 Yukon In	1984-09-14	1984-09-06	2012-11-30
Whitehorse	P 26447	Placer	Creek Claim	44995 Yukon In	1984-11-16	1984-11-07	2012-11-30
Whitehorse	P 26519	Placer	ERIK	44995 Yukon In	1985-06-04	1985-05-26	2012-11-30
Whitehorse	P 50199	Placer	LLOYD CLAIM	44995 Yukon In	2007-07-23	2007-07-16	2012-11-23

Victoria Creek Grouping





Legend

- New Placer Claims
- Placer Claims (50K)
  - Active and Pending
  - Expired
- Prospecting Leases
  - Active and Pending
  - Expired
- Adjoin Placer
- Placer Mining Land Use Permi
  - Class 3
  - Class 4
- Placer Baselines (50K)
- Placer Baselines (surveyed)
- New Quartz Claims
- Quartz Claims (50K)
  - Active and Pending
  - Expired
- Quartz Claims (Surveyed)
- Quartz Leases (50K)
- Adjoin Quartz
- Quartz Mining Land Use Permi
  - Class 3
  - Class 4
- Quartz Staking Direction
- Coal Exploration License
  - Active and Pending
  - Expired

Notes

0 0.82 1.6 Kilometers

...kon Albers

Produced from: Yukon Mining Viewer

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

Date Printed: 20-Aug-2012

YUKON WATER BOARD

Pursuant to the *Waters Act* and *Waters Regulation*, the Yukon Water Board hereby grants a Type B water use licence for placer mining undertaking to:

Spring Cove Enterprises Ltd.
Box 1932, 207 Park Drive
Clearwater, BC V0E 1N0

LICENCE NUMBER: PM06-524

LICENCE TYPE: B **UNDERTAKING:** PLACER

WATER USE AREA: 2 **STREAM CLASSIFICATION:** IV

LOCATION: Latitude: 62° 07' N Longitude: 137° 07' W

WATER SOURCE: Victoria Creek, a tributary of the Nisling River and Eva Creek, a tributary of Victoria Creek

MAXIMUM QUANTITY: 9,636 cubic metres per day

EFFECTIVE DATE: The effective date of this licence shall be the date on which the signature of the Chairperson of the Yukon Water Board is affixed.

EXPIRY DATE: April 20, 2017

This licence shall be subject to the restrictions and conditions contained herein, and to the restrictions and conditions contained in the *Waters Act* and the *Waters Regulation* made thereunder.

Dated this _____ day of

_____, 2007

Original signed by a witness

_____
Witness

Approved by:

Original signed by Chair

_____
Chairperson
YUKON WATER BOARD

PART A DEFINITIONS

"Act" means *Waters Act* and any amendments thereto.

"Application" means application for water use licence PM06-524 and placer mining land use approval AP06524, and any subsequent information presented to the Yukon Water Board up to the date of the Board's decision.

"Board" means the Yukon Water Board.

"Inspector" means any person designated as an Inspector under the Act.

"Natural Boundary" means the visible high water mark of any lake, river, stream or other body of water where the presence and action of the water is so common and usual, and so long continued, as to mark upon the soil of the bed of the lake, stream or other body of water, a character distinct from that of the banks thereof, both in respect to vegetation and in respect to the nature of the soil itself. In addition, the best estimates of the edge of dormant or old side channels and marsh areas are considered to be natural boundaries.

"Regulation" means the *Waters Regulation.*

"Spring Freshet" means the sudden increase in flow carried by a stream as snowmelt occurs at higher elevations in the watershed.

"Watercourse" means any stream, lake, pond, river, creek, spring, ravine or swamp, whether ordinarily containing water or not.

"Work Areas" means any area disturbed and/or altered by mining activities, excluding any stable diversion channel.

PART B WATER USE AND WASTE DEPOSIT

1. The Licensee is hereby authorized:

   a) to obtain water from Victoria Creek and Eva Creek at a maximum combined quantity of 9,636 cubic metres per day; and

   b) to use this water for a placer mining undertaking on the following grant numbers as shown in Appendix A, attached; and

   c) to return a flow of water to Victoria Creek and Eva Creek, and to deposit waste into Victoria Creek and Eva Creek.

2. All of the activities authorized in Part B (1) shall be as described in the Application and subject to the conditions of this licence. Where there is a discrepancy between the Application and the conditions of this licence, then the conditions of this licence shall prevail.

3. The Board has relied on the representations, warranties and undertakings provided by the Licensee in the material filed in the Application. Such representations, warranties and undertakings are considered by the Board to be a part of the licence, but shall be subject to, and may be modified by, the conditions of the licence.

4. All work authorized by this licence shall occur on property that the Licensee has the right to enter upon and use for that purpose.

1. Effluent Quality Standard: Any grab sample at the point of discharge from the final settling facility shall not exceed settleable solids of 3.0 millilitres per litre above levels in the Watercourse immediately above the uppermost mine operation.

2. Except as otherwise provided in this licence, the Licensee shall not deposit, or permit the deposit of waste containing:

   a) anything toxic to fish;
   b) floating solids;
   c) visible oil or grease; or
   d) a total concentration of mercury in excess of 0.005 milligrams per litre;

   into a receiving Watercourse, or in any place, under conditions where such waste, or any other waste that results from the deposit of such waste, if resulting waste contains any of the items prohibited by this paragraph, may enter the receiving Watercourse.

3. If, subsequent to the issuing of this licence, the Licensee uses water and/or deposits waste in one or more ways not authorized in this licence, and the combined effect of those uses and/or deposits of wastes, as determined by an Inspector:

   a) has no potential for significant adverse environmental effects; and

   b) does not interfere with existing rights of other water users or waste depositors; and

   c) satisfies the criteria set out in column 2 of Schedule 6 of the Regulation;

   no amendment to this licence will be required for that use of water and/or deposit of waste.

4. Fuels, lubricants, cleansers, solvents and similar chemicals or substances shall be used, transported, stored and disposed of in such a way that said substances are not deposited in, or allowed to be deposited in, waters.

PART C MINING ACTIVITIES

5. The Licensee may construct an intake ditch to an out-of-stream pump pond/reservoir.

6. Amouring shall be installed at the confluence of the intake ditch and the creek.

7. All ditches, spillways and any other water related structures built, or otherwise constructed, for the storage or conveyance of water shall be able to withstand seasonal floods.

8. All storage and settling facilities and associated spillways, drains and water supply ditches located outside the Watercourse channel shall be of adequate capacity and construction.

9. All works associated with the undertaking, including, but not limited to, all dams, weirs, spillways, stream crossings, ditches, gates, water intakes, culverts and settling facilities shall be maintained in good repair.

10. Settling facilities shall be provided for all mining wastewater.

11. Available overburden shall be stockpiled for use in future site restoration, and such stockpiles shall be located where they will not adversely affect water quality in any Watercourse.

PART D WATERCOURSE CROSSINGS

12. The Licensee may modify the bed or banks of streams to allow fording of the Watercourse. The number of fords shall be limited to those shown in the Application.

13. The Licensee shall adhere to the following conditions regarding fording of the creek channels:

    a) all crossings shall be at a right angle to the Watercourse; and

    b) removal of vegetation adjacent to the crossings shall be minimized; and

    c) non-erodible materials shall be placed up the bank on both sides of the crossing to stabilize the banks; and

    d) the Watercourse crossing approaches shall be low and stable enough to support the vehicles and equipment; and

    e) the Watercourse shall be crossed on either a firm rock bottom or a coarse gravel bottom; and

    f) equipment crossing the Watercourse shall be mechanically sound and free of leaks; and

    g) the blade or bucket on equipment shall be left in a raised position when crossing the Watercourses.

PART E SEASONAL CLOSURE

14. The Licensee shall comply with the following conditions pertaining to seasonal closure:

a) The mine site shall be left in a stable condition at the end of each mining season.

b) An Inspector shall be contacted not less than 2 weeks prior to seasonal closure.

c) To prevent flood damage during freshet, the intake ditch to the out of stream reservoir shall be blocked.

d) Spring Freshet shall not be routed through Work Areas.

e) All mined or otherwise disturbed ground surfaces, including cut banks, fill slopes and tailings piles shall be stabilized annually to prevent erosion and surface runoff from carrying sediment into adjacent Watercourses.

PART F DECOMMISSIONING

15. Prior to final decommissioning and/or expiry of this licence, the Licensee shall:

a) ensure that the final creek channel approximates its pre-licence condition in length, gradient and stability, except as may otherwise be required in this licence; and

b) contact an Inspector not less than 2 weeks prior to final decommissioning.

PART G REPORTS, SAMPLING AND ANALYSIS

16. Where there is a surface discharge from the settling facilities, the Licensee shall take weekly samples at a point upstream of the water supply intake and at the point of discharge from the final settling facility, and shall analyze these samples for settleable solids using the Imhoff cone 1 hour test.

17. Where no discharge from the settling facility to a Watercourse occurs, whether by surface discharge or seepage, no sampling is required.

18. On or before the anniversary of the date of issuance of this licence, and for each year during which this licence is in effect, the Licensee shall submit an annual report to the Board.

19. Annual reports during the year reported shall include the information required by this licence and by the Regulation including, but not necessarily limited to:

a) the quantity of water used under this licence; and

b) the quantity, concentration and type of any waste deposited under this licence; and

c) all data collected which is required by this licence; and

d) a description of the reclamation that has taken place; and

e) a list of grant numbers of claims where any reclamation has taken place.

PART H GENERAL CONDITIONS

20. The expiry date of this licence shall be April 20, 2017.

21. Sewage, including all human excreta and wastewater associated with daily camp operations, shall be disposed of in accordance with the *Public Health and Safety Act* of the Yukon.

22. The location of subsurface grey water pits and/or pit privies shall be not less than 30 metres from the high water mark of any Watercourse, and at least 1.2 metres above bedrock or the water table.

23. If very permeable soils are encountered, the pit privy or grey water pit shall be lined with 0.6 metres of sand or silt.

24. All garbage and refuse shall be kept in a covered container until removed from the site or, where appropriate, incinerated and buried under not less than 1 metre of compacted soil in pits located not less than 30 metres from the Natural Boundary of any Watercourse.

25. The Licensee shall immediately contact the 24-hour Yukon Spill Report number (867) 667-7244, and implement the Spill Contingency Plan should a spill or unauthorized discharge occur. A detailed written report on any such event including, but not limited to, dates, quantities, parameters, causes and other relevant details and explanations shall be submitted to the Board no later than 10 days after its occurrence.

26. No condition of the water use licence limits the application of any federal, territorial, first nation or municipal legislation.

27. In the event that the Licensee fails to comply with any provision or condition of this licence, the Board may, subject to the Act, cancel the licence.

28. Where any direction, notice, order or report under this licence is required to be in writing, it shall be given:

a) to the Licensee, if delivered or mailed by registered mail, to the following address:

Spring Cove Enterprises Ltd.
Box 1932, 207 Park Drive
Clearwater, BC V0E 1N0

and shall be deemed to have been given to the Licensee on the day it was delivered or 7 days after the day it was mailed, as the case may be; or

b) to the Board, if delivered, faxed or mailed by registered mail, to the following address:

Yukon Water Board
Suite 106, 419 Range Road
Whitehorse, YT Y1A 3V1

Fax #: (867) 456-3890

and shall be deemed to have been given to the Board on the day it was delivered or faxed, or 7 days after the day it was mailed, as the case may be.

c) The Board or the Licensee may, by notice in writing, change its address for delivery.

APPENDIX A

Grant Number	Watercourse	Grant Number	Watercourse
P12533	Eva	P26234	Victoria
P12534	Eva	P26235	Victoria
P12535	Eva	P26236	Victoria
P12536	Eva	P26237	Victoria
P12537	Eva	P26217	Victoria
P12538	Eva	P26218	Victoria
P12539	Eva	P26219	Victoria
P12540	Eva	P26220	Victoria
P12541	Eva	P26221	Victoria
P12542	Eva	P26222	Victoria
P26228	Victoria	P26223	Victoria
P26229	Victoria	P26224	Victoria
P26230	Victoria	P26225	Victoria
P26231	Victoria	P26226	Victoria
P26232	Victoria	P26227	Victoria
P26233	Victoria		

Yukon
Energy, Mines and Resources

LAST NAME

PLACER MINING
INSPECTION REPORT

Licensee: SPRING COVE	Licence #: PM07-565	Date: (YYYY/MM/DD) JUNE 22, 2012
Operator (if different from Licensee): STEVE / HARASIMIUK	MLU Approval #:	District: D M (WH) WL
Person Contacted: STEVE	Activity: PRE SEASON SET UP IN PROGRESS	NTS #: 115I03
Location: VICTORIA CREEK		Work Location GPS: Lat: N/A Long:
Fuel Tank(s) Registered: Yes ☐ No ☑	Spill Plan Posted: ? yes Yes ☐ No ☐ NOT NOTICED	
Numbers Posted: Yes ☐ No ☑	Spill Kit: ? onsite Yes ☐ No ☐	

Imhoff Cone: N/A ml/l	Compliance	Warning: Verbal ☐ Written ☐
Compliance Std: 2.5 ml/L	Effluent: Yes ☑ No ☐	Ticket type:
Water Sample: Yes ☑ No ☐	Waters Act: Yes ☑ No ☐	Ticket #:
Photos: Yes ☑ No ☐	Fisheries Act: Yes ☑ No ☐	Heritage Resources: Yes ☐ No ☑
Videos Yes ☐ No ☑	PMA/MLU: Yes ☑ No ☐	Certificate of Completion Recommended: Yes ☐ No ☑
	Reclamation: Yes ☐ No ☑	Minor Amendment requested: Yes ☐ No ☑
	Environment Act: Yes ☑ No ☐	Annual Reports/Plans submitted: Yes ☐ No ☑

Conditions: A–Acceptable C–Concerns U–Unacceptable N/A–Not Applicable N/I–Not Inspected

Water Use Activities	Condition	Comment
Water Intake		
Reservoir Construction		
Reservoir Outflow Structure		
Reservoir Capacity		
Diversion Channel		
Protective Berm		
Drains/Ditches		
Settling Pond Construction		
Settling Outflow		
Settling Capacity		
Ponds		
Deposit of Waste (i.e. sewage)		

N/I AT THIS TIME

Mining Land Use/ Environment Act Activities	Condition	Comment
Camp/Structures	A	
Fuel Storage and Handling	A	
Cleanliness	A	KEEP CLEAN
Line/Corridor Construction	N/A	
Stripping	N/A	
Trenching	N/A	
Tailings/Overburden Storage	A	
Drilling	N/A	
Vehicles	A	
New Roads/Trails	N/A	
Site Stability/Safety	A	
Waste Management	A	HAUL OUT/BURN
Explosives	N/A	

Reclamation/Rehabilitation	Condition	Comment
Seasonal Diversion		
Temporary Diversion		
Permanent Diversion		
Fish Habitat Features		
Site Stability/Safety		
Site Contouring		
Revegetation		
Site Clean Up		
Waste Disposal		
Fuel		
Structure Removal		
Land Treatment Facility		
Other Approval Conditions		

N/I AT THIS TIME

Comments:

– PROGRESSIVE RECLIMATION IS RECOMMENDED.
– PLEASE REMOVE ALL WASTE PROGRESSIVLY.
– OLD STRUCTURES CAN BE REMOVED BY BURNING PLEASE OBTAIN BURN-PERMIT FROM WILDLAND FIRE MANAGEMENT IN CARMACKS, BETWEEN APRIL 1 AND SEPT. 30.
PLEASE NOTIFY THIS OFFICE @ 867-456-5505 OR Steve.beaulieu@gov.yk.ca UPON START-UP OF SLUICING OPERATIONS.
* FUEL TANK BY CAMP IS TOO CLOSE TO SMALL CREEK PLEASE PULL BACK TO AT LEAST 30.48 M FROM HIGH WATER MARK. DONE June 29/2012 SB
* KEEP ACCESS ROADS WELL MAINTAINED. DONE June 29/2012 SB
THANKS

Inspector:	Received by:
(signature) STEVE BEAULIEU	(signature) Steve Harasimiuk
(printed name)	(printed name)

Page 1 of _____

YG(5081)NC3 Rev.02/2012 Distribution: 1 – Client Services and Inspections 2 – Licensee/Operator 3 – Inspector
Photocopies to: Yukon Water Board Mining Lands Fisheries and Oceans Environment Yukon

Yukon
Energy, Mines and Resources

PLACER MINING
INSPECTION REPORT

Licensee: STEVE HARASIMIAK Box 64409 Bonnyville, Alberta		Licence #: PM07-565	Date: (YYYY/MM/DD) 2012/10/18
Operator (if different from Licensee) STEVE HARASIMIAK J9N 8S9		MLU Approval #: AP06524	District: D M (WH) WL
Person Contacted: SAME.	Activity: SHUT DOWN FOR SEASON		NTS #: 115I03
Location: HEADWATER OF 1/1c			Work Location GPS: Lat: 62°08' Long: 137° 11'
Fuel Tank(s) Registered: Yes ☑ No ☐ Numbers Posted: Yes ☑ No ☐	Spill Plan Posted: Yes ☑ No ☐ Spill Kit: Yes ☑ No ☐		

Imhoff Cone: Nil ml/l	Compliance: YES	Warning: Verbal ☐ Written ☐	
Compliance Std:	Effluent: Yes ☑ No ☐	Ticket type:	
Water Sample: Yes ☐ No ☑	Waters Act: Yes ☑ No ☐	Ticket #:	
Photos: Yes ☑ No ☐	Fisheries Act: Yes ☑ No ☐	Heritage Resources: Yes ☐ No ☑	
Videos Yes ☐ No ☑	PMA/MLU: Yes ☑ No ☐	Certificate of Completion Recommended: Yes ☐ No ☑	
	Reclamation: Yes ☐ No ☑	Minor Amendment requested: Yes ☐ No ☑	
	Environment Act: Yes ☑ No ☐	Annual Reports/Plans submitted: Yes ☐ No ☑	

Conditions: A–Acceptable C–Concerns U–Unacceptable N/A–Not Applicable N/I–Not Inspected

Water Use Activities	Condition	Comment
Water Intake	A	
Reservoir Construction	A	
Reservoir Outflow Structure	A	
Reservoir Capacity	A	
Diversion Channel	A	
Protective Berm	C	(1)
Drains/Ditches	A	
Settling Pond Construction	A	
Settling Outflow	A	
Settling Capacity	A	
Fords	A	
Deposit of Waste (i.e. sewage)	N/A	

Mining Land Use/ Environment Act Activities	Condition	Comment
Camp/Structures	A	
Fuel Storage and Handling	A	
Cleanliness	A	Nice
Line/Corridor Construction	A	
Stripping	A	
Trenching	A	
Tailings/Overburden Storage	A	
Drilling	A	
Vehicles	A	
New Roads/Trails	N/A	
Site Stability/Safety	A	
Waste Management	A	
Explosives	N/A	

Reclamation/Rehabilitation	Condition	Comment
Seasonal Diversion	A	
Temporary Diversion	A	
Permanent Diversion	N/A	
Fish Habitat Features	N/A	
Site Stability/Safety	A	
Site Contouring	N/A	
Revegetation	N/A	
Site Clean Up	A	
Waste Disposal	A	
Fuel	A	
Structure Removal	N/A	
Land Treatment Facility	NA	
Other Approval Conditions	NA	

Comments:

(1) AS PLEASE REINFORCE PROTECTIVE BERM DISCUSSED. AS SOON AS DIRECTION.

PLEASE SUBMIT A PRE SEASON REPORT ON MINING SEASONAL PLANS AT LEAST TWO WEEKS BEFORE SEASONAL START.

There were no further Concerns. Thank-you

-Entered into Yukon Conservation to Fisheries Environment mailed 03.19.2013
-Scanned to S: drive

Inspector:
(signature) Steve Beaudoin
(printed name)

Received by:
(signature) VIA MAIL
(printed name)

YG(5081)NC3 Rev.02/2012 Distribution: 1 – Client Services and Inspections 2 – Licensee/Operator 3 – Inspector
Photocopies to: Yukon Water Board Mining Lands Fisheries and Oceans Environment Yukon

Yukon
Energy, Mines and Resources

PLACER MINING
INSPECTION REPORT

Licensee: Steve Harasionirk	Licence #: PM06-524	Date: (YYYY/MM/DD) July 3/13
Operator (if different from Licensee)	MLU Approval #:	District: D M WH WL
Person Contacted: Steve Harasionirk	Activity: Testing	NTS #: 115I/3
Location: Victoria Creek		Work Location GPS: Lat:
Fuel Tank(s) Registered: Yes [X] No [ ]	Spill Plan Posted: Yes [ ] No [ ] N/I	Long:
Numbers Posted: Yes [X] No [ ]	Spill Kit: Yes [ ] No [ ]	

Imhoff Cone: _____ ml/l	Compliance	Warning: Verbal [ ] Written [ ]
Compliance Std: _____	Effluent: Yes [X] No [ ]	Ticket type: _____
Water Sample: Yes [ ] No [X]	Waters Act: Yes [X] No [ ]	Ticket #: _____
Photos: Yes [X] No [ ]	Fisheries Act: Yes [X] No [ ]	Heritage Resources: Yes [ ] No [ ]
Videos Yes [ ] No [X]	PMA/MLU: Yes [X] No [ ]	Certificate of Completion Recommended: Yes [ ] No [ ]
	Reclamation: Yes [X] No [ ]	Minor Amendment requested: Yes [ ] No [ ]
	Environment Act: Yes [X] No [ ]	Annual Reports/Plans submitted: Yes [ ] No [ ]

Conditions: A–Acceptable C–Concerns U–Unacceptable N/A–Not Applicable N/I–Not Inspected

Water Use Activities	Condition	Comment
Water Intake	A	
Reservoir Construction	A	
Reservoir Outflow Structure	A	
Reservoir Capacity	A	
Diversion Channel	A	
Protective Berm	A	X See Lab
Drains/Ditches	A	
Settling Pond Construction	A	
Settling Outflow	A	
Settling Capacity	A	X
Fords	A	
Deposit of Waste (i.e. sewage)	A	

Mining Land Use/ Environment Act Activities	Condition	Comment
Camp/Structures	A	
Fuel Storage and Handling	A	
Cleanliness	A	
Line/Corridor Construction	N/A	
Stripping	A	
Trenching	N/A	
Tailings/Overburden Storage	A	
Drilling	N/A	
Vehicles	A	
New Roads/Trails	A	
Site Stability/Safety	A	
Waste Management	A	
Explosives	N/A	

Reclamation/Rehabilitation	Condition	Comment
Seasonal Diversion		
Temporary Diversion		
Permanent Diversion		
Fish Habitat Features		
Site Stability/Safety		
Site Contouring		
Revegetation	N/A	
Site Clean Up		
Waste Disposal		
Fuel		
Structure Removal		
Land Treatment Facility		
Other Approval Conditions		

Comments:

Operator is currently testing left limit of Victoria Creek quite far down from Camp. Small drain ditch established around current plant which is draining out. Has currently sluiced approx 2000 yd³. Settling facilities adequate for current scale of operation. Operator is bringing in + setting up a deck to process approx. 100 yd³/hr. Additional settling will then be required.

No concerns with current activities. Operator is in compliance. Protective Berm seems adequate.

Inspector:	Received by:
(signature) Stephen Colp	(signature) [signature]
(printed name) Steve Colp	(printed name)

YG(5081)NC3 Rev.02/2012 **Distribution:** 1 – Client Services and Inspections 2 – Licensee/Operator 3 – Inspector
Photocopies to: Yukon Water Board Mining Lands Fisheries and Oceans Environment Yukon

Yukon
Energy, Mines and Resources

PLACER MINING
INSPECTION REPORT

Licensee: Steve Harasiomik	Licence #: PM06-524	Date: (YYYY/MM/DD) 2014 06 13
Operator (if different from Licensee)	MLU Approval #: AP06524	District: D M (WH) WL
Person Contacted: Steve Harasiomik	Activity: Testing - NO sluicing	NTS #: 115 I/3
Location: Victoria Creek		Work Location GPS: Lat: N 62.09361 Long: W 137.14212
Fuel Tank(s) Registered: Yes ☑ No ☐ Numbers Posted: Yes ☑ No ☐	Spill Plan Posted: Yes ☐ No ☑ Spill Kit: Yes ☑ No ☐	

Imhoff Cone: _____ ml/l	Compliance	Warning: Verbal ☐ Written ☐
Compliance Std: _____	Effluent: Yes ☑ No ☐	Ticket type:
Water Sample: Yes ☑ No ☐	Waters Act: Yes ☑ No ☐	Ticket #:
Photos: Yes ☑ No ☐	Fisheries Act: Yes ☑ No ☐	Heritage Resources: Yes ☐ No ☐
Videos Yes ☐ No ☑	PMA/MLU: Yes ☑ No ☐	Certificate of Completion Recommended: Yes ☐ No ☐
	Reclamation: Yes ☑ No ☐	Minor Amendment requested: Yes ☐ No ☐
	Environment Act: Yes ☑ No ☐	Annual Reports/Plans submitted: Yes ☐ No ☐

Conditions: **A**–Acceptable **C**–Concerns **U**–Unacceptable **N/A**–Not Applicable **N/I**–Not Inspected

Water Use Activities	Condition	Comment
Water Intake	A	
Reservoir Construction	A	
Reservoir Outflow Structure	A	
Reservoir Capacity	A	
Diversion Channel	A	
Protective Berm	A	
Drains/Ditches	A	
Settling Pond Construction	A	
Settling Outflow	A	
Settling Capacity	A	
Fords	A	
Deposit of Waste (i.e. sewage)	A	

Mining Land Use/ Environment Act Activities	Condition	Comment
Camp/Structures	A	
Fuel Storage and Handling	A	
Cleanliness	A	
Line/Corridor Construction	N/A	
Stripping	A	
Trenching	N/A	
Tailings/Overburden Storage	A	
Drilling	N/A	
Vehicles	A	
New Roads/Trails	A	
Site Stability/Safety	A	
Waste Management	A	
Explosives	N/A	

Reclamation/Rehabilitation	Condition	Comment
Seasonal Diversion		
Temporary Diversion		
Permanent Diversion		
Fish Habitat Features		
Site Stability/Safety		
Site Contouring		
Revegetation	N/A	
Site Clean Up		
Waste Disposal		
Fuel		
Structure Removal		
Land Treatment Facility		
Other Approval Conditions		

Comments:

Currently Steve is conducting seismic testing to define his claims geologic stratification. Stripping began last year on the left limit of unnamed tributary of Victoria creek. Stripping will re-commence in 2015 along with sluicing. Further testing above camp will also start next season (42 claims total). Pit exhibits hydrologic influence via groundwater which returned to surface water. Diversion ditch, settling pond / channels all stable. All Four(4) creek ford crossing stable. Operator encouraged to post spill plan and position Spill Kit in Hauling area when actively operating. No concerns with present activities operator in compliance with terms and conditions.

Inspector:

(signature) _____

(printed name) MATTHEW TENNER

Received by:

(signature) _____

(printed name) _____

YG(5081)NC3 Rev.02/2012 **Distribution:** 1 – Client Services and Inspections **Photocopies to:** Yukon Water Board, Mining Lands, 2 – Licensee/Operator, Fisheries and Oceans, 3 – Inspector, Environment Yukon

Soil Sampling Tips

- Surficial geology maps are your guide to the distribution of parent materials on the landscape.
- A complete list of surficial geology maps in Yukon is published on the Glacial Limits of Yukon Territory map (Duk-Rodkin, 1999). For more information about digital surficial geology information contact Jeff Bond or Panya Lipovsky at the Yukon Geological Survey.
- Understand the origin of the various parent materials and their suitability for conventional soil geochemistry.
- Do not assume an area is suitable for soil sampling. Check the surficial geology map first.
- Plot old soil geochemistry data against a surficial geology map and discard samples taken from unsuitable parent materials.
- Know the location of the glacial limits in your study area. If your property is close to the glacial limits, this will likely mark a change in parent material.
- Learn to recognize parent materials by the look and feel (texture) of the sediment in your hands. Note textural changes between samples.
- Beware of loess due to its dilution factor. Loess can be especially thick and widespread adjacent to large rivers.
- Past or present permfrost enhances slope dispersion.
- Be consistent in sample depth and parent material.
- Stress quality over quantity when soil sampling.

Information to include on a soil sampling field data form

Sample Number: UTM Position:
Sampler: Date:
Site Characteristics
Aspect:
Topographic position:
Drainage: poor/moderate/well
Parent Material Properties
Total depth (cm):
Genesis:
Texture: silty/sandy/silty sand
Density: low/moderate/high
Colour:
Clast shape: angular/subrounded/well rounded
Organic material present in sample: yes/no/minor

Notes:



Hand soil augers are the method of choice for accessing the C horizon and for ease of transport.

In the adjacent photo, each successively deeper sample is layed out on the surface giving an indication of colour and textural changes with depth.

photo courtesy of Mike Burke and Ryanwood Exploration

Further Reading and References

Bloom, L., 2001. Writing geochemical reports: Guidelines for surficial geochemical survey, 2nd edition. The Association of Exploration Geochemists Special Volume No. 15, 38 p.

Bond, J.D. and Sanborn, P.T., 2006. Morphology and geochemistry of soils formed on colluviated weathered bedrock: Case studies from unglaciated upland slopes in west-central Yukon. Yukon Geological Survey, Open File 2006-19, 70 p.

Duk-Rodkin, A., 1999. Glacial limits map of Yukon. Geological Survey of Canada, Open File 3694, Exploration and Geological Services Division, Yukon Region; Indian and Northern Affairs Canada Geoscience Map 1999-2, scale 1:1 000 000.

McClenaghan, M.B., Bobrowsky, P.T., Hall, G.E.M. and Cook, S.J. (eds.), 2001. Drift Exploration in Glaciated Terrain. Geological Society Special Publication No. 185, The Geological Society, London, U.K., 350 p.

Smith, C.A.S., Meikle, J.C. and Roots, C.F. (eds.), 2004. Ecoregions of the Yukon Territory: Biophysical properties of Yukon landscapes. Agriculture and Agri-Food Canada, PARC Technical Bulletin No. 04-01, Summerland, British Columbia, p. 63-72.

Acknowledgements

This publication benefited from technical reviews by Panya Lipovsky (YGS) and Paul Sanborn (UNBC). Exceptional editing comments were provided by Leyla Weston and Diane Emond.

For more information, check the Yukon Geological Survey at:
www.geology.gov.yk.ca

Yukon Geological Survey
Department of Energy, Mines and Resources
Yukon Government
Box 2703
Whitehorse, Yukon
Canada
Y1A 2C6
phone: (867) 667-8520
fax: (867) 393-6242

Information in this brochure was compiled by Jeffrey D. Bond

Published: January 2007

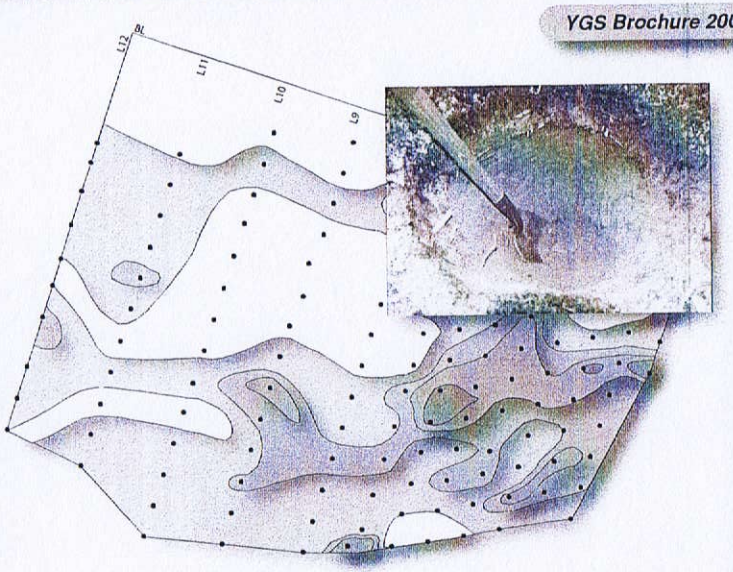
Yukon Geological Survey

Yukon Energy, Mines and Resources

SOIL SAMPLING

A guide to soil sampling in Yukon

YGS Brochure 2007-2



- Approximately 70% of the Yukon has been glaciated and 30% is unglaciated.
- Wind-blown silt (loess) is a common component of the B soil horizon and is geochemical dilutant.
- The Cordilleran ice sheet flowed over some interior mountain ranges resulting in up-valley drift transport.
- Discontinuous permafrost is a common sampling inhibitor on north-facing slopes.

www.geology.gov.yk.ca

Parent Material and Soil Horizons

Introduction

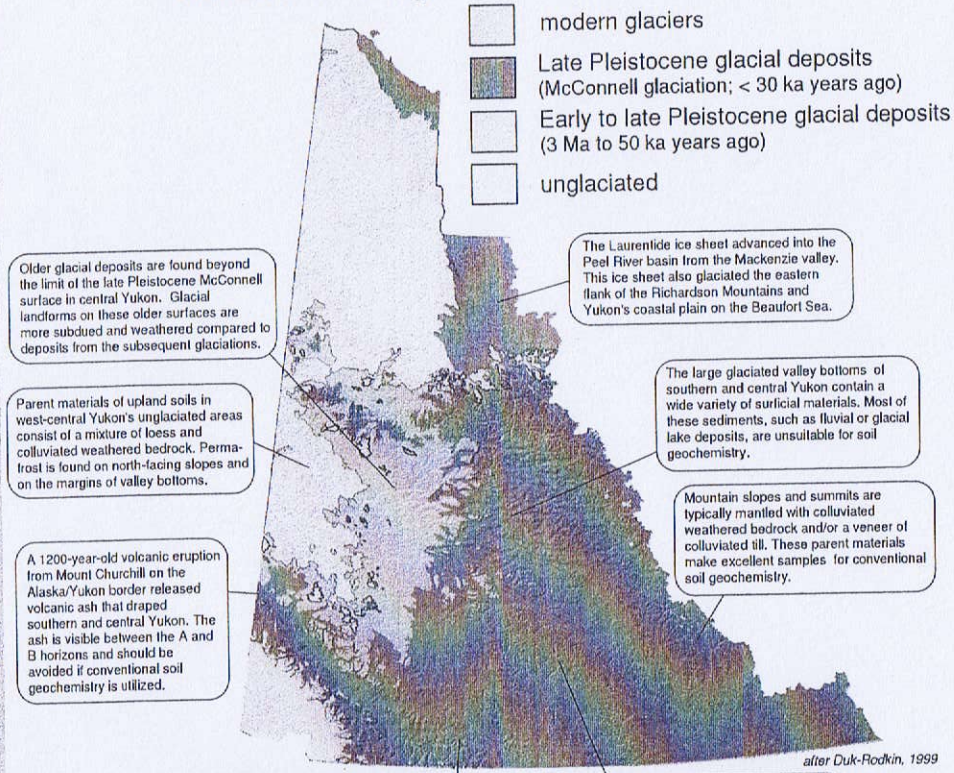
CHOOSING THE BEST SOIL SAMPLE = CHOOSING THE BEST PARENT MATERIAL

Soil sampling and soil geochemical data are a common component of the mineral exploration process. This may involve collecting new soil data or compiling and evaluating pre-existing data from previous exploration programs. Traditionally, sampling within a consistent soil horizon, such as the B-horizon, was the only guideline used in conventional* soil sampling. Today, more attention is placed on choosing the appropriate parent material. In Yukon, there are a variety of parent material types each having a unique genesis. The genesis determines whether the material will be useful for conventional soil geochemistry. The greatest contrast in parent material assemblages occurs between the glaciated and unglaciated regions.

*Conventional soil geochemistry: *e.g.*, an aqua regia digestion (near total digestion) followed by ICP-MS
Unconventional soil geochemistry: *e.g.*, MMI or enzyme (weak) leach

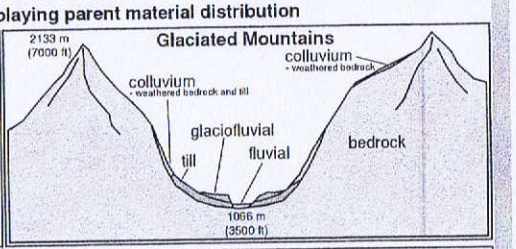
Regional Surficial Geology

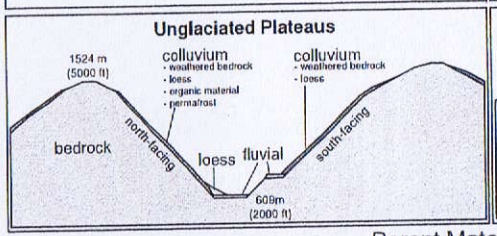
Glaciated and unglaciated regions of Yukon

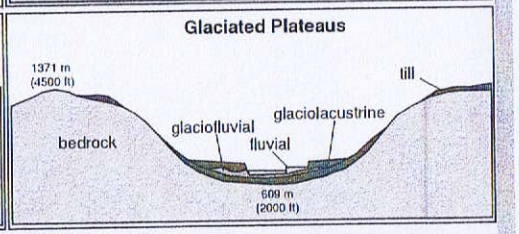


Idealized valley cross-sections displaying parent material distribution

Parent material	Genesis	Sample rating
weathered bedrock	insitu weathing	excellent
fluvial	stream/river	poor
loess	wind	poor
lacustrine	lake	poor
moraine/till	directly by glacier	very good
glaciofluvial	glacial meltwater	poor
glaciolacustrine	glacial lake	poor
colluvium	slope/gravity	depends on moving material







Parent Material Textures



- sand and angular rock fragments
- silt with minor organics and roots
- oxidation common
- no bedding, cohesive
- mixed clay, silt, sand and gravel
- no bedding (massive)
- polished stones, compact
- clay, silt and sand
- few stones
- laminae (banded), bedding
- sand and gravel
- non-cohesive
- laminae, bedding, cross-bedding

What about soil horizons?

A soil profile and its associated horizons are a reflection of the Earth's climate on the land surface. Humification of organic matter, as well as chemical and physical weathering all play a role in the development of a soil profile. So what is the significance of this process on altering the character of the parent material and how might this affect its geochemistry?

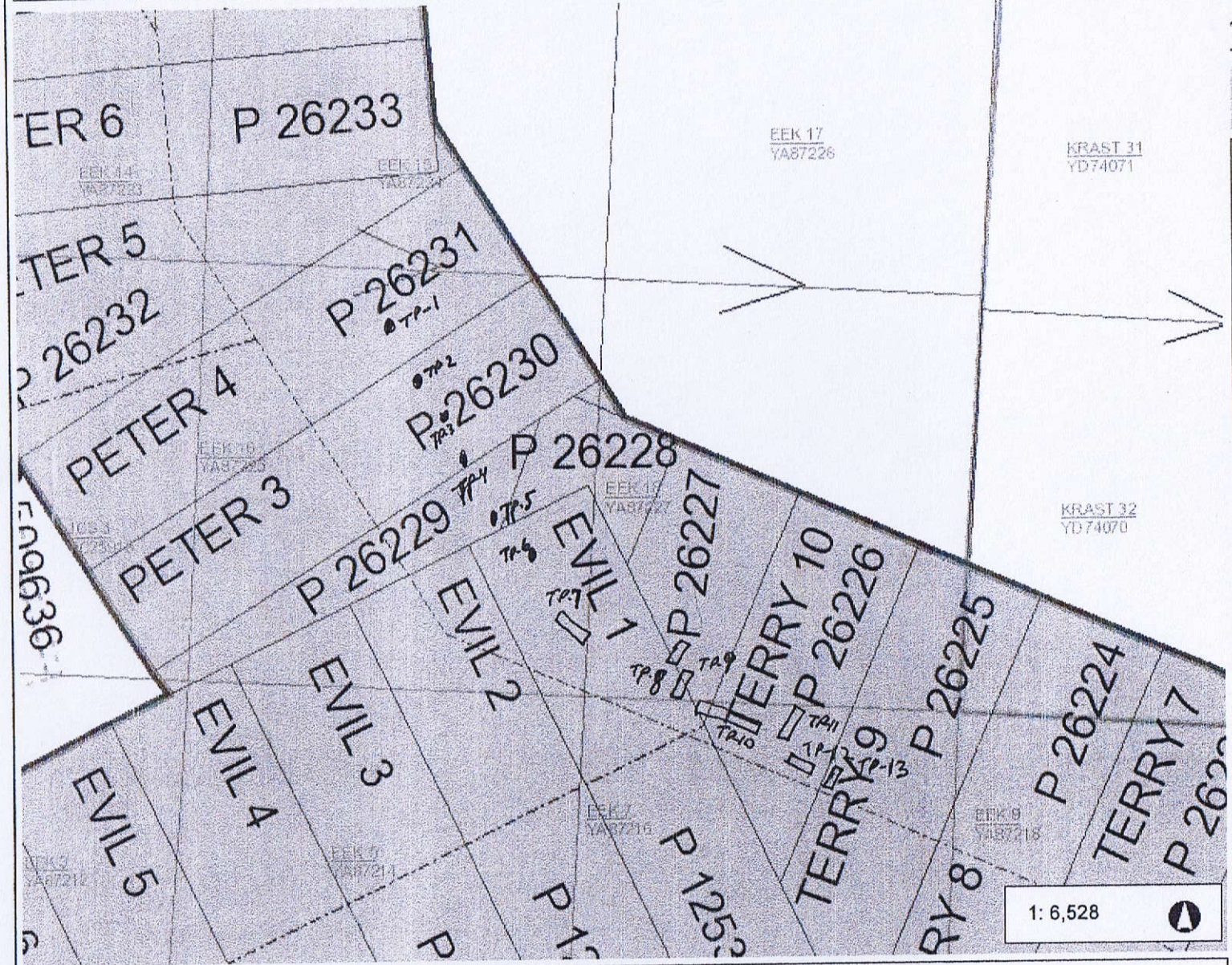


Horizon	Description	Utility for conventional soil geochemistry
A	mixed organic and parent material, zone of leaching	Generally considered poor for soil geochemistry due to the abundance of organic material.
B	mostly altered parent material; enriched in organic matter, iron, aluminum and manganese oxides transported from the A horizon	Adequate for soil geochemistry, but some elements may be enriched or depleted. Upper B-horizons may contain loess, which may alter the geochemistry.
C	weakly altered parent material; some enrichment from B horizon such as carbonate accumulation	Best horizon for conventional soil geochemistry (least oxidation). On north-facing slopes, this horizon may be inaccessible due to permafrost.

2015 Victoria Creek Testing

Yukon
Energy, Mines and Resources





Legend

- New Placer Claims
- Placer Baselines (unsurveyed)
- Placer Baselines (surveyed)
- Placer Claims (50K)
  - Active and Pending
  - Expired
- Prospecting Leases
  - Active and Pending
  - Expired
- Adjoin Placer
- Placer Mining Land Use Permi
  - Class 3
  - Class 4
- New Quartz Claims
- Quartz Staking Direction
- Quartz Claims (50K)
  - Active and Pending
  - Expired
- Quartz Leases (50K)
- Adjoin Quartz
- Quartz Mining Land Use Permi
  - Class 3
  - Class 4
- Quartz Mining License
- Coal Exploration License
  - Active and Pending
  - Expired

1: 6,528

Notes

Bulk sampling and test pits. May-July 2015

0.3 0 0.17 0.3 Kilometers

Yukon Albers
Produced from: Yukon Mining Viewer

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

Date Printed: 03-Dec-2015

BOSS

Bonnyville Oilfield Service & Supply Ltd
Box 8402 Bonnyville Alberta T9N 2G9
Phone 780 812 3000 Fax 780 812 3002

2015 VICTORIA CREEK TEST PIT SAMPLE VOLUME SUMMARY LOG

BOSS TP 01

Facility Name	Victoria Creek	Total #	1761 m^3
Location	Victoria Creek		
Operator	Steve Harasimiuk	Date Start: May 28/15	Date Finish: July 1/2015
GPS	See details	LAT.	LON.

Equipment Used: Hitachi EX400C, Komatsu LC400-3 | Komatsu WA500 loader, Goldfield 50 wash plant

Test Pit #	Dimensions			Volume (m3)	Volume of Frozen Material		Comments
	Width	Length	Depth		thawed	frozen	
TP-1	3	3	6	54		✓	claim P26231
TP-2	3	3	6	54		✓	"
TP-3	3	3	5	45		✓	P26230
TP-4	3	3	5	45		✓	"
TP-5	3	5	5	75		✓	"
TP6	3	6	7	126	✓		P12533
TP-7	3	8	7	168	✓		"
TP-8	6	8	6	288	✓		"
TP-9	6	8	6	288	✓		"
TP-10	5	7	6	210	✓		P 26227
TP-11	5	7	6	210	✓		"
TP-12	3	6	6	108		✓	P26226
TP-13	3	5	6	90		✓	P26225

Comments: From TP-6-11 were side hill cuts and false channel. Material (1290 m^3) was individually run through washplant as bulk samples

Representative (indicate role)	Name	Signature	Date
Operator	STEVE HARASIMIUK	[signature]	Aug 31/15
Operator			

SOIL TEST PIT LOG FORMS

Project:_____ Test Pit Logged By:

Location:_____ _____

Weather Conditions_____

Method of Excavation_____ Date:_____

Test Pit_____ Ground Surface Slope_____% Time_____

Depth	Texture	Consistence Or Density	Color	Mottles	Comments

Weather Conditions_____

Method of Excavation_____ Date _____

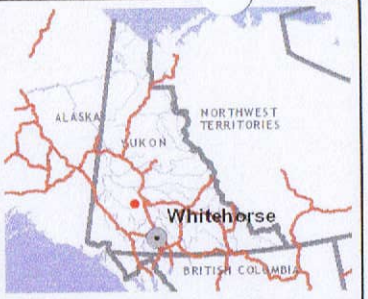
Test Pit_____ Ground Surface Slope_____% Time_____

Depth	Texture	Consistence Or Density	Color	Mottles	Comments

2016 Victoria Creek Deep Placer Testing

Yukon
Energy, Mines and Resources





Legend

- New Placer Claims
- Placer Baselines (unsurveyed)
- Placer Baselines (surveyed)
- Placer Claims (50K)
  - Active and Pending
  - Expired
- Prospecting Leases
  - Active and Pending
  - Expired
- Adjoin Placer
- Placer Mining Land Use Permi
  - Class 3
  - Class 4
- Coal Exploration License
  - Active and Pending
  - Expired
- Coal Mining Lease
  - Active and Pending
  - Expired
- Surveyed Mineral Claims
- Current Class 1 Notifications
  - Valid
  - In Review
  - Pending
  - Cancelled
  - Expired
  - Rejected

Notes

Bedrock overlaid on placer map.

1.5 0 0.76 1.5 Kilometers

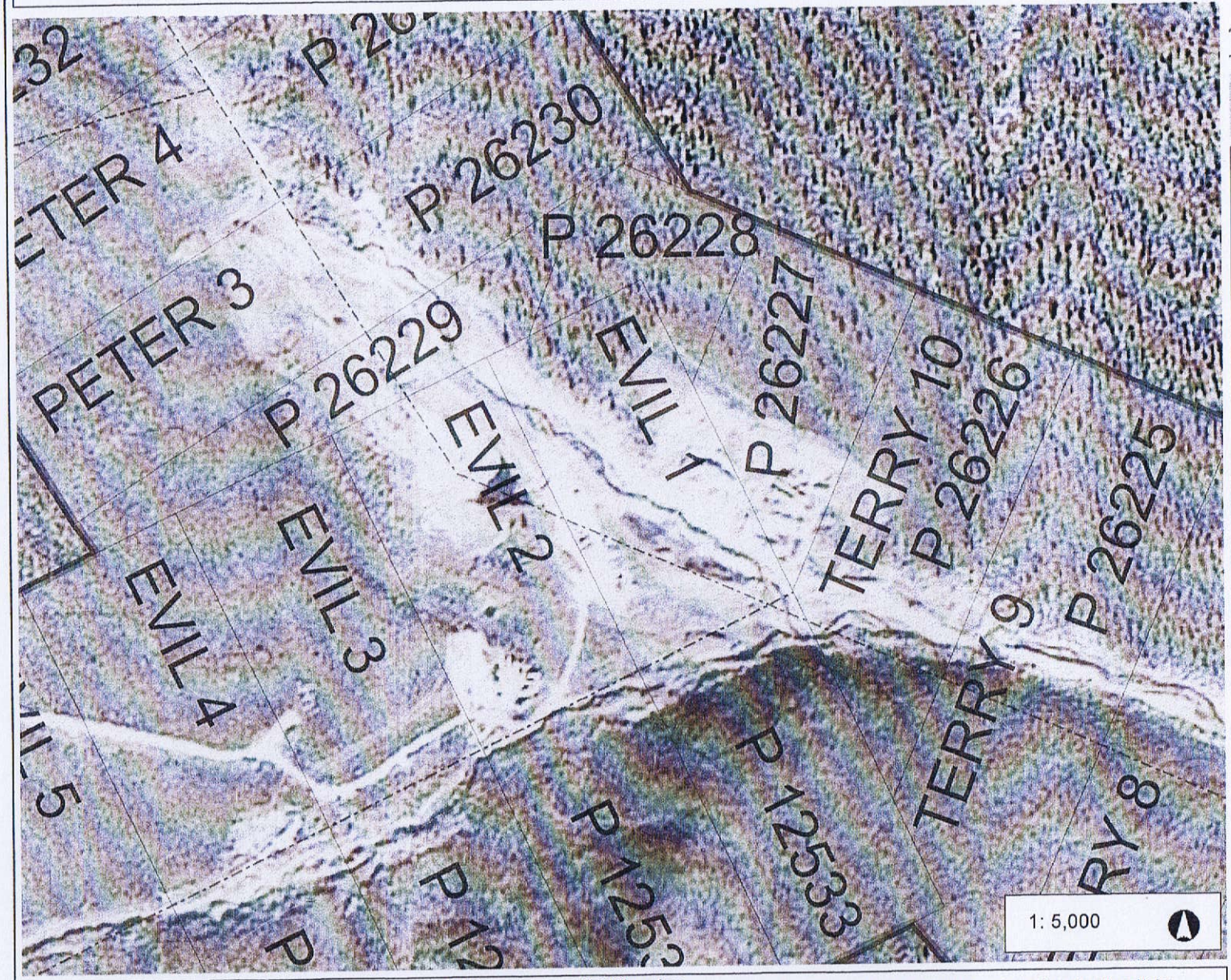
Yukon Albers
Produced from: Yukon Mining Viewer

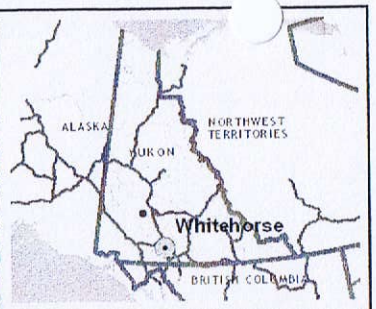
This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

Date Printed: 13-Mar-2016

Yukon
Energy, Mines and Resources

2016 Victoria Creek Deep Placer Testing





Legend

- New Placer Claims
- Placer Baselines (unsurveyed)
- Placer Baselines (surveyed)
- Placer Claims (50K)
  - Active and Pending
  - Expired
- Prospecting Leases
  - Active and Pending
  - Expired
- Adjoin Placer
- Placer Mining Land Use Permi
  - Class 3
  - Class 4
- Surveyed Mineral Claims
- Current Class 1 Notifications
  - Valid
  - In Review
  - Pending
  - Cancelled
  - Expired
  - Rejected
  - Closed
- Areas defined by OIC
- First Nation Survey Lands - Ca
- First Nation Unsurveyed Lands
- Areas withdrawn from staking
- Mineral occurrences (MINFILE

Notes

Google map overlaid on placer map.
Area # 1.

0.3 0 0.13 0.3 Kilometers

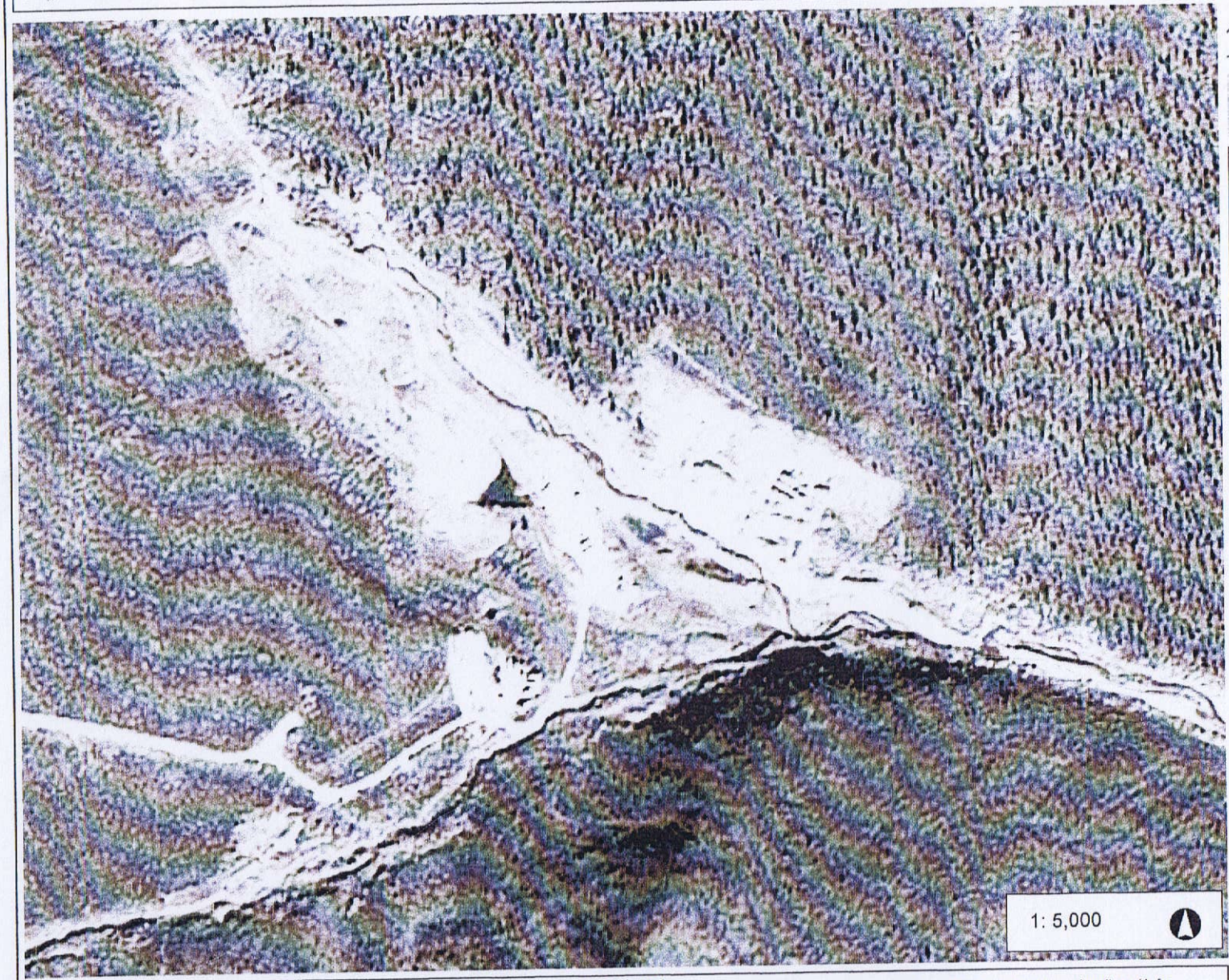
Yukon Albers
Produced from: Yukon Mining Viewer

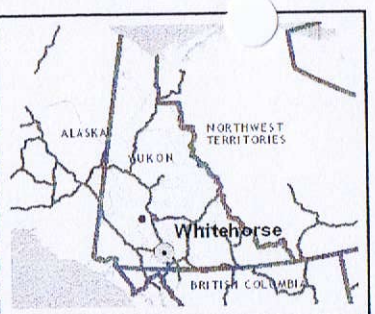
This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

Date Printed: 13-Mar-2016

Yukon
Energy, Mines and Resources

2016 Victoria Creek Deep Placer Testing





Legend

Current Class 1 Notifications
- Valid
- In Review
- Pending
- Cancelled
- Expired
- Rejected
- Closed

Areas defined by OIC
First Nation Survey Lands - Ca
First Nation Unsurveyed Lands
Areas withdrawn from staking

Mineral occurrences (MINFILE
- Anomaly
- Deposit
- Drilled Prospect
- Open Pit Past Producer
- Open Pit Producer
- Prospect
- Showing
- Staked - No Work Recorded
- Underground Past Producer
- Unknown

Notes

Google map of Area # 1.

0.3 0 0.13 0.3 Kilometers

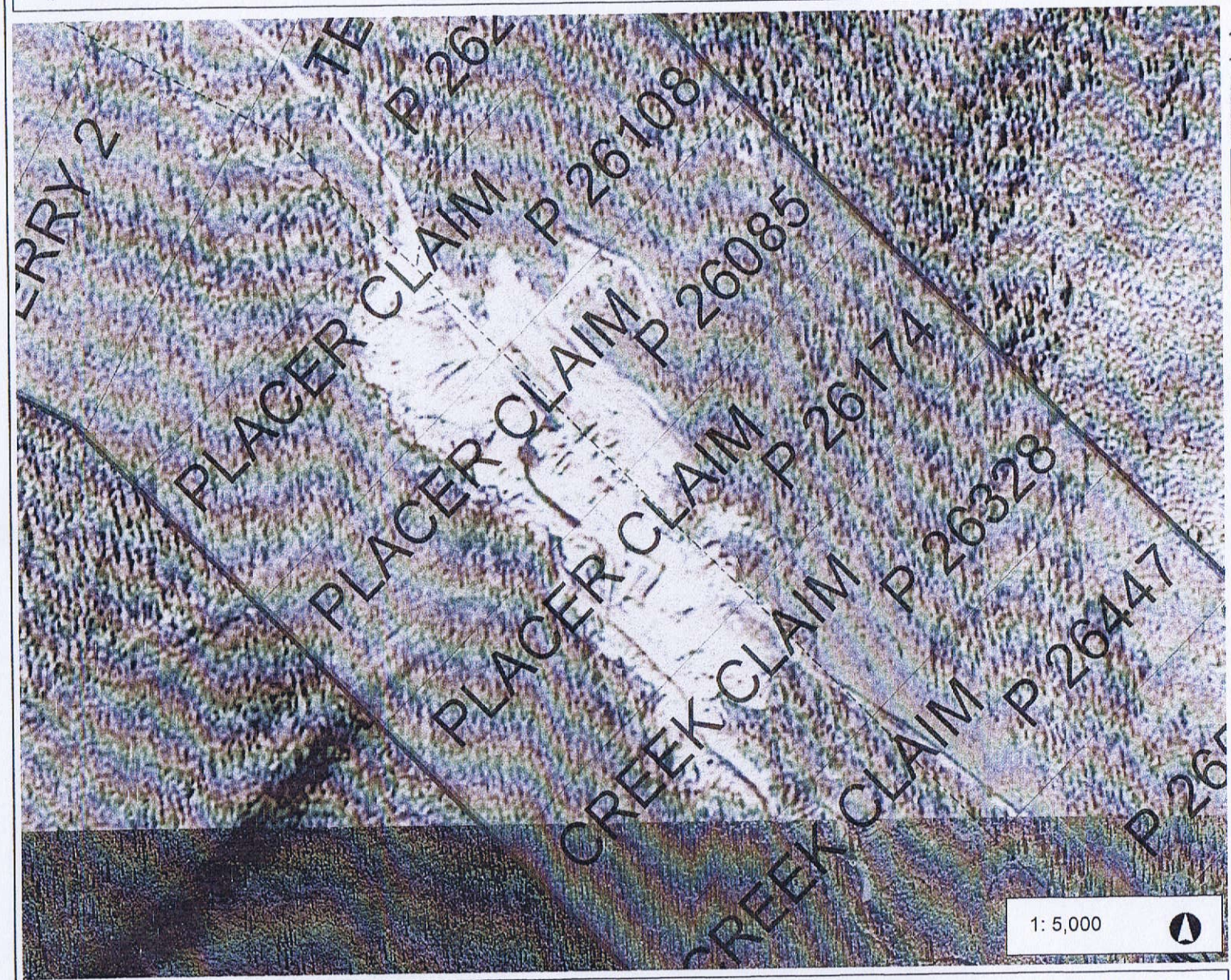
Yukon Albers
Produced from: Yukon Mining Viewer

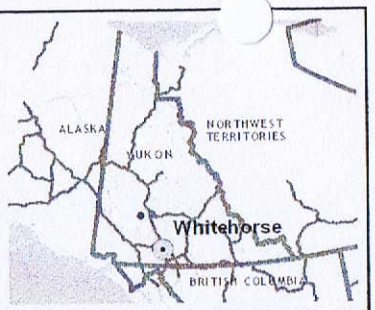
This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

Date Printed: 13-Mar-2016

Yukon
Energy, Mines and Resources

2016 Victoria Creek Deep Placer Testing





Legend

- New Placer Claims
- Placer Baselines (unsurveyed)
- Placer Baselines (surveyed)
- Placer Claims (50K)
  - Active and Pending
  - Expired
- Prospecting Leases
  - Active and Pending
  - Expired
- Adjoin Placer
- Placer Mining Land Use Permi
  - Class 3
  - Class 4
- Surveyed Mineral Claims
- Current Class 1 Notifications
  - Valid
  - In Review
  - Pending
  - Cancelled
  - Expired
  - Rejected
  - Closed
- Areas defined by OIC
- First Nation Survey Lands - Ca
- First Nation Unsurveyed Lands
- Placer Stream Classification
  - Water Quality

Notes

Google map overlaid on placer map.
Area # 2

0.3 0 0.13 0.3 Kilometers

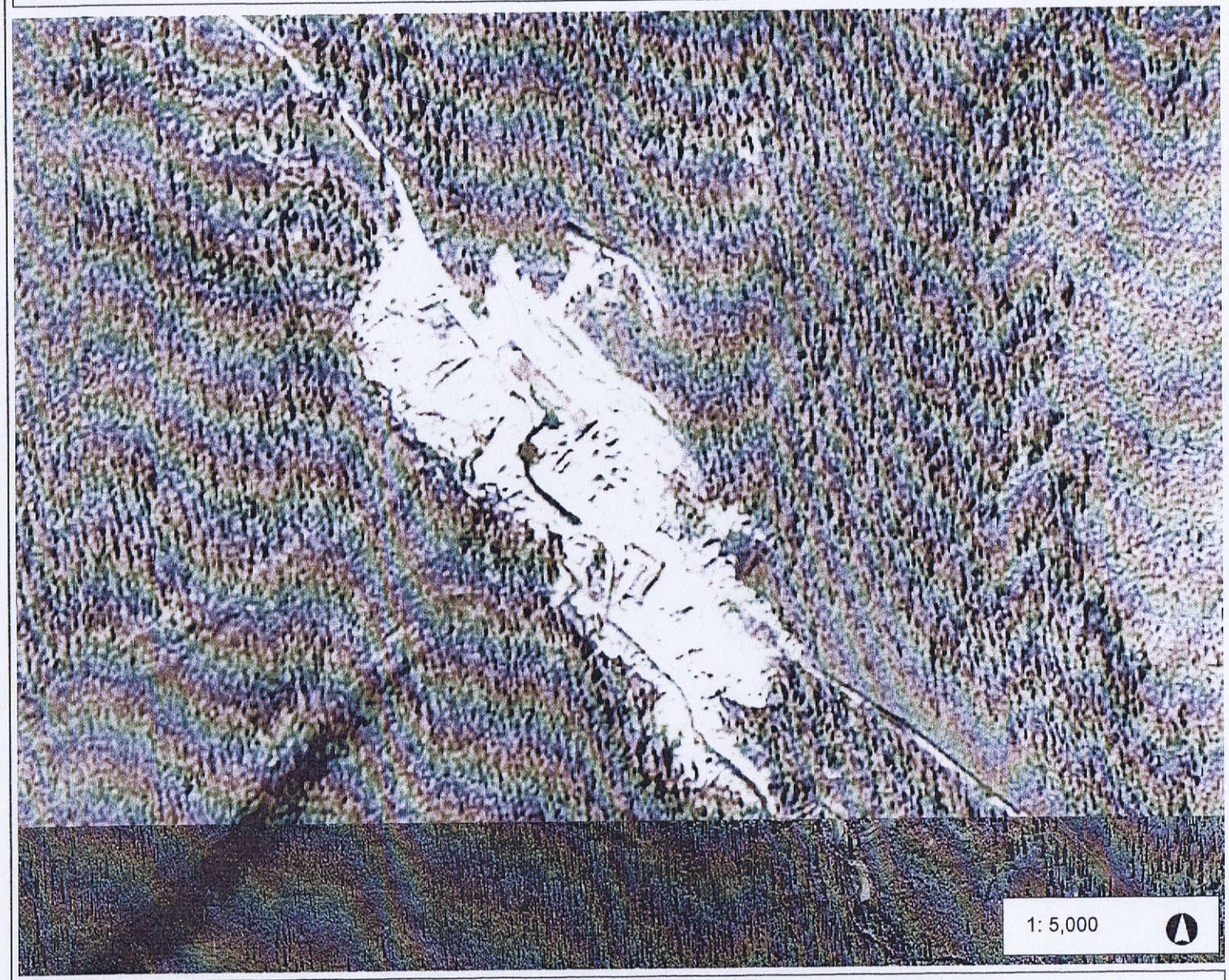
Yukon Albers
Produced from: Yukon Mining Viewer

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

Date Printed: 13-Mar-2016

Yukon
Energy, Mines and Resources

2016 Victoria Creek Deep Placer Testing





Legend

Current Class 1 Notifications
- Valid
- In Review
- Pending
- Cancelled
- Expired
- Rejected
- Closed

Areas defined by OIC
First Nation Survey Lands - Ca
First Nation Unsurveyed Lands
Areas withdrawn from staking
Mineral occurrences (MINFILE
- Anomaly
- Deposit
- Drilled Prospect
- Open Pit Past Producer
- Open Pit Producer
- Prospect
- Showing
- Staked - No Work Recorded
- Underground Past Producer
- Unknown

Notes

Google map of Area # 2.

0.3 0 0.13 0.3 Kilometers

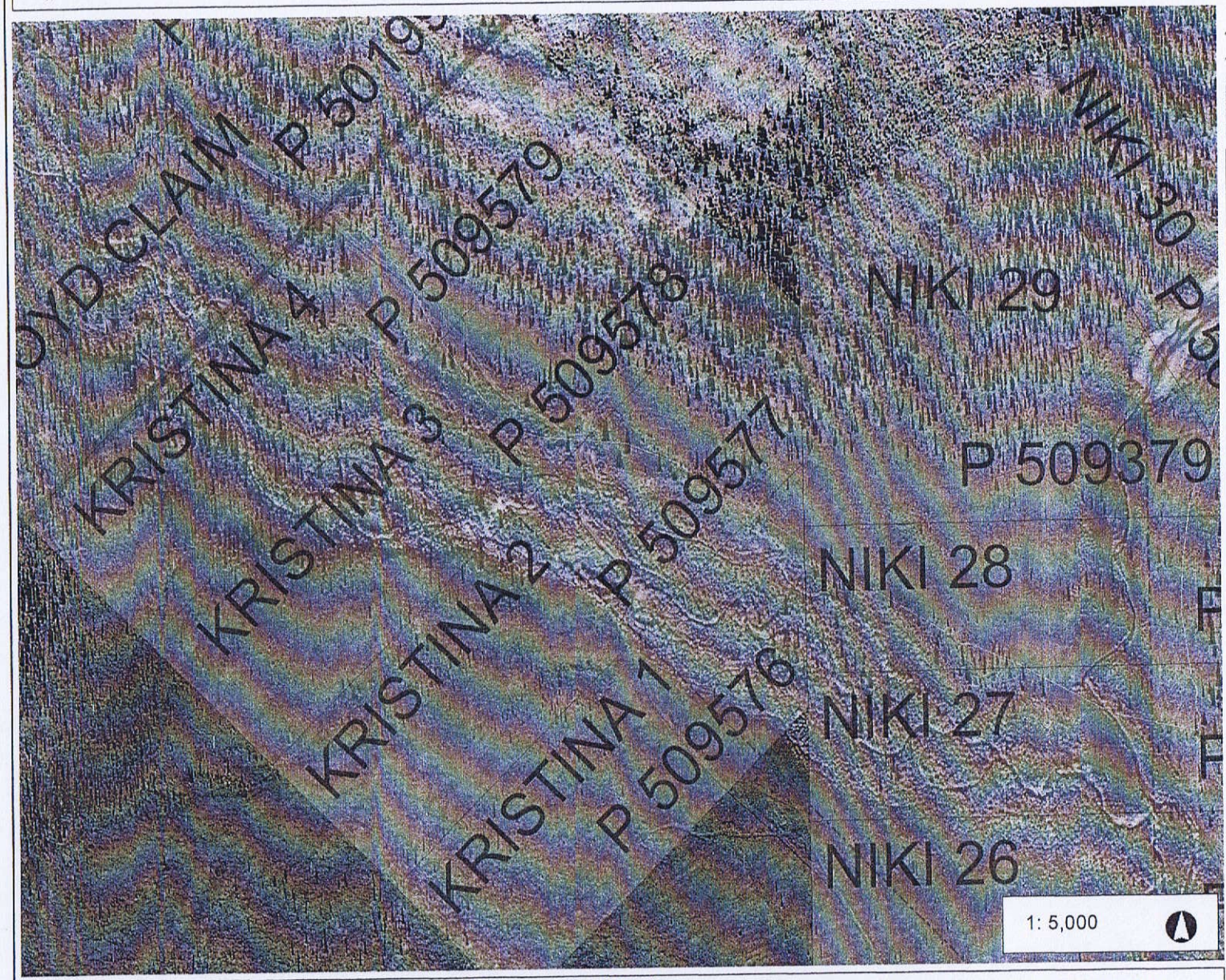
Yukon Albers
Produced from: Yukon Mining Viewer

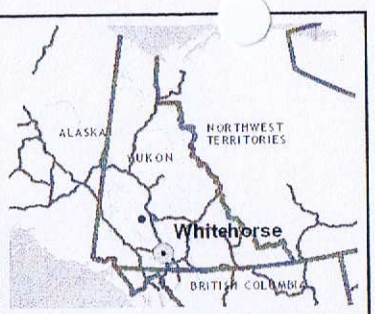
This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

Date Printed: 13-Mar-2016

Yukon
Energy, Mines and Resources

2016 Victoria Creek Deep Placer Testing





Legend

- New Placer Claims
- Placer Baselines (unsurveyed)
- Placer Baselines (surveyed)
- Placer Claims (50K)
  - Active and Pending
  - Expired
- Prospecting Leases
  - Active and Pending
  - Expired
- Adjoin Placer
- Placer Mining Land Use Permi
  - Class 3
  - Class 4
- Surveyed Mineral Claims
- Current Class 1 Notifications
  - Valid
  - In Review
  - Pending
  - Cancelled
  - Expired
  - Rejected
  - Closed
- Areas defined by OIC
- First Nation Survey Lands - Ca
- First Nation Unsurveyed Lands
- Areas withdrawn from staking
- Mineral occurrences (MINFILE

Notes

Google map of Area # 3.

0.3 0 0.13 0.3 Kilometers

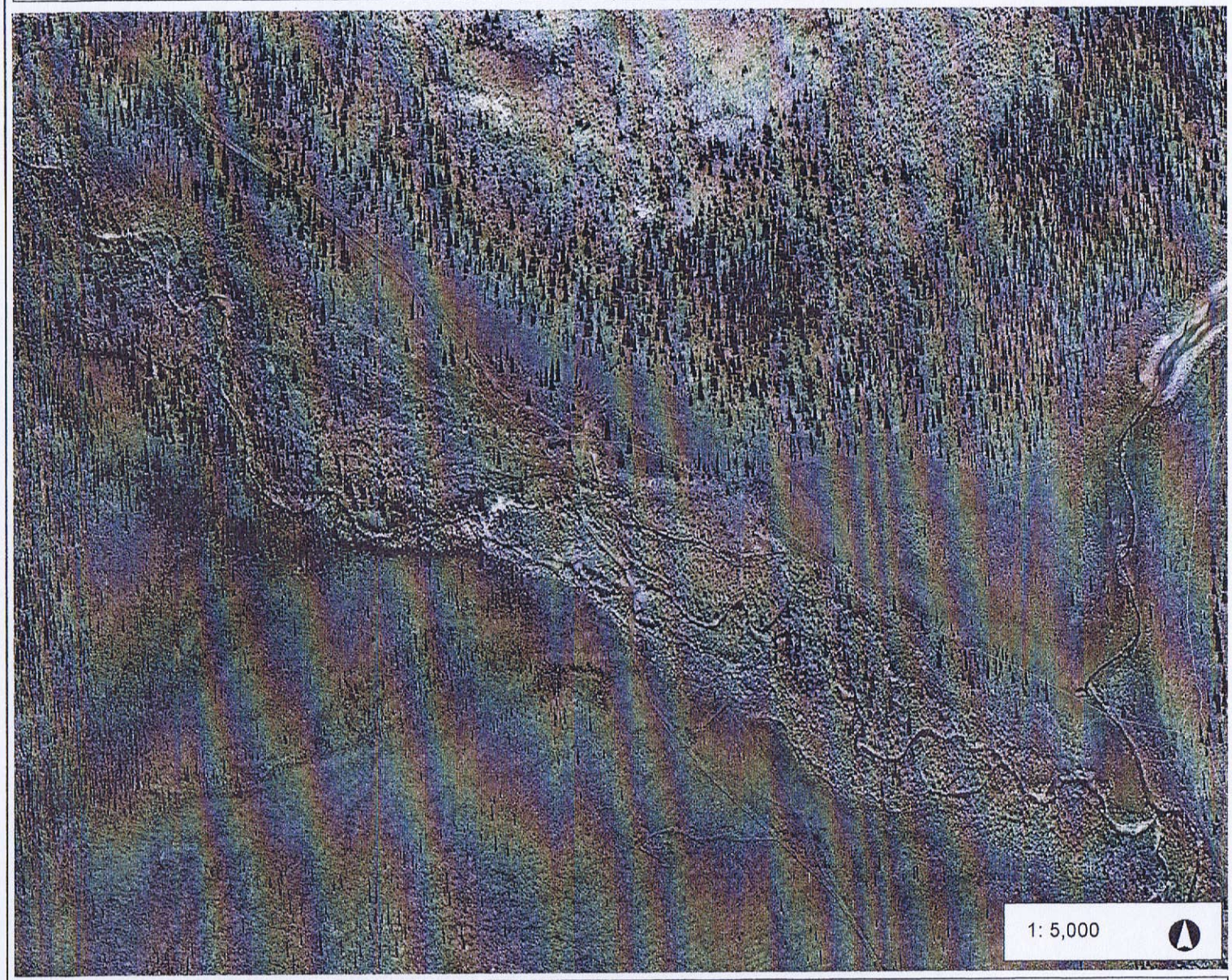
Yukon Albers
Produced from: Yukon Mining Viewer

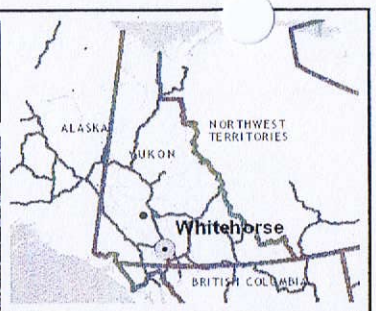
This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

Date Printed: 13-Mar-2016

Yukon
Energy, Mines and Resources

2016 Victoria Creek Deep Placer Testing





Legend

Current Class 1 Notifications
- Valid
- In Review
- Pending
- Cancelled
- Expired
- Rejected
- Closed

Areas defined by OIC
First Nation Survey Lands - Ca
First Nation Unsurveyed Lands
Areas withdrawn from staking
Mineral occurrences (MINFILE
- Anomaly
- Deposit
- Drilled Prospect
- Open Pit Past Producer
- Open Pit Producer
- Prospect
- Showing
- Staked - No Work Recorded
- Underground Past Producer
- Unknown

Notes

Google map of Area # 3.

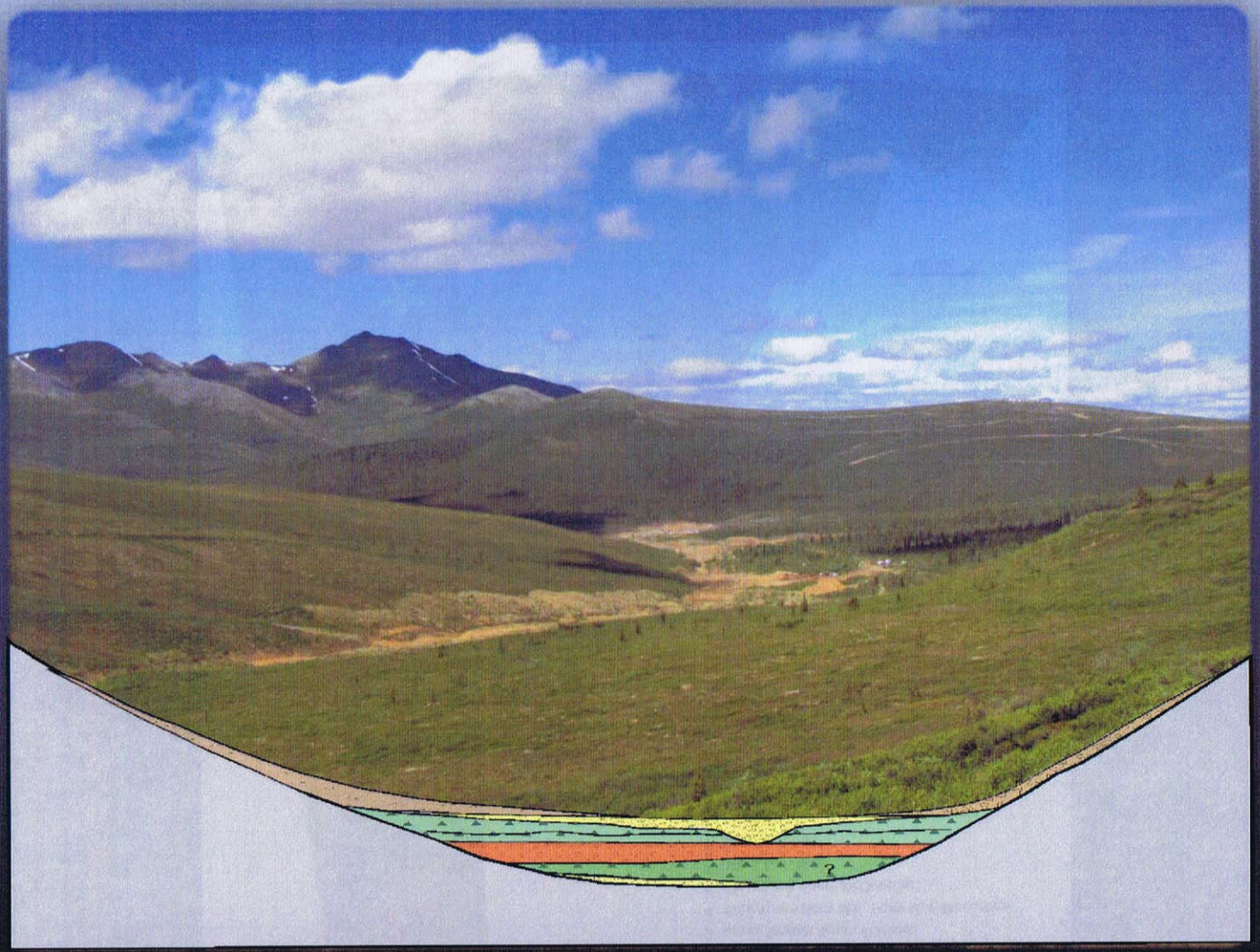
0.3 0 0.13 0.3 Kilometers

Yukon Albers
Produced from: Yukon Mining Viewer

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

Date Printed: 13-Mar-2016

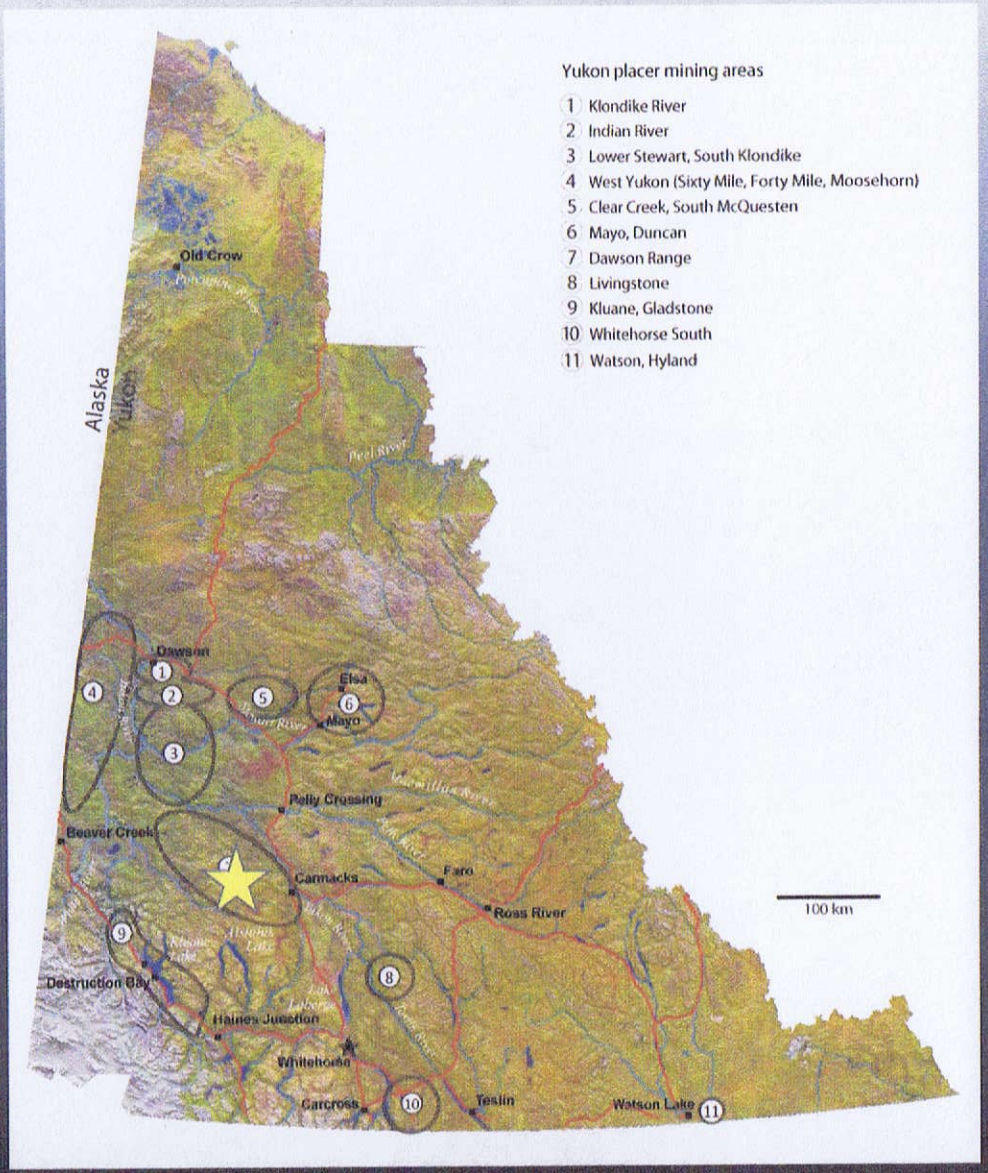
The Deep Placers of Mount Nansen (part 1)



Jeffrey Bond

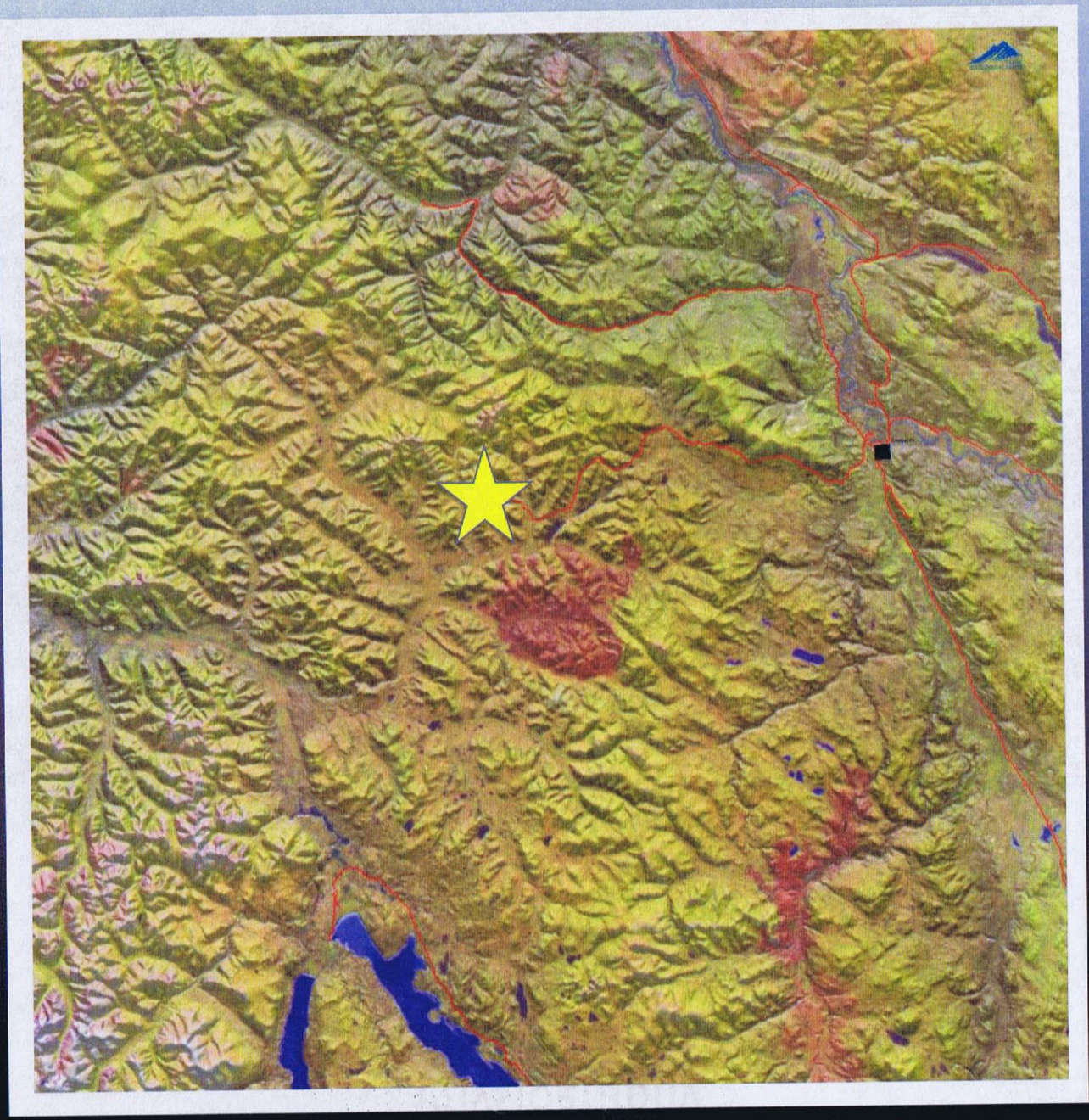
Yukon Geological Survey

Mount Nansen Location



YUKON GEOLOGICAL SURVEY

Mount Nansen Location



Physiography



LeBarge photo

Yukon Geological Survey

Physiography



Geology



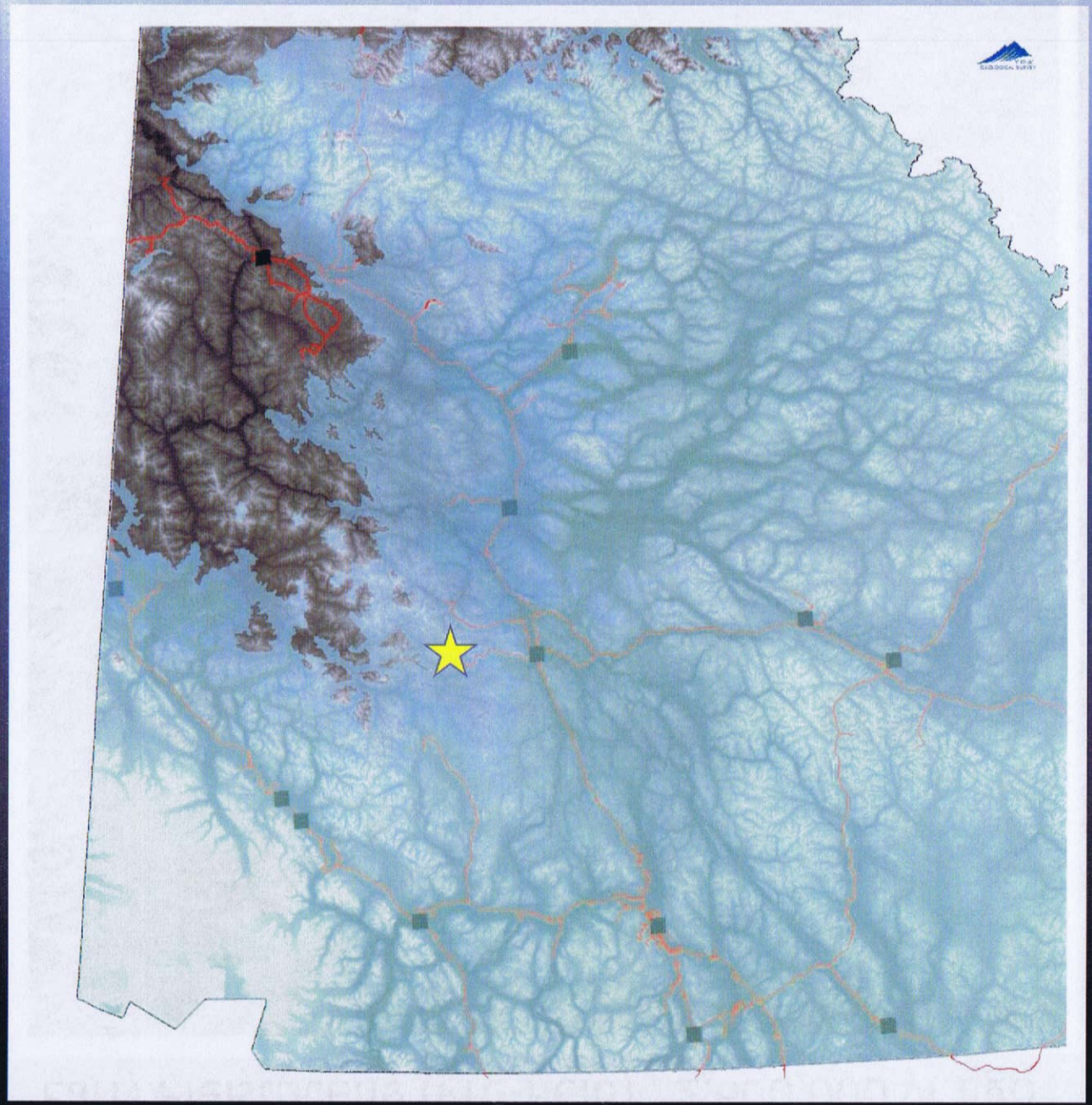
Cairnes, 1916
Bostock, 1936
Tenpelman-Kluit, 1984
Carlson, 1987

Geology and mineral deposits of the Mount Nansen camp, Yukon

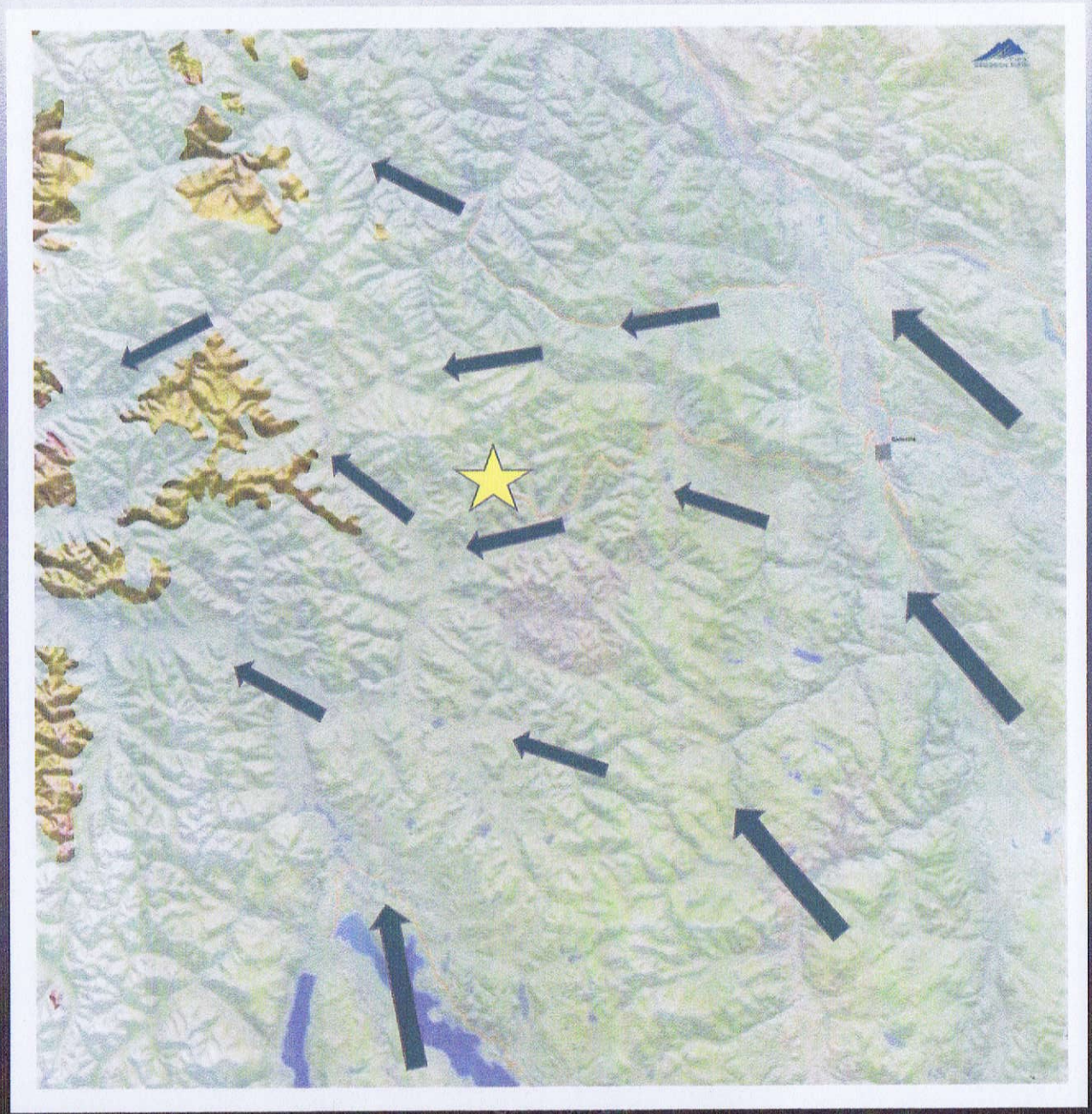
Craig J.R. Hart[1] and Mark Langdon[2]
[1]Yukon Geology Program (F-3), Box 2703, Whitehorse, Yukon, Y1A 2C6, e-mail: craig.hart@gov.yk.ca
[2]Mineral Resources, DIAND, 325-300 Main Street, Whitehorse, Yukon, Y1A 2B5

Hart, Craig J.R. and Langdon, Mark. Geology and mineral deposits of the Mount Nansen camp, Yukon. *In:* Yukon Exploration and Geology 1997, Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p.129-138.

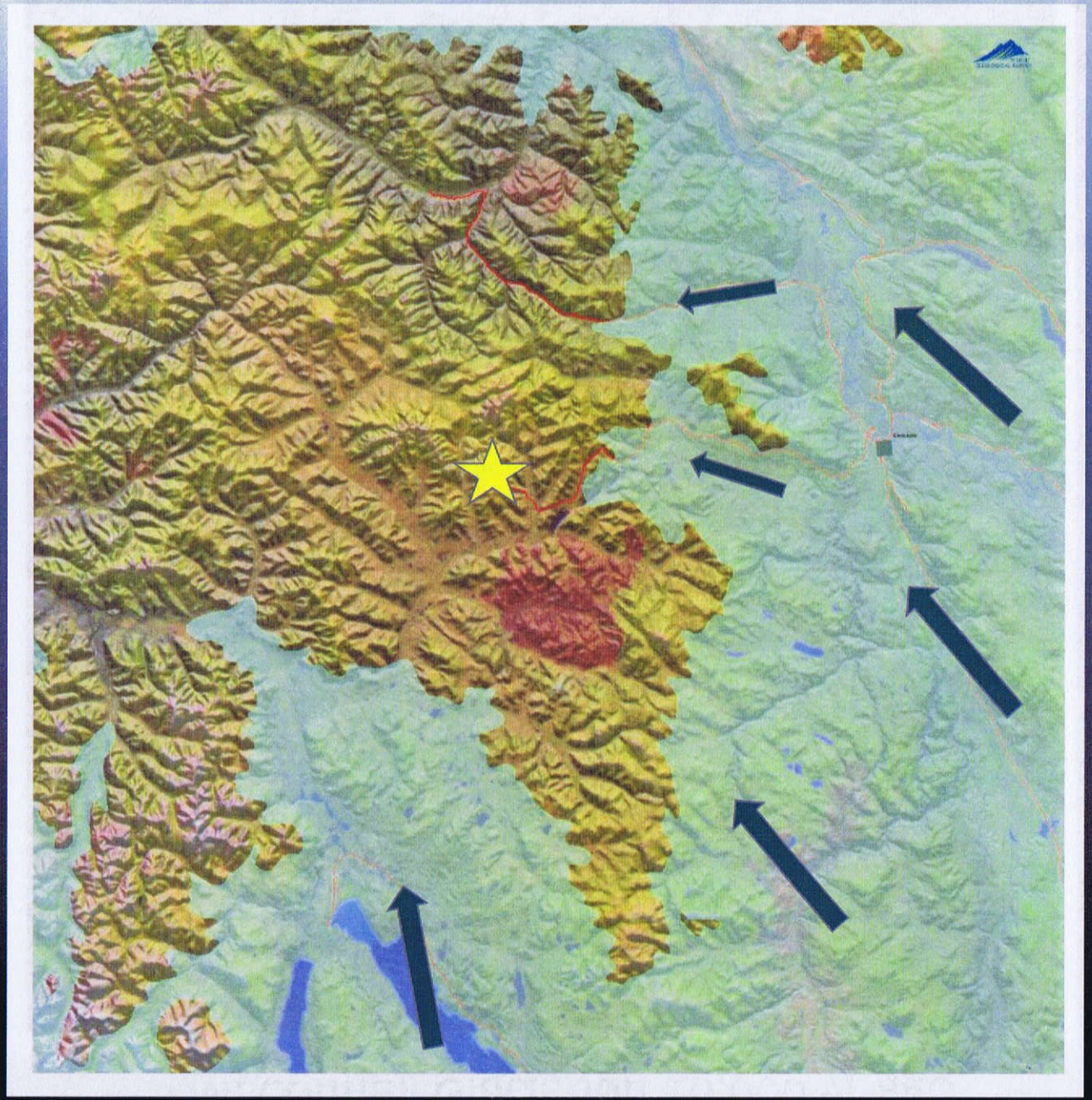
Mount Nansen Location



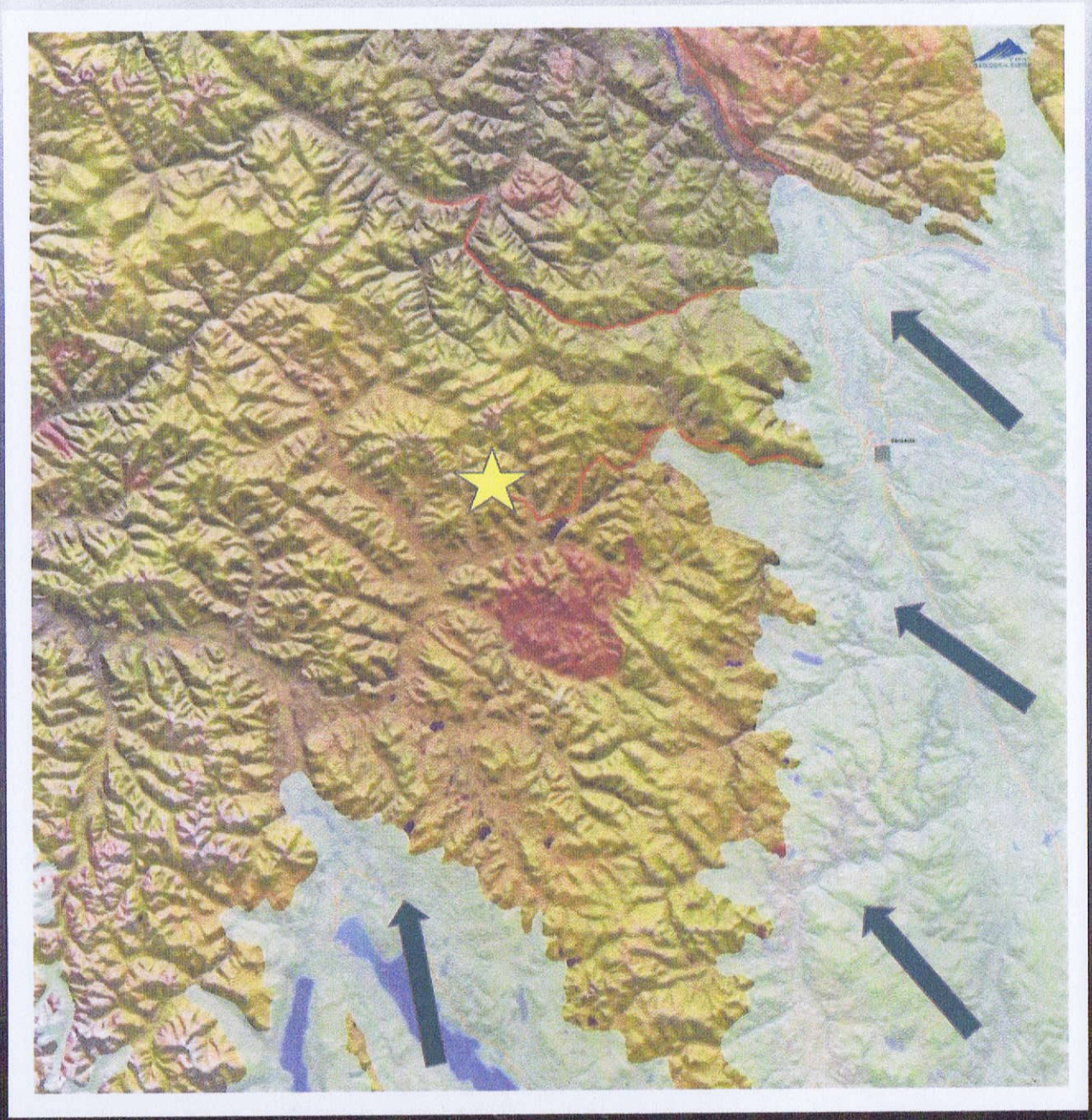
Early Pleistocene (Pre-Reid) ~2,600,000 yr ago



Reid Glaciation 150,000 yr ago



McConnell Glaciation 16,000 yr ago



Previous Placer Studies

LeBarge, 1995

Indian and Northern Affairs Canada | Affaires indiennes et du Nord Canada

Exploration and Geological Services Division, Yukon Region

BULLETIN 4

SEDIMENTOLOGY OF PLACER GRAVELS NEAR MT. NANSEN CENTRAL YUKON TERRITORY



W.P. LeBarge 1995

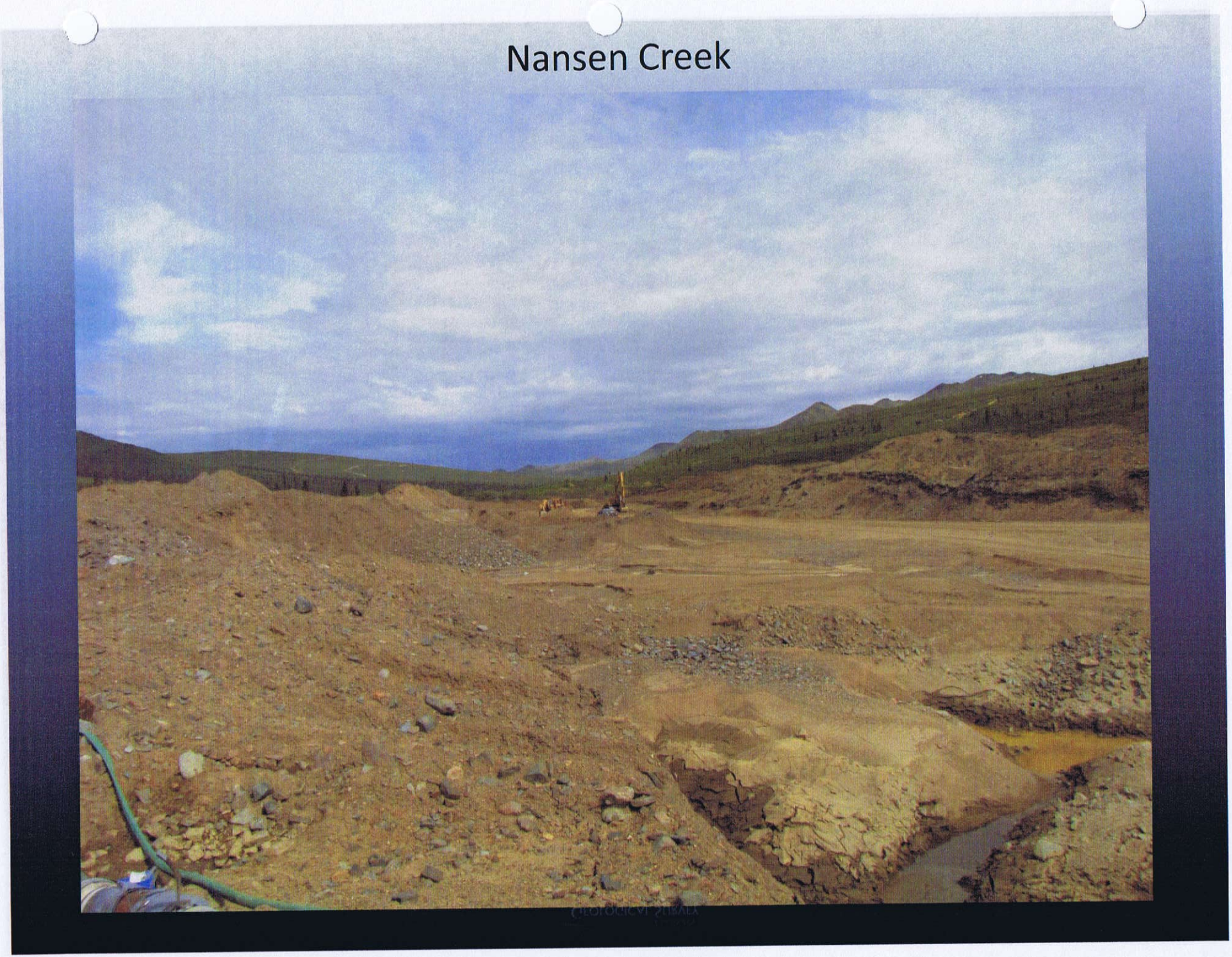
Canada

Yukon Geological Survey

Back Creek



Nansen Creek



Nansen Creek



YUKON GEOLOGICAL SURVEY

Nansen Creek Till



Yukon Geological Survey

Dawson Range
Nansen



Pre-Reid Glacial History

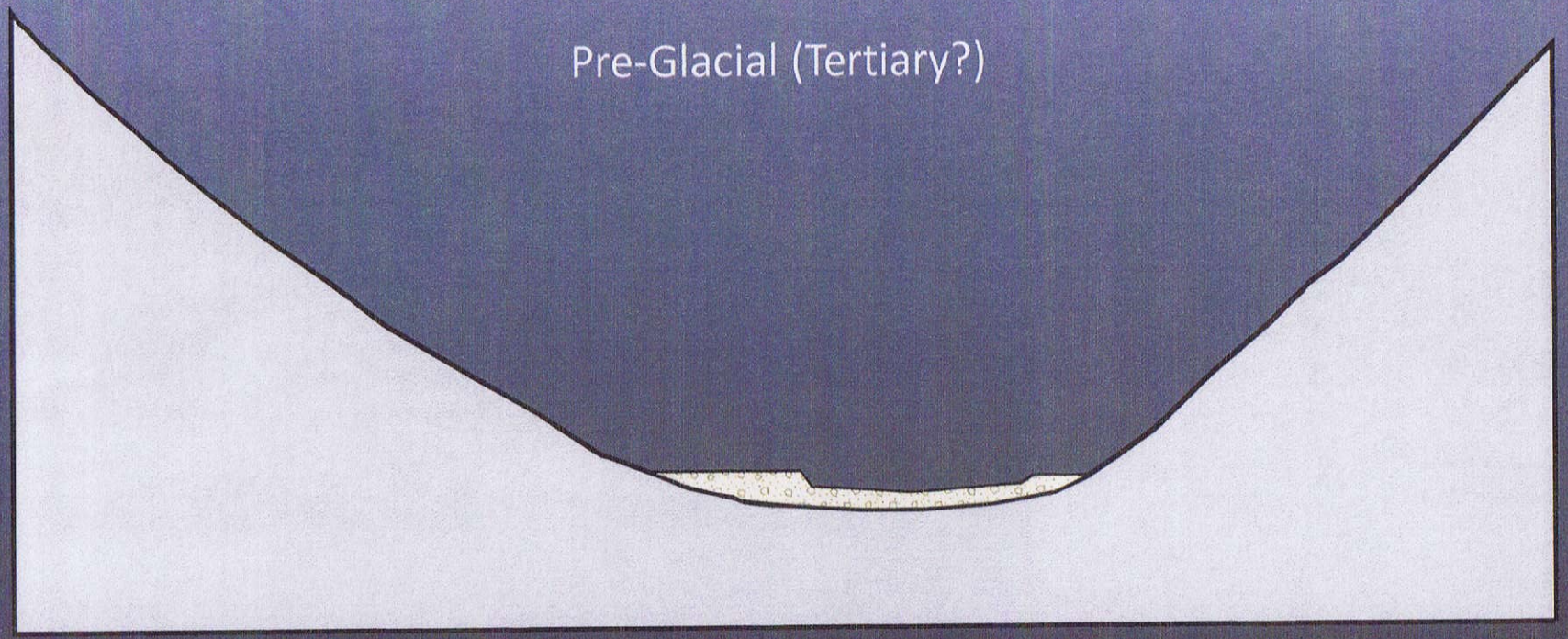


LeBarge photo

Yukon Geological Survey

Hypothetical Cross-section
Nansen Creek

Pre-Glacial (Tertiary?)



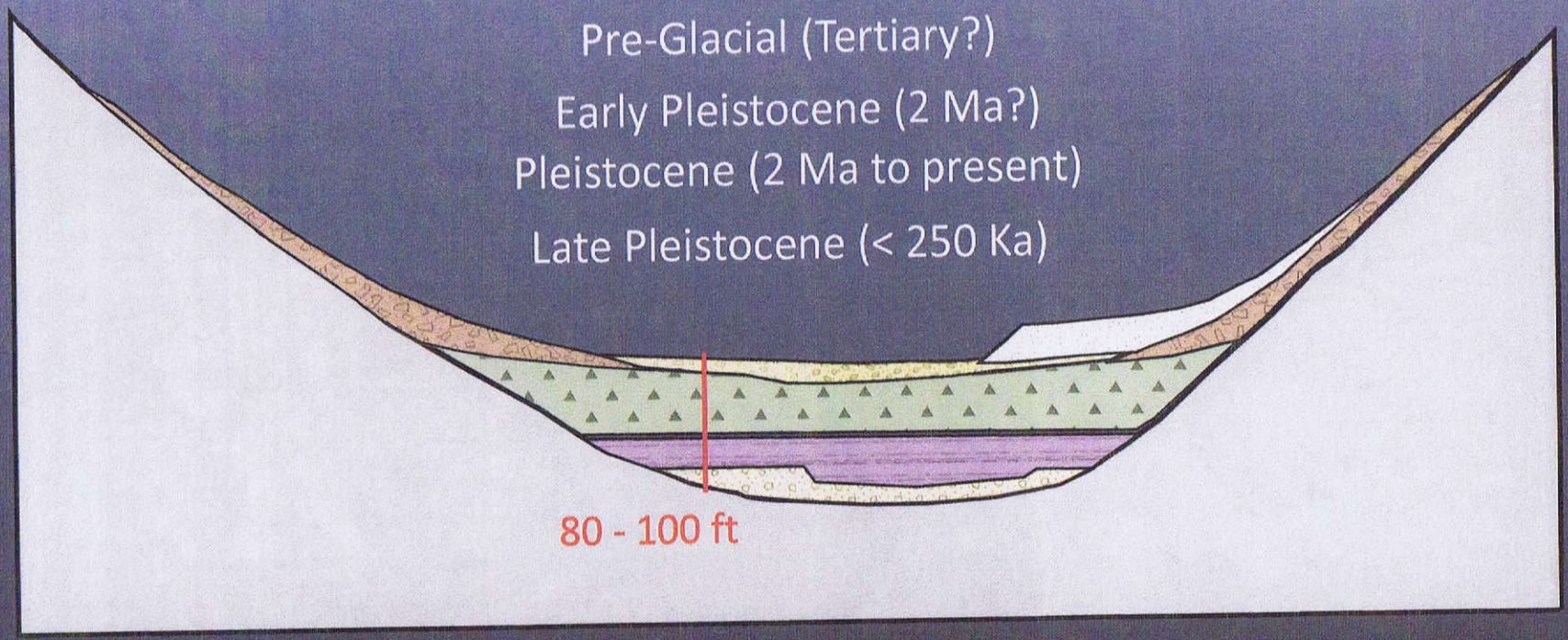
YUKON GEOLOGICAL SURVEY

Back Creek Pre-Glacial gravel



Yukon Geological Survey

Hypothetical Cross-section
Nansen Creek



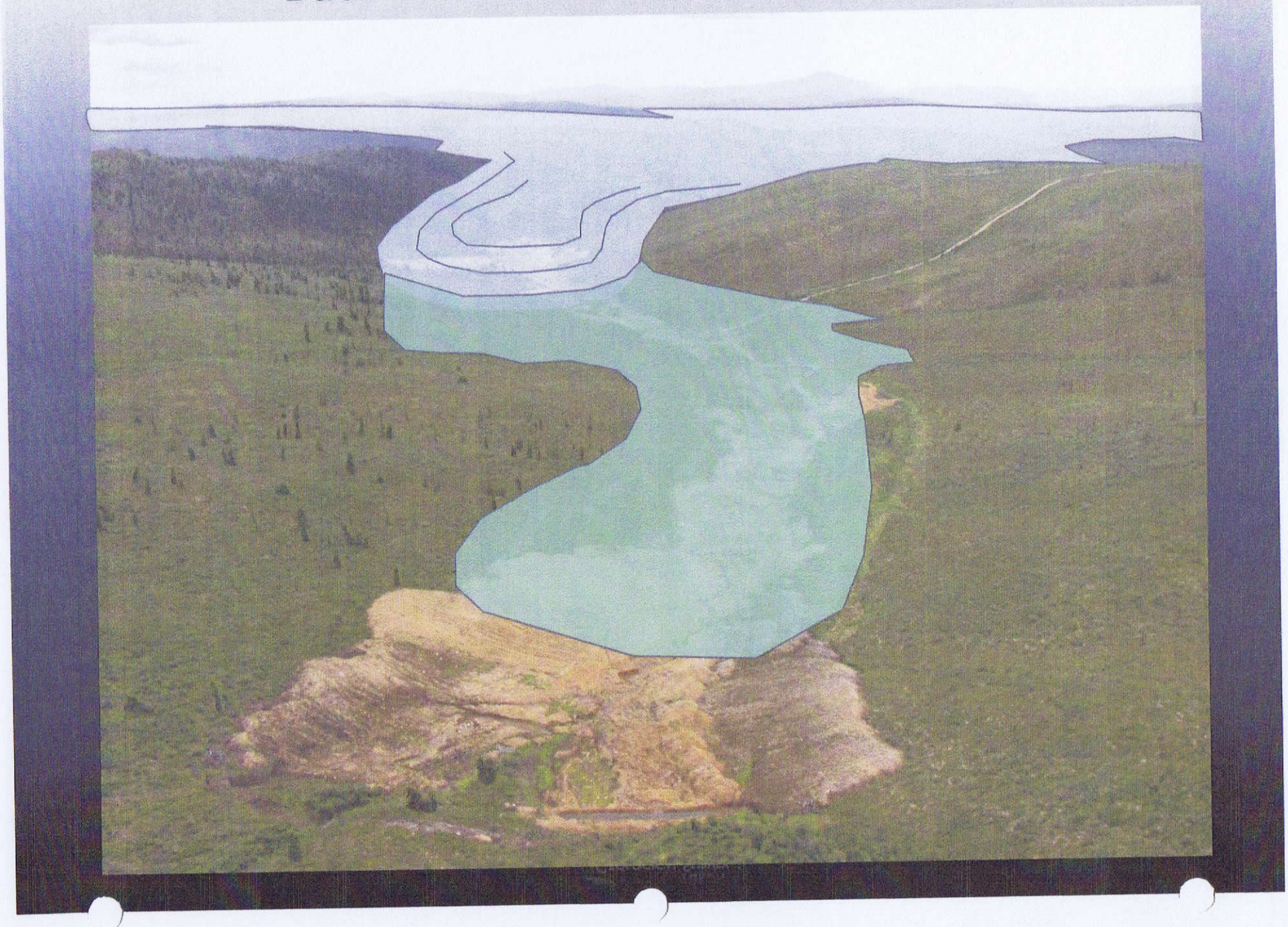
Yukon Geological Survey

Mouth of Discovery Creek



LeBarge photo

Back Creek - Pre-Reid Glacial History



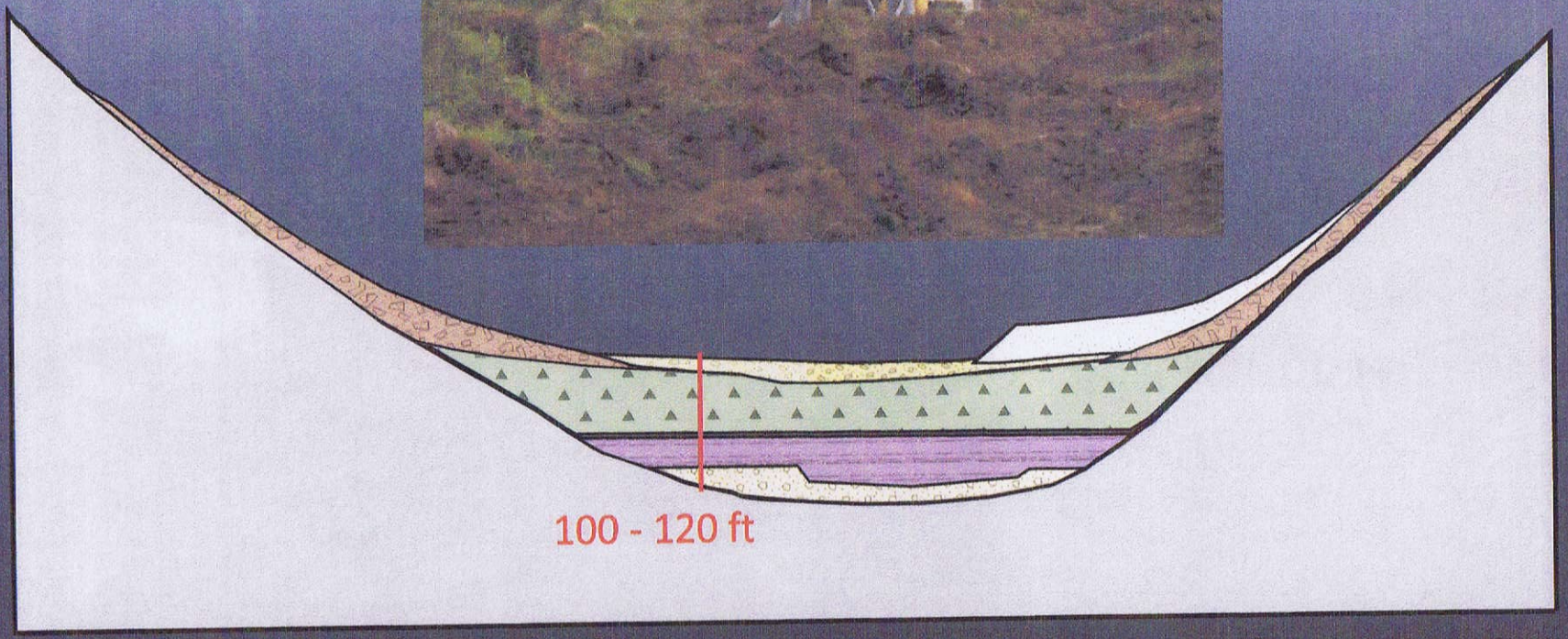
Back Creek



LeBarge photo

A-1 Cats
Back Creek 2014



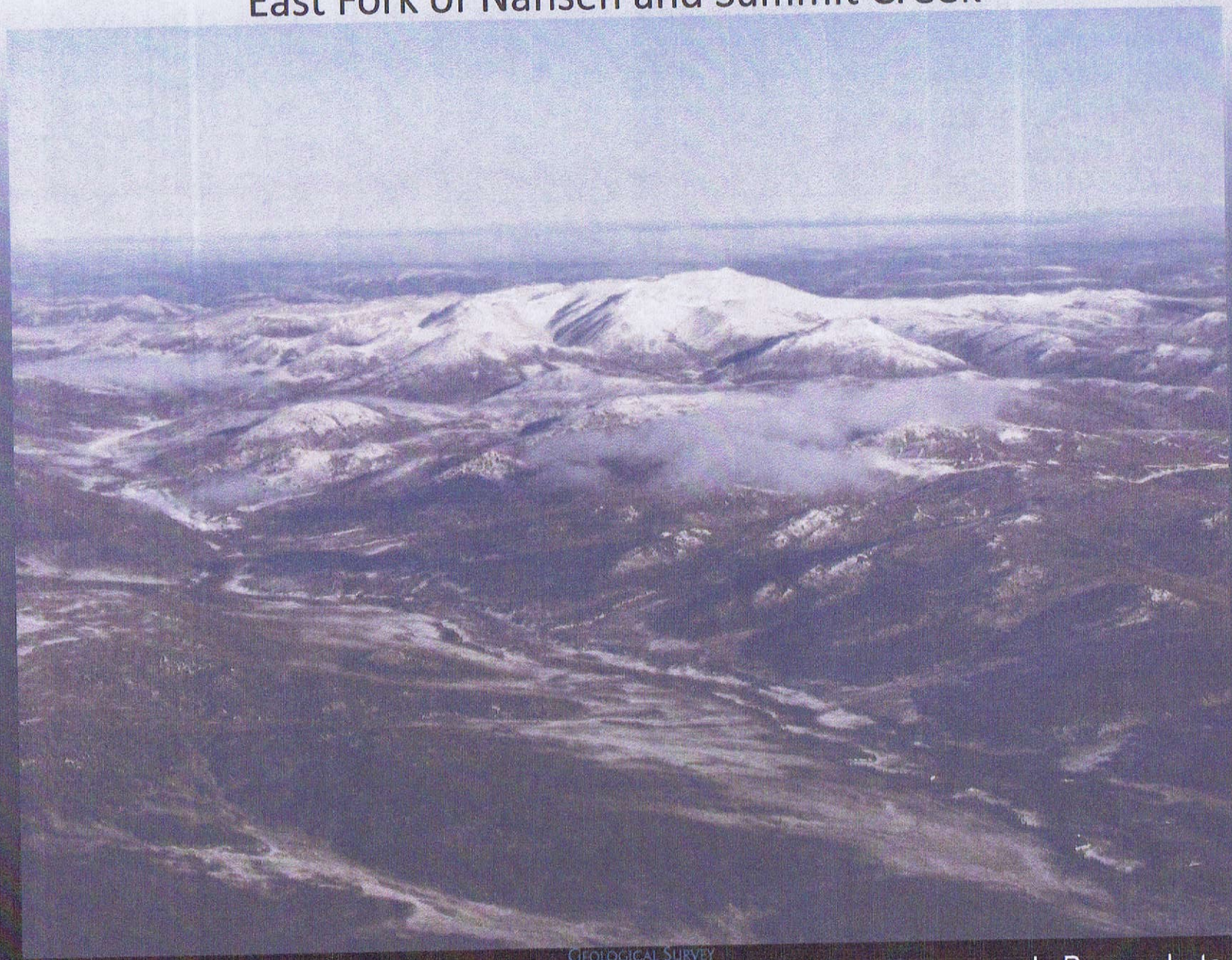


Yukon Geological Survey

Upper Drainage Stratigraphy



East Fork of Nansen and Summit Creek

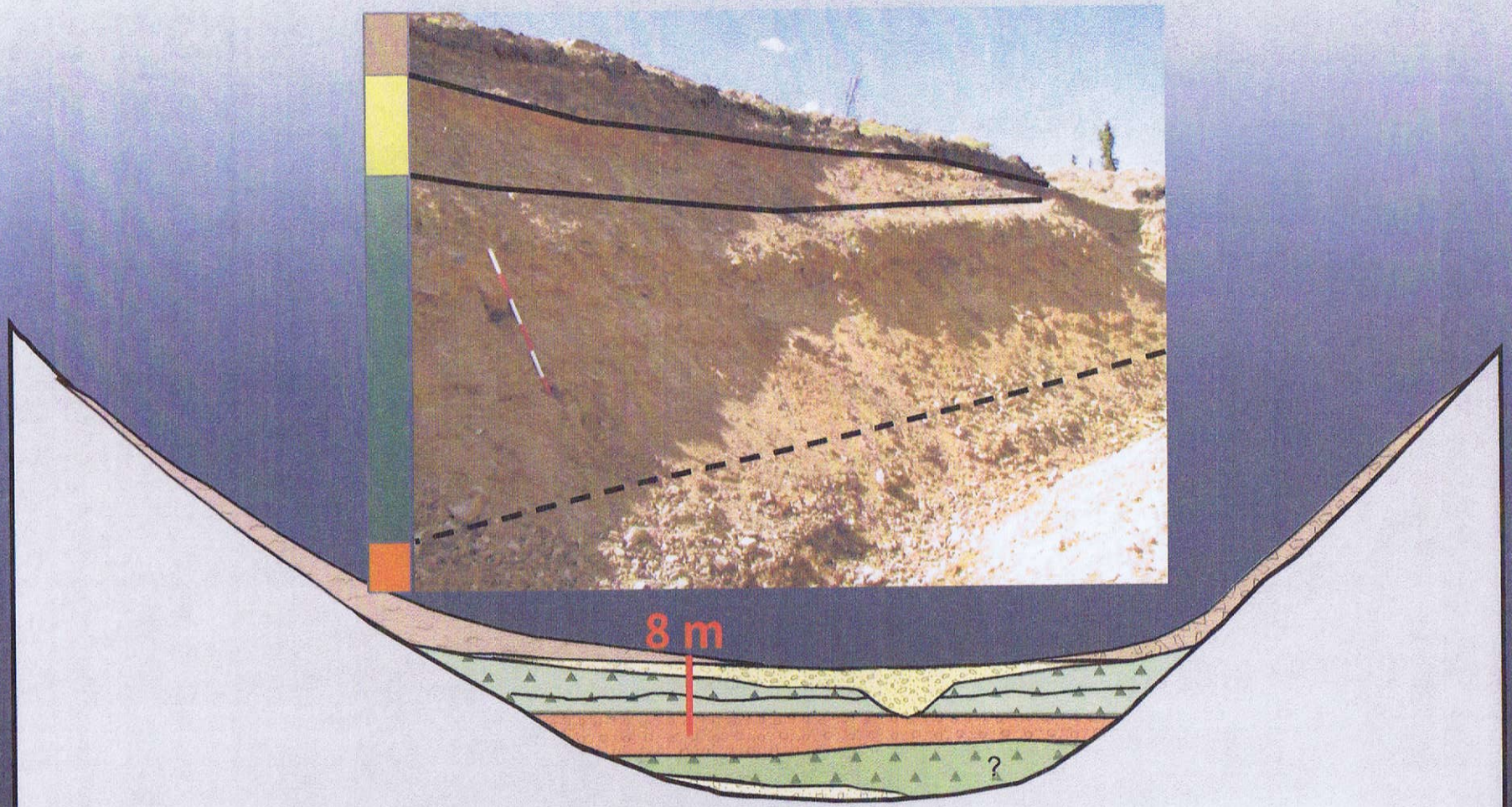


LeBarge photo

East Fork of Nansen and Summit Creek



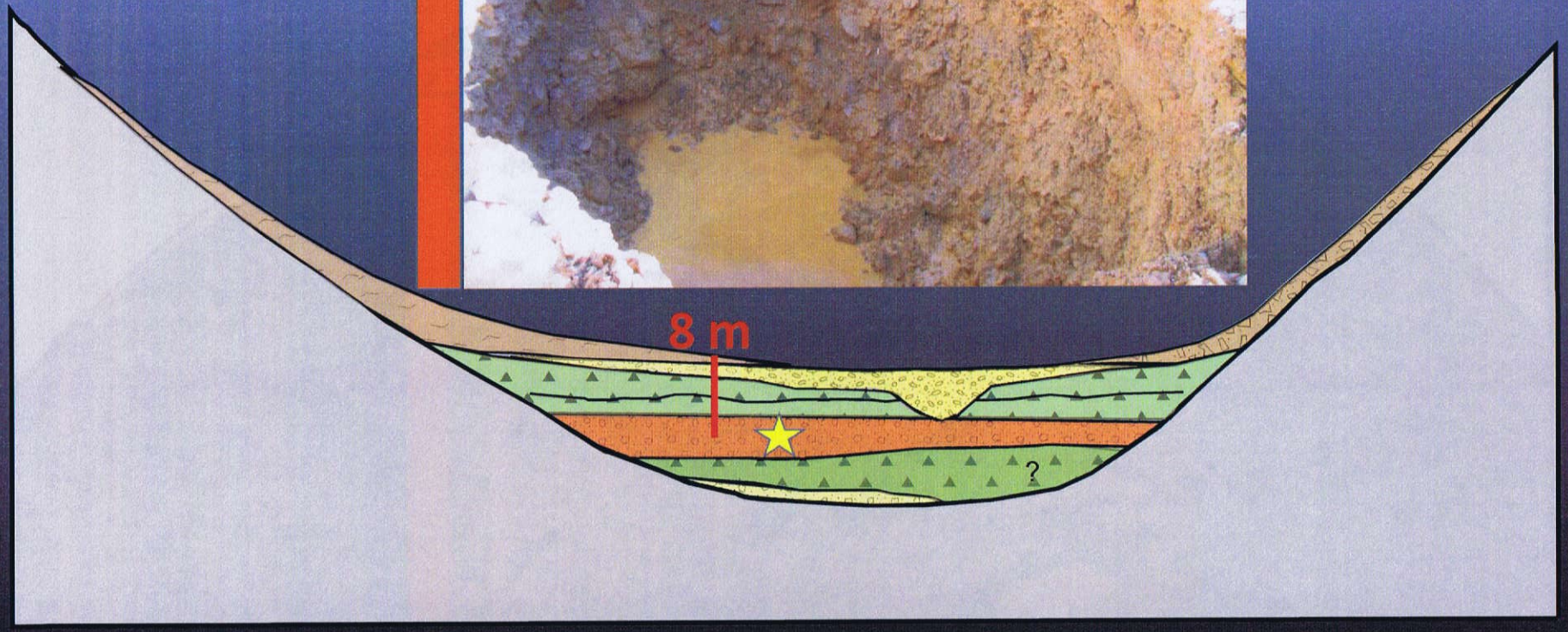
Summit Creek – Pishon Gold



Yukon Geological Survey

Summit Creek – Pishon Gold





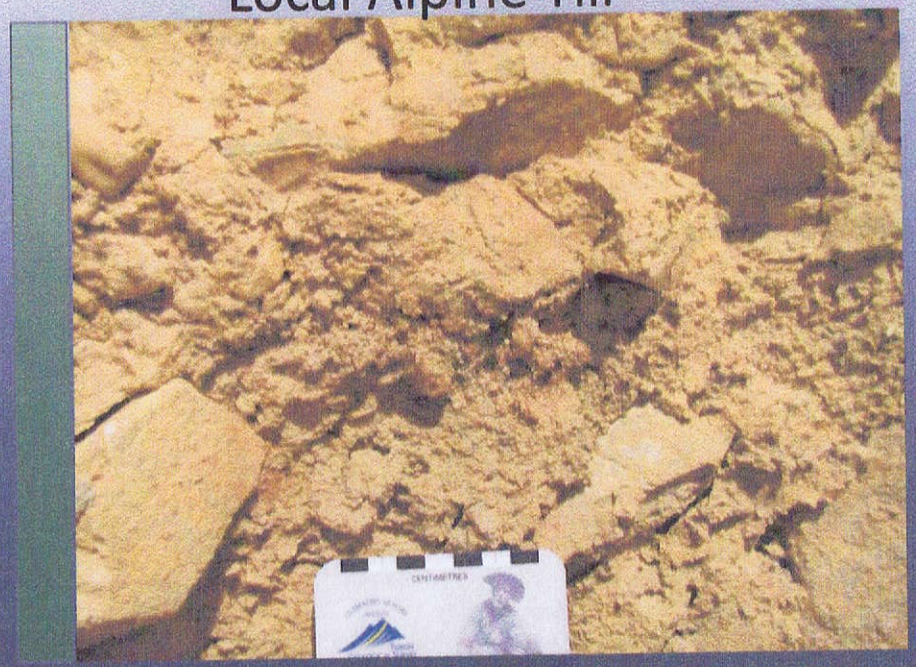
Yukon Geological Survey

Summit Creek – Pishon Gold



YUKON
GEOLOGICAL SURVEY

Summit Creek – Pishon Gold
Local Alpine Till



Yukon Geological Survey

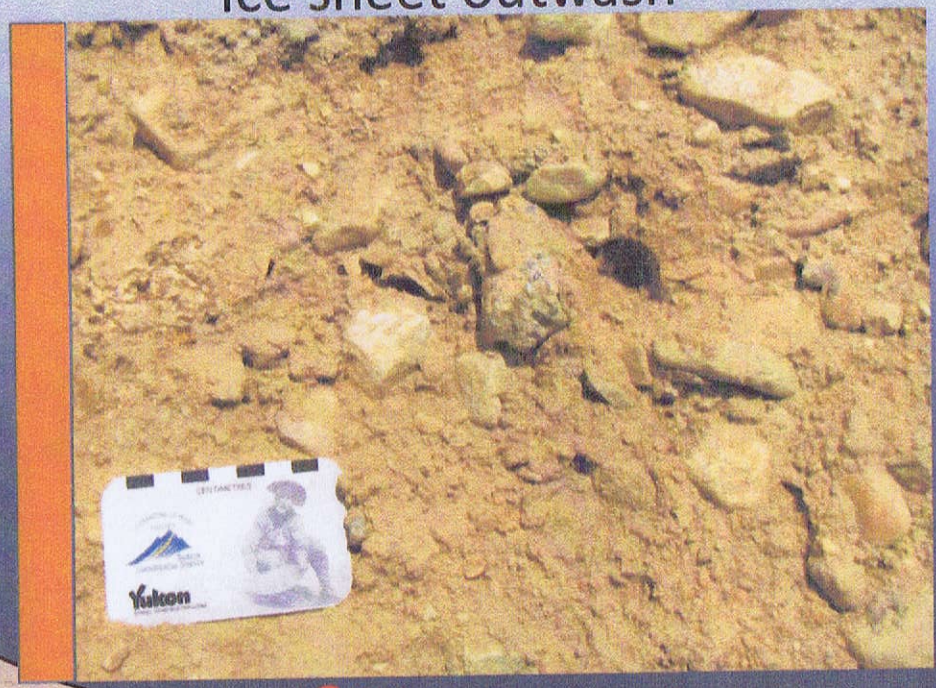
Conclusions

- Deep placers have been confirmed in Back Creek
- Potential for deep placers exists in Nansen, Victoria, lower Summit, Cabin and Webber Creeks
- Depths will range from approx. 50-130 ft (15-40 m)
- Drilling and geophysics is required to locate the center line of the deep pay channel



Yukon Geological Survey

Summit Creek – Pishon Gold
Ice sheet outwash



Yukon Geological Survey

Placer-lode gold relationships in the Nansen placer district, Yukon

Rob Chapman[1], Matthew Cook, Matthew Grimshaw and Scott Myles
University of Leeds, UK

Chapman, R., Cook, M., Grimshaw, M. and Myles, S., 2016. Placer-lode gold relationships in the Nansen placer district, Yukon. *In:* Yukon Exploration and Geology, K.E. MacFarlane and M.G. Nordling (eds.), Yukon Geological Survey, p. 63-78.

ABSTRACT

Compositional studies have been undertaken on gold particles recovered from hypogene ore, eluvial material and placer samples in and around the Klaza property. These data have been correlated with previous descriptions of *in situ* mineralization to elucidate placer-lode relationships and systematic change in gold compositions between porphyry and epithermal environments.

Gold alloy from the porphyry environment is Ag-poor with respect to Au formed in later stage veins. Silver, and to a lesser extent Cu, have been the main discriminants for inferring the source of Au within the placers, and in general, vein mineralization is a more important source-type than porphyry mineralization.

The signature of Pb-Bi-Te previously identified in the inclusion suites of Au grains from Nucleus/ Revenue, Casino and Sonora Gulch has also been identified at Klaza, demonstrating that generic compositional signatures can underpin a robust exploration methodology. The relative sizes of porphyry and epithermal footprints of detrital Au together with their respective compositions are important considerations when targeting Cu-Au systems.

[1]R.J.Chapman@leeds.ac.uk

INTRODUCTION

The Dawson Range, south central Yukon is an emerging metallogenic province, and has been the focus of considerable study since 2009 (Allan *et al.* 2013). In part, this proliferation of exploration activity has been underpinned by the importance of widespread placer gold, which continues to support an important industry. The gold in the established placer regions can be broadly categorized into that derived from orogenic mineralization (*e.g.*, the Klondike, Sixtymile R., Tenmile R. and the White Gold District; Wrighton, 2013; Chapman *et al.*, 2014), and that derived from mineralization associated with early Late Cretaceous magmatism (Revenue/Nucleus, Casino, Sonora Gulch; Wrighton, 2013; Chapman *et al.*, 2014).

The Mount Nansen camp is situated at the south end of the Dawson Range (Fig.1); it comprises multiple mineral occurrences of porphyry and epithermal mineralization hosted within the 12 by 3 km 'Nansen Trend' within metasedimentary and meta-igneous rocks of the Yukon-Tanana terrane, (Hart and Langdon 1997; Fig. 1). The spatial relationships between porphyry mineralization and vein arrays, together with a parallel systematic change in mineralogy, are interpreted by Hart and Langdon (1997) as indicative of porphyry-epithermal transitions. Consequently, the mineralization in the Cyprus porphyry and gold-bearing precious metal veins of the Klaza deposit provide an excellent field area for study of mineralogical changes associated with an evolving magmatic hydrothermal system. The present study area comprises the northern part of the Nansen Trend and encompasses the Cyprus porphyry and the epithermal occurrences on the Klaza property, located between East Fork Nansen Creek and the Klaza River. The Klaza property is currently the focus of exploration by Rockhaven Resources.

In the Nansen Creek area, placer deposits are spatially located near the Klaza property, the very low grade

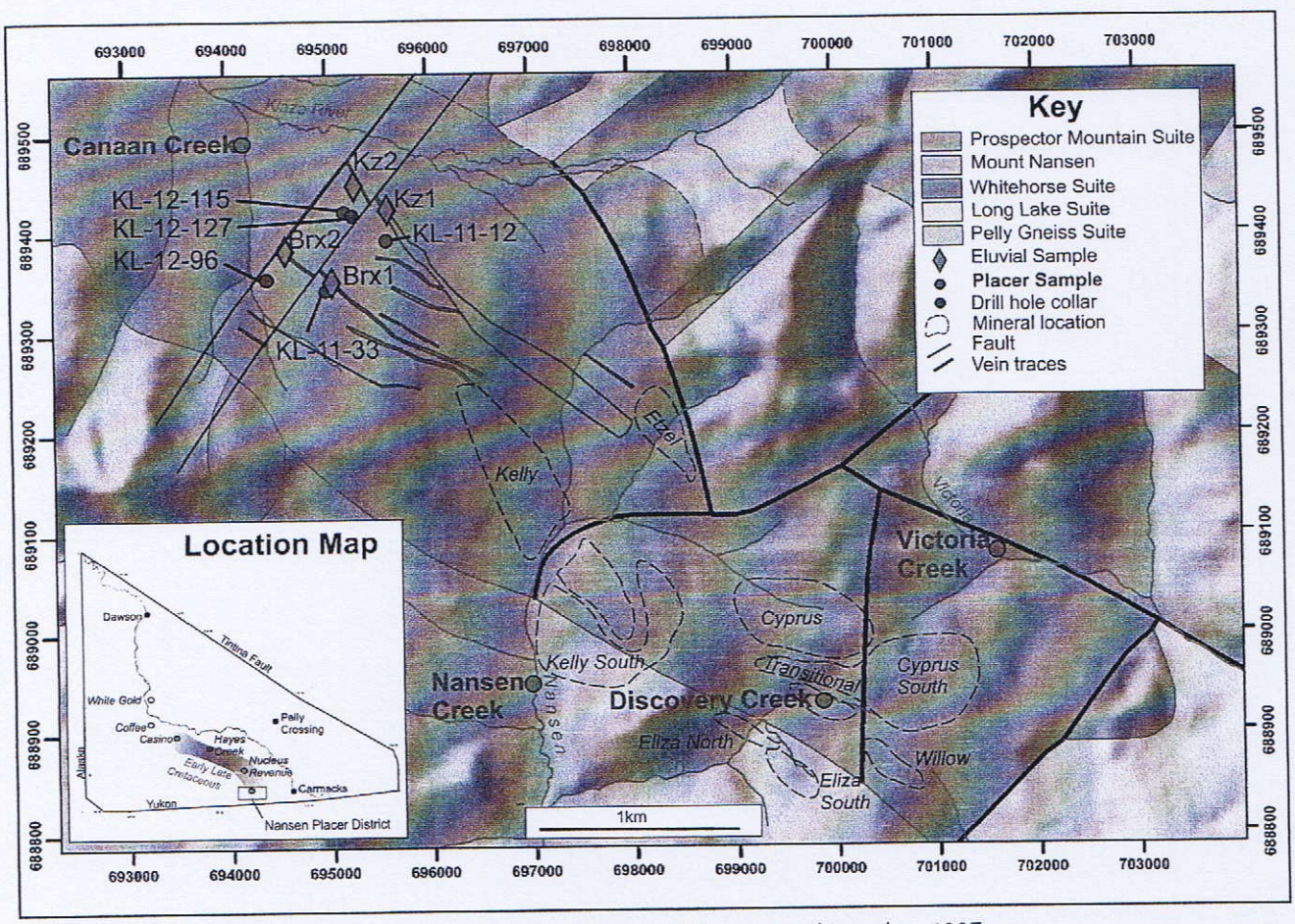


Figure 1. *Regional Geology and mineralization (after Colpron, 2006; Hart and Langdon, 1997.*

Cyprus Cu-porphyry and the Kelly occurrence. The YGS Placer Database (LeBarge, 2007) indicates that different gold fineness has been regularly reported from different creeks. Whilst bulk fineness data are only partially useful as a discriminant (due either to mixing of gold from different sources with different compositions, or derivation from a single source with a variable Au-Ag ratio), broad variation of gold composition with geographical location is suggestive of multiple sources. This study aims to establish clear compositional signatures of gold from both the hypogene and placer environments in the environs of the Klaza deposit to inform two avenues of investigation: i. evaluation of the variation in gold mineralogy within a porphyry-epithermal transition; and ii. evaluation of the relative importance of porphyry and epithermal Au as sources of local placers.

GEOLOGY AND MINERALIZATION

The regional and local geology of the study area is summarized by Hart and Langdon (1997) and depicted in Figure 1. The study area is situated in the north part of the Mount Nansen Trend; the trend is a 12 by 3 km NW-SE corridor which hosts approximately 30 mineral localities.

The locations of mineralization relevant to the present study are illustrated in Figure 1 and described in Table 1 which is organized according to the classification of Hart and Langdon, (1997)

The mineralogical descriptions of the various zones presented in Table 1 indicate a progressive decrease in Cu content away from the Cyprus porphyry both to the NW and SE, into Au-Ag-Pb-Zn dominated vein systems. The Klaza property hosts multiple sub-parallel veins of which the BRX vein and Klaza zone (Fig. 1) have been explored most extensively. The veins exhibit differences in their mineralogy with the Klaza zone containing higher levels of Pb and Ag, (Tarswell and Turner, 2014). The vein outcrops are offset by an up-thrown faulted block (throw probably around 150 m) perpendicular to strike. Tarswell and Turner (2014) propose that the Klaza veins correspond to a class of 'base metal carbonate' epithermal veins described by Corbett (2002), in which metal precipitation is induced by mixing with bicarbonate-rich groundwater. Such deposits are commonly zoned, reflecting marked differences in local temperature change, aH_2S (associated with sulphide precipitation) and degree of dilution. Samples of eluvial and hypogene material from these two zones formed part of the sample suite of the current study.

Table 1. *Descriptions of mineralized localities in the study area, adapted from Hart and Langdon (1997).*

Name	Description
Central Porphyry Zone	
Cyprus1,3	Quartz monzonite porphyry, Cu-Mo zone: py, cpy, mo, Cu 0.1-0.15%. Au anomalous but erratic
Kelly1	0.275 x 2.5km NW trending potassic alteration zone identified by soil geochemistry. Trench sample yielded 0.86 g/T Au and 0.25% Cu. cpy, Cc bn and mo
Peripheral porphyry zone	
Cyprus South1	Quartz sulphide veins and stockworks in phyllic zone. Au grade of 0.31g/T recorded in core.
Kelly South1	Au recorded in pyrite shell associated with phyllic alteration
Transitional zone	
Eliza Creek extension1	Veins and stockworks associated with porphyry stocks breccia and argillic/phyllic alteration. Au grades to 17.5g/T and Ag to 27 g/T in core
Transitional	Four veins very similar to those of the Eliza Creek extension
Epithermal veins	
Klaza Zone2	py, sp, ars, ga, sb, ss. au
BRX zone1	py, sp, ars, ga, sb, ss. au
Eliza Creek South 1	Au-Ag-Zn-Pb veins. Trench samples of Au to 3.9g/T
Eliza Creek North1	Au-Ag-Zn-Pb veins. Cu content > Eliza Creek North. Au to 10.3g/T
Etzel	Au-Ag-Pb-Zn veins
Willow1	3 Au-Ag-Pb-Zn veins containing Au to 3.5g/T

Key: py=pyrite, cpy=chalcopyrite, sp=sphalerite, ars=arsenopyrite, ga=galena, sb=stibnite. 1=(Hart and Langdon, 1997), 2=Tarswell and Turner (2014), 3=YGS Minfile 1151 066.

The surficial geology of the Nansen area is described by LeBarge (1995) and comprises sediments originating in an array of pre-glacial, glacial and post glacial environments. Eight sedimentary facies are identified and each was investigated in terms of the concentration of detrital gold. Provenance of the gold in placers on Nansen and Victoria creeks and Canaan Creek was informed by clast analyses and morphological studies of the gold grains themselves. The highest concentrations of gold are observed in diamictons, interpreted to be the erosional products of pre-existing weathered ore and placers. *In situ* mineralization is observed in weathered bedrock, within the outcrop of the Cyprus porphyry such that direct liberation of gold from host to modern placer is possible at some localities. The presence of paystreaks on a false bedrock of early Pleistocene till in upper Nansen Creek till indicates that rejuvenation of the placer is ongoing (J. Bond pers. Comm.).

The Mount Nansen area has supported placer mining since the early twentieth century (LeBarge, 2007). An overview of the relative importance of various creeks is presented in Table 2, and summarizes production figures to 2005. The data show the placer resource in Nansen Creek is the most economically important. Bulk fineness data (LeBarge, 2007) indicate that most gold in the Nansen Creek system is between 800 and 850 fine, whereas gold from Victoria Creek, Canaan Creek and one of the reported Back Creek populations exhibits lower fineness values. LeBarge (2007) reports that many streams in the area were explored for their placer potential, but only a small number supported sustained activity.

PREVIOUS STUDIES OF GOLD GRAIN COMPOSITION IN THE DAWSON RANGE

Understanding the relationship between economically important placer gold deposits in Yukon and their potential lode sources has developed significantly during the last decade. Various studies have characterized gold particles derived both from lode and placers in terms of their alloy compositions and suite of mineral inclusions revealed in polished section, (e.g. Chapman *et al.*, 2010a,b; Chapman *et al.*, 2011; Wrighton, 2013; Chapman *et al.*, 2014). These combined data sets yield a 'microchemical signature' for a specific population of grains. Comparison of microchemical signatures of hypogene Au grains with detrital Au particles from local placer populations can establish placer-lode relationships. Wider studies are ongoing which seek to establish the characteristics of each signature which are diagnostic for different styles of gold mineralization.

A regional study of placer-lode gold relationships in the Dawson Range was undertaken between 2010 and 2012 under the auspices of the Yukon Gold Project, an academia- industry collaboration based at the Minerals Deposit Research Unit (MDRU) at UBC. Studies of placer and lode gold grains derived from the early Late Cretaceous intrusions of Revenue and Nucleus are distinct from those associated with orogenic mineralization, (Wrighton, 2013). Chapman *et al.* (2014) expanded this study to show that porphyry mineralization at Casino, Revenue/Nucleus and Sonora Gulch yield gold grains with a distinctive Bi-Pb-Te inclusion signature.

Table 2. *placer gold information (data from LeBarge 2007).*

Placer Creek	Fineness	Production (oz) to 2005	Comments
Discovery	820-850	1586	
E. Fork Nansen	No data	448	Some dendritic gold
Nansen	805-820	21,251	
Victoria	720-730	1185	
Back	760-836	3478	'Coarse' pay streak reported
Slate	800	-	Minor trib, no mining
Canaan	750	Unknown	No data in YPDB

SAMPLING

CORE SAMPLES

Core samples were selected based on the proximity of the hole collar to the localities of trench sampling (Table 3a). Selection of the intersections studied in each hole was based on the location of high Au grade. Sample preparation and analysis was undertaken at the University of Leeds.

OXIDIZED VEIN MATERIAL IN TRENCHES

The vein system at Klaza outcrops at surface and has been exposed by trenching. Decomposed vein material was collected from four localities, (see Table 3b and Fig. 1) and was thoroughly wetted before processing using a 'Le Trap' portable sluice. Sluice concentrates were panned to recover a 'super concentrate' containing gold grains.

COLLECTION OF PLACER SAMPLES

Samples of placer gold were collected using a combination of panning and sluicing. The details of the sample sites are provided in Table 3c and Figure 1. Characterization of Au from Nansen Creek was facilitated by study of two sample populations, the first of which is described in Table 3c. The second Nansen Creek sample comprised 56 gold grains collected by the Yukon Geological Survey close to the confluence of Nansen and East Fork Nansen creeks, although the exact locality is unknown. The inclusion assemblage of this second sample was useful to augment that observed in the sample collected slightly downstream during the current study.

Table 3. *Samples collected for this study.*

3a. Core samples used in preparation of polished blocks

Hole _ID	Close to	Sample depth m	From (m)	To (m)	Interval (m)	Collar Easting	Collar Northing	Au ppm	Ag ppm
KL-11-33	BRX 1	121.1	120.3	121.64	1.34	382080	6889865	5.51	180
KL-12-96	BRX 2	342.8	342.46	345.36	2.9	381509	6890034	10.55	92.7
KL-11-12	KZ1	221.7	221	222.6	1.6	382724	6890305	6.81	123
KL-12-115	KZ2	219.7	219.48	221.59	2.11	382340	6890627	13.75	357
KL-12-127	KZ2	169	168.11	169.11	1	382418	6890581	5.73	204

3b. Eluvial samples collected from vein outcrop

label	Trench	E	N	g/T Au	g/T Ag	intercept (m)	Volume of -2.5 cm material sluiced (L)
BRX 1	TR 13-49	382410	6889676	8.4	548	1.31	140
BRX 2	TR 13-47	381715	6890310	87	768	1.15	400
KZ 1	TR13-66	382758	6890614	25.7	449	2.27	200
KZ 2	TR 13-70	382462	6890888	16.76	1052	3.03	200

3c. Placer samples

locality	E	N	Comments	Potential sources
Discovery Ck	386521	6885312	Sample from headwaters of creek	CyS, El.N, El.S, Tr,
Victoria Ck	388391	6886630	Side pay	Unknown
Canaan Ck	381422	6891421	From active cut	BRX, Klaza zone
Nansen Ck	383700	6885781	From active cut	K, KS, Et, Cy

Abbreviations, corresponding to mineralization described in Table 1. Cy=Cyprus porphyry, CyS=Cyprus South, El.N=Eliza North, El.S=Eliza South, Tr=transitional, WC=Willow Creek, K=Kelly, KS=Kelly South.

ANALYTICAL WORK

Polished blocks were prepared from core samples and examined using both reflected light microscopy and the scanning electron microscope (SEM). Analysis of Au grains >5 µm in diameter was undertaken by electron probe microanalysis (EMP). Gold grains from eluvial and placer samples were isolated from the sluice concentrates by picking under a binocular microscope. These gold grains were mounted according to size as described by Chapman *et al.* (2000). The extreme small size of some of the gold particles necessitated the design of a new polishing technique specifically for extremely tiny (30-50 µm) particles. This involved introducing the grains into small pools of resin placed on a glass slide. The gold grains were revealed during controlled polishing of the slides in a manner similar to that employed when preparing rock thin sections to the required thickness.

Analysis of the Au grains was carried out in two stages. Firstly, qualitative analyses were undertaken using a FEI Quanta 650 FEG-ESEM. This involved inspection of each grain section and recording alloy heterogeneity and the presence of inclusions, either of minerals or intermetallic compounds. Secondly, quantitative alloy compositions were determined by EMP using a Jeol 8230 Superprobe. The minor element suite analyzed was Ag, Cu and Hg and the detection limits for each element were 0.03%, 0.02% and 0.1% respectively. All values are expressed in wt%. Polished blocks of core samples were prepared for inspection by reflected light microscopy and SEM/EMP analysis.

RESULTS

HYPOGENE ORE

The aim of this element of the project is to identify minerals coeval with the gold and that could be subsequently correlated to the suite of inclusions recorded in placer gold samples. Native gold is identified in samples from both veins, (in cores Kl-12-96 and Kl-12-115) although many of these gold grains are less than 2 µm in diameter and consequently too small to analyze by EMP. Mostly, gold is observed as small blebs in early stage pyrite, as is Bi telluride (Fig. 2a,b). Both galena and arsenopyrite post-date the pyrite, but Au is only observed in galena (Fig. 2c). Only gold in core from hole KL-12-96 (adjacent to BRX-2) is sufficiently coarse to analyse by EMP. The Ag contents of these grains are illustrated in Figure 3a, and the co- variance of Ag with Cu is illustrated in Figure 4.

SAMPLES COLLECTED FROM VEIN OUTCROPS

The alloy compositions of Au grains from BRX 1 and BRX 2 are shown in Figure 3a. Both populations are dominated by grains in the 18-25% Ag range; however there are other small contributions from other sub-populations which exhibit lower Ag contents, one of which appears similar to the Ag range of gold grains observed in the core samples. Table 4 shows that around 90% of grains from the BRX zone contain Hg to above LOD of 0.06%, although the maximum value recorded is only 1.5%. The percentage of grains containing measurable Cu is much lower at 35% and 36% in BRX 1 and BRX 2 respectively.

The low incidence of inclusions in the samples from the BRX zone grains is probably related to the tiny size of most of these gold grains. Table 4, shows the number of gold grains that contained specific minerals. Overall the inclusion assemblage reflects the mineralogy of the hypogene ore, with minerals coeval with Au observed as inclusions (e.g., galena and Bi telluride; Fig. 2d,e). Arsenopyrite is not observed as an inclusion, (neither are Au grains observed within arsenopyrite in hypogene ore) but secondary As minerals are observed coating Au grains.

Covariance of minor alloying metals is investigated using the bivariate plots shown in Figure 4. Figure 4a shows the compositional fields of grains from Discovery Creek and Figure 4b superimposes these data onto that describing gold from the BRX Zone. In the Discovery Creek sample, the relationship of Ag to Cu is generally inverse, although most grains cluster in the mid-range of Ag and Cu. The distribution of alloy compositions of gold from the BRX zone shown in Figure 4b differs because the majority of points cluster in two Ag ranges, and within these Cu varies independently. A small number of grains contain relatively high Cu values but their compositional field does not correspond to that observed for grains from Discovery Creek (Fig 4a). These two differing compositional fields have been used as a template for comparison with sample populations of placer gold from the Canaan Creek (Fig. 4d), Nansen Creek (Fig. 4c) and Victoria Creek (Fig. 4e).

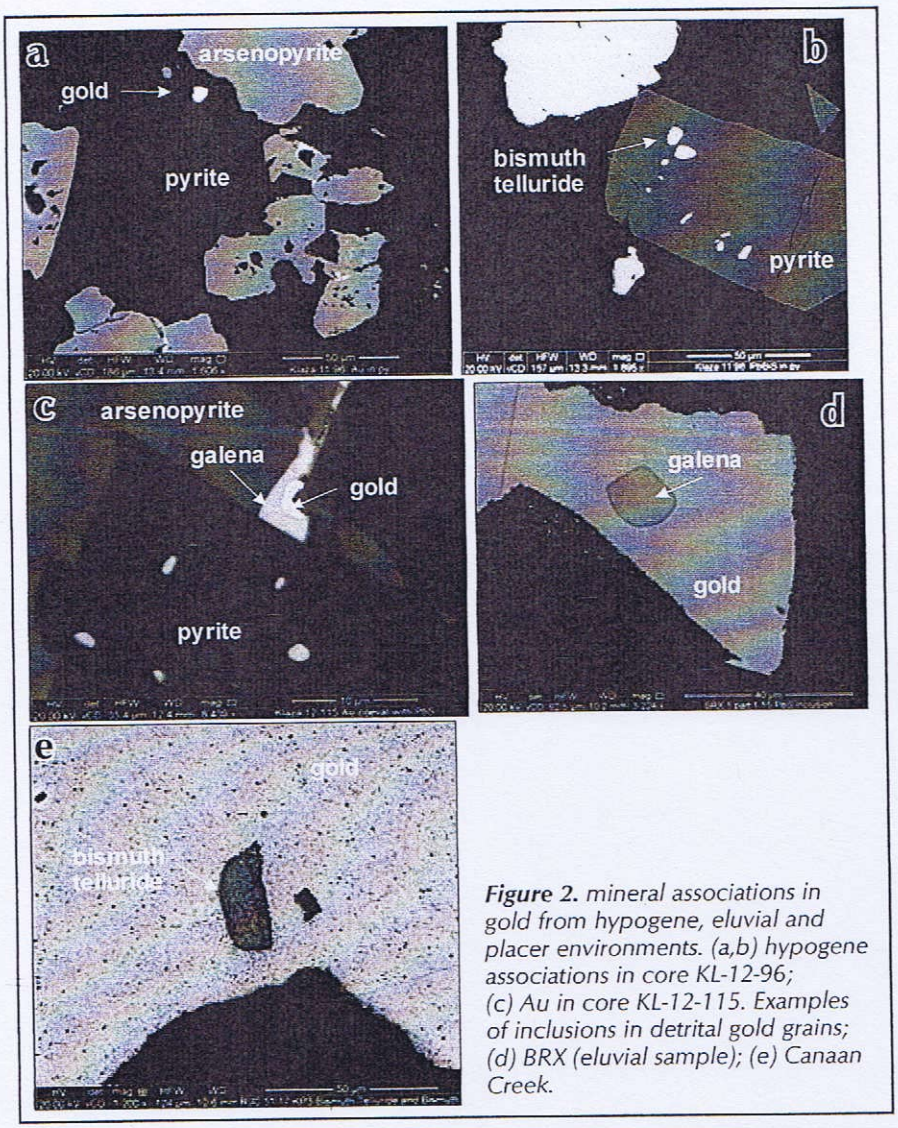


Figure 2. *mineral associations in gold from hypogene, eluvial and placer environments. (a,b) hypogene associations in core KL-12-96; (c) Au in core KL-12-115. Examples of inclusions in detrital gold grains; (d) BRX (eluvial sample); (e) Canaan Creek.*

PLACER SAMPLES

The morphology of the placer gold grains within the different sample populations are illustrated in Figure 5. Gold grains from Discovery Creek and Canaan Creek are rough, whilst the other placer samples include grains which exhibit a range of morphologies. The Ag content of the placer populations are depicted on the plots in Figure 3b. The sample from Canaan creek shows the highest overall Ag values, whilst the sample from the Discovery Creek exhibits the lowest values. These two samples have been used as 'end members' to evaluate other placer samples which exhibit features of both, but in different proportions. The placer sample from Victoria Creek resembles most closely that from the Canaan Creek, whereas that from Nansen Creek appears to conform to the Discovery Creek signature at low Ag values, but deviates thereafter.

The Ag curve describing Au from Discovery Creek also exhibits a shallow gradient for lower Ag values (Fig 3b). It also contains a substantial number of grains which contain higher levels of Ag, which could represent either an evolving system within the porphyry environment or additions from later vein mineralization as discussed above.

The covariance of Ag and Cu within the sample populations from Canaan Creek, Nansen Creek and Victoria Creek are shown in Figure 4c-e, where they are compared with the signatures of gold from both the BRX zone and Discovery Creek. The compositional field of gold from Canaan Creek overlaps with that of the gold from the BRX zones and shows the same general form, but it extends to a more Ag-rich area. Gold from Nansen Creek generally conforms to the compositional field of gold from Discovery Creek but there is also a clustering of more Ag-rich points similar to that observed in the sample from the Klaza River. Finally the small gold sample from Victoria Creek most closely resembles gold from the Canaan Creek, but a few grains show a high-Ag and high-Cu signature similar to the Discovery Creek sample.

The inclusion suites of the placer samples are shown in Table 4. Galena and Bi telluride are observed in every sample.

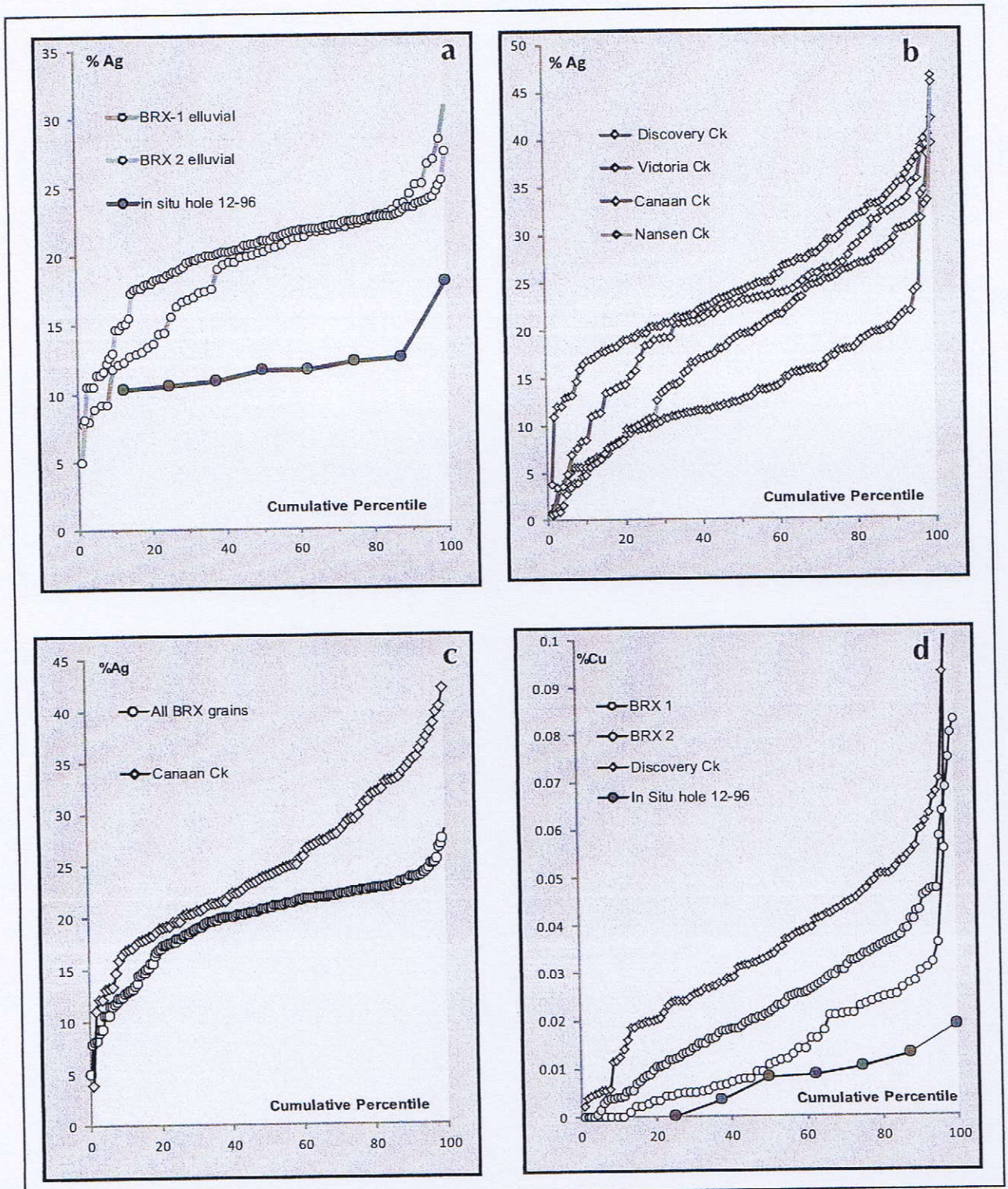


Figure 3. *Alloy compositions of gold grains from in situ eluvial and placer environments (a-c) Ag contents of alloys; (d) Cu content.*

Table 4. *Inclusion assemblages in placer and eluvial gold.*

Locality	Grains	Hg	Cu	Inclusion species											
				py	po	cpy	ga	sp	ars	Bi	ss	cv	hs	l	Sec
Discovery Ck	102	100	80				4		1	2					
Victoria Ck	78	95	54	1		1	1	1		3					
Canaan Ck	104	91	32	6		2	2			2		4			
Nansen Ck	157	100	40	12			5	2	3	3	1		1		
BRX-1	63	86	35	2		1	1				1				
BRX-2	114	90	56	1	1		1	1		2	1			1	2
Hayes Ck	122	12	32	6	2	3	8		2	3		1			

Mineral key as for Table 1, plus po=pyrrhotite, cv=cervelleite, (Ag_4TeS), hs=hessite, l=loelingite (FeAs), Sec=undetermined secondary (PbAs) bearing mineral on grain surface. 'Hg' and 'Cu'=% grains containing that metal to> LOD.

PLACER-LODE GOLD RELATIONSHIPS

RELATIONSHIP BETWEEN HYPOGENE ORE AND GOLD IN THE ELUVIAL ENVIRONMENT

The gold identified in polished blocks is much smaller in size than the eluvial grains recovered by sluicing. Consequently it is possible that there is a bias in the relationship between grain size and composition, although no such bias is observed in the data obtained from each block (where the samples are mounted according to size). Figures 3 and 4 show the relationships between the alloy compositions of hypogene and eluvial gold grains. The majority of the *in situ* grains (in core from around 340 m depth) show lower Ag content in comparison to most grains collected at surface. However, the lower Ag range exhibited by the gold in core is evident as a sub-population in the eluvial sample.

There is an overall similarity between the mineralogy of the hypogene ore and the inclusion suite observed within gold grains from the eluvial environment. Inspection of polished sections suggests that Au, Bi minerals and pyrite form the first phase of mineralization followed by arsenopyrite, galena and sphalerite. Table 4 and Figure 2 show that pyrite and Bi minerals form inclusions within the eluvial gold particles, whereas As is observed only as coatings of a Pb-As secondary mineral. Figure 2c shows that Au may also be coeval with galena, and galena inclusions in placer gold are also observed (Fig. 2d).

RELATIONSHIP BETWEEN ELUVIAL GOLD GRAINS AND PLACER GOLD GRAINS

The signatures of the BRX vein eluvial samples are used as a template to aid characterization of other placer samples in the study area. Figure 3c compares the Ag content of all grains collected from the BRX zone to the placer sample from the Canaan Creek. Gold grains containing >25% Ag form 97% of the population of grains from the Canaan Creek, but only 40% of the eluvial population of BRX vein Au. Figure 1 shows that the placer locality could also contain Au grains derived from veins situated between the BRX vein and the Klaza zone, although no information is available regarding their mineralogy. The Western Klaza zone is known to be relatively Ag-rich (Tarswell and Turner, 2014; Table 3) and Au grains from here could have travelled downslope to the placer sampling locality.

The suites of inclusion species observed within gold grains from the BRX zone and placer gold grains from Canaan Creek are largely compatible (Table 4), with the exception of cervelleite (Ag_4TeS). Four inclusions of cervelleite are observed the placer sample, but this mineral is not observed in either the BRX hypogene or the eluvial samples. All cervelleite inclusions are hosted by relatively Ag-rich Au alloy, and two of these exhibited Ag contents higher than any of the grains from the BRX vein. It is possible that the cervelleite-bearing grains are derived from the relatively Ag-rich Western Klaza zone or veins situated between the BRX and Klaza zones (Fig. 1).

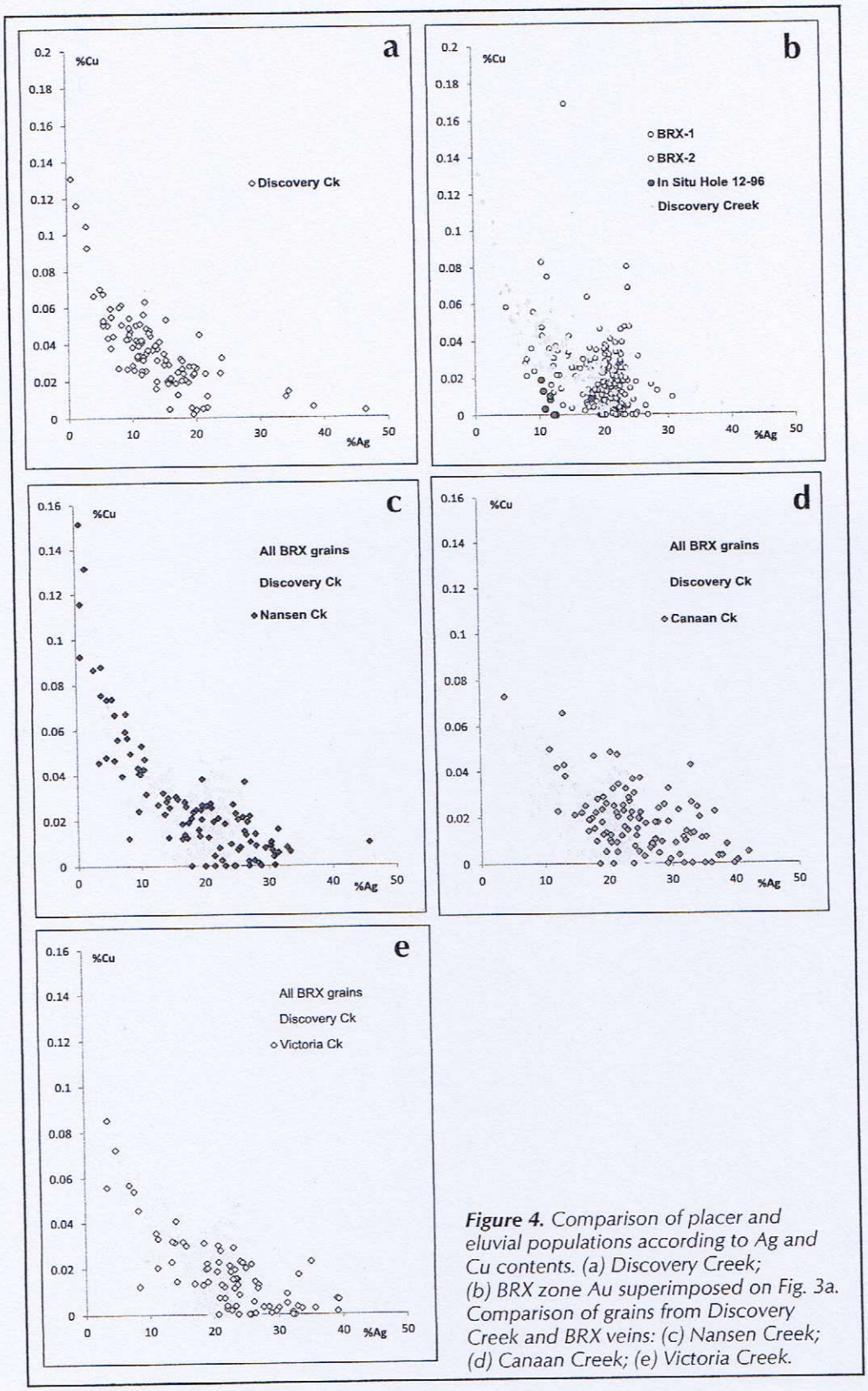
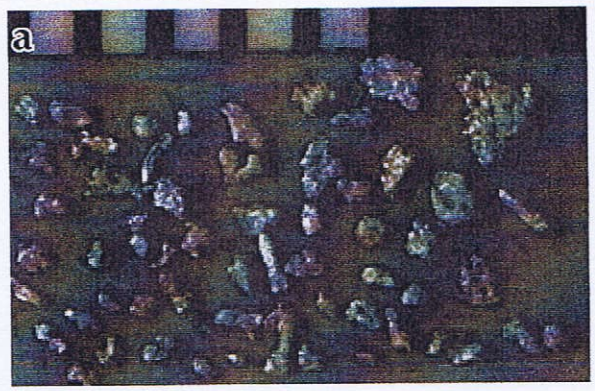
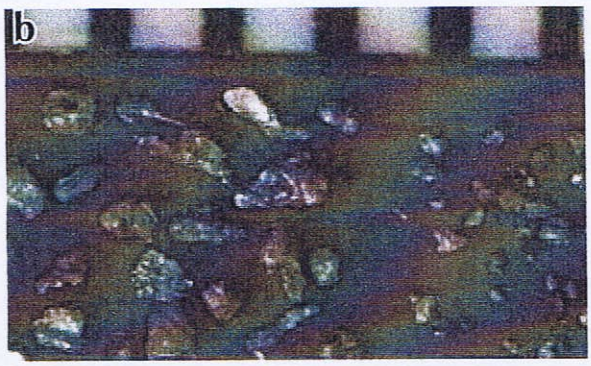


Figure 4. *Comparison of placer and eluvial populations according to Ag and Cu contents. (a) Discovery Creek; (b) BRX zone Au superimposed on Fig. 3a. Comparison of grains from Discovery Creek and BRX veins: (c) Nansen Creek; (d) Canaan Creek; (e) Victoria Creek.*







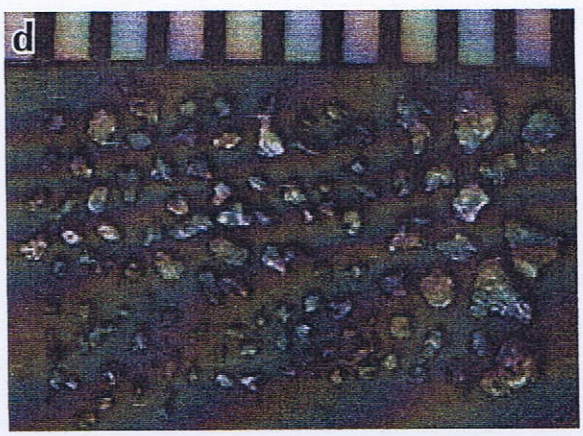


Figure 5. *Morphological characteristics of gold grains from various placer localities. (a) Canaan Creek; (b) Discovery Creek; (c) Victoria Creek; (d) Nansen Creek. Scale intervals are 1 mm.*

POTENTIAL SOURCES OF PLACERS

Consideration of the new data presented in this study has been undertaken in conjunction with bulk assay data from mining records, consideration of surficial geology (LeBarge, 1995) and the overview of regional mineralization presented in Hart and Langdon (1997) to clarify the most likely sources/source styles of mineralization for the various placers.

The Discovery Creek sample was collected from within the outcrop of the Cyprus South porphyry in the peripheral porphyry zone as defined by Hart and Langdon (1997). LeBarge (1995) reports that over 99% of the clasts in the drainage are proximal and consequently it is almost certain that all the placer Au grains were collected close to their source. Figure 5 shows that the Au grains have a rough surface texture and show little signs of fluvial transport. There are three possibilities for the source of these grains. Firstly, Au has been recorded in core samples from the phyllic alteration of the Cyprus south zone. Gold grains from this environment are probably formed from Au-bearing fluids which have stripped Au from pre-existing Cu-Au mineralization formed in the potassic zone, (Gammons and Williams-Jones, 1997). Secondly the 'Transitional' zone, in the headwaters of the Creek comprises veins and stockworks in a phyllic/argillic alteration zone (Table 1). An argillic overprint would probably not remobilize Au so the Au grains in this zone would likely resemble those in the Cyprus south mineralization. Finally there is a possibility of contribution of grains from the Eliza Creek localities although these occurrences outcrop slightly downstream of the sampling locality. From consideration of known *in situ* mineralization it could be expected that the Discovery Creek Au would consist predominantly of Au formed in an evolving porphyry environment, and indeed this sample is distinguished both by a lower Ag content (Fig. 3b) and higher Cu content (Fig. 3d).

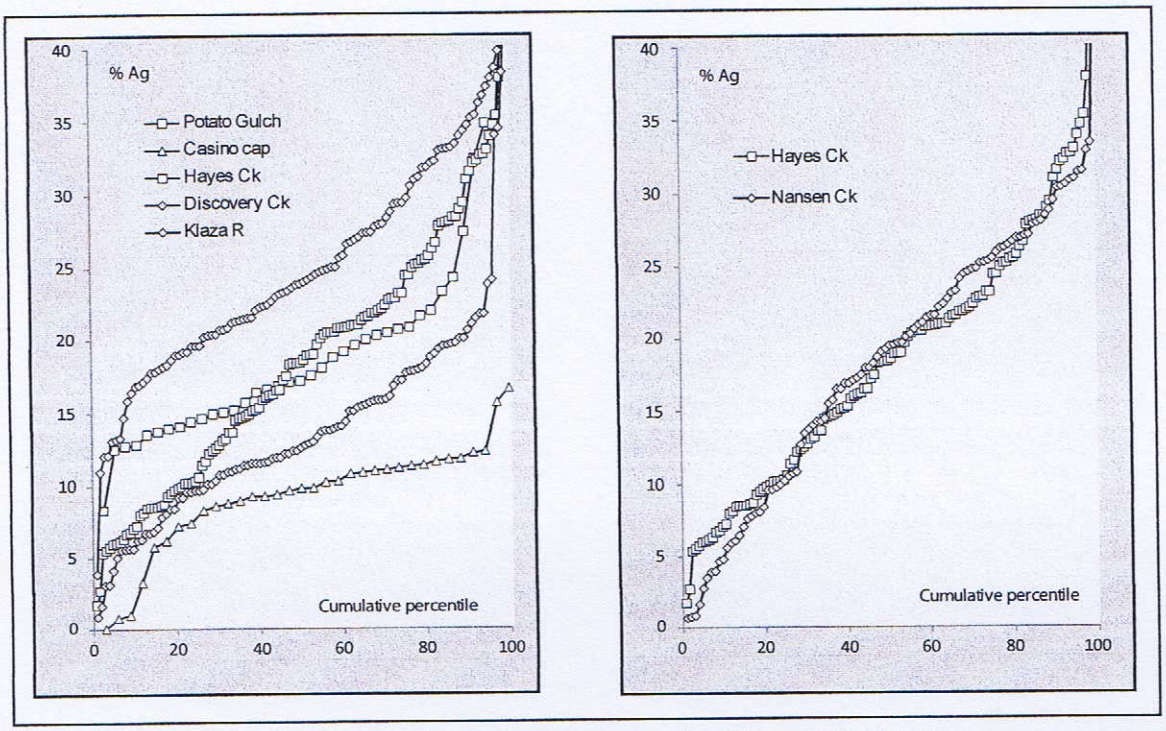


Figure 6. *Comparison of Ag contents of gold from porphyry and epithermal environments.*

Figure 3b shows that the Ag cumulative curve for Nansen Creek follows that of the gold from the Cyprus porphyry for the low-Ag component, but deviates to resemble that of the Canaan Creek sample at higher Ag values. Consideration of the Cu and Ag contents of the alloy also suggests multiple sources (Fig. 4d) as the cluster of compositions of around 30% Ag with variable Cu content is more similar to the signature of the BRX vein than the Discovery Creek gold. Figure 1 shows that Nansen Creek drains a number of potential *in situ* occurrences, principally Cyprus, Kelly and Kelly South. The Kelly and Kelly South occurrences also represent a potassic-phyllic transition, and it is entirely possible that Au from the Kelly South locality is of similar composition to that from the Cyprus south locality. There is no information available to establish whether the Au grades reported from either the Cyprus or Kelly porphyries (Table 1) relates to free Au, *i.e.*, tiny Au grains exsolved from Cu-bearing sulphides which are mostly too small to collect in placers (*e.g.*, Arif and Baker, 2004) or Au distributed within sulphide lattices.

The evidence presented in this section and the previous one, indicates that the Ag content of vein-derived Au is in general higher than that associated with porphyry mineralization. Consideration of Nansen Creek placer gold in the context of Ag content from contributing sources strongly suggests that a large proportion of the placer Au is derived from veins rather than the Kelly porphyry. Table 2 shows the large difference between the mass of placer Au recovered from Nansen and East Fork Nansen creeks. This spatial variation of Au appears incompatible with the model of the Cyprus porphyry being the major local source. It seems more probable that the bulk of Au in Nansen Creek is derived from either undiscovered or eroded veins associated with the Kelly porphyry system.

Data derived from the present study and gold fineness data (Table 2) show the Au from Victoria Creek to be relatively Ag-rich. Figure 5 shows that the grains exhibit varied morphologies, and there is a distinct population of relatively coarse, rough grains. Figure 4e shows a Ag-Cu signature very similar to that of the BRX vein sample, and it is proposed that similar, as yet undiscovered veins form the source of the Victoria Creek placer.

Although no samples of placer Au from Back Creek were available for this study, the range of fineness values reported (Table 2) suggests a contribution from both

porphyry and vein Au. van Loon and Bond (2014) report that nuggets up to 2 oz have been recovered recently, and these are most likely associated with a local vein source, rather than a porphyry environment. Figure 1 shows that the Willow Creek vein and the Cyprus South occurrences could constitute distinct sources consistent with this model.

The geomorphological development of the Nansen area described by LeBarge (1995) involves glacial erosion and transport of Au from pre-existing deep weathered material and associated fluvial sediments. LeBarge (1995) reports that Au grains are present within till, particularly at the bedrock-till contact. Consequently, it could be expected that some placer samples show an influence of relatively distal Au grains, although it is clear that that individual samples retain a strong signature of the most local source. The size of Au reservoir within present glacial sediments is unknown, consequently the placer mining records represent an unknown fraction of the total regional Au inventory. In addition, the most important placer creek (Nansen Creek) has not been mined to bedrock, but to a clay layer which is approximately 24 m thick (van Loon and Bond, 2014).

VARIATION IN GOLD SIGNATURE ASSOCIATED WITH THE PORPHYRY-EPITHERMAL TRANSITION

Whilst porphyry mineralization has a localized focus, the associated epithermal expression may be considerably more widespread, and consequently the peripheral geochemical footprint of the mineralization in the surficial environment may be influenced mostly by distal epithermal veins. From an exploration perspective, establishing the link between gold signatures in porphyries and related epithermal systems provides a mechanism to establish a vector to the most economically attractive mineralization. This study has provided the opportunity to examine the relationship between the composition of native gold formed in the porphyry environment and that of gold found in the associated epithermal expression.

EMPIRICAL CONSIDERATIONS

Hart and Langdon (1997) report four zones in the porphyry epithermal transition in the Nansen area, although this sequence is best developed to the southwest of the Nansen porphyry complex, outside the current study area. Sample suites available to the current study correspond to the peripheral porphyry zone and the epithermal zone. The most striking compositional difference is the variation in Ag content between gold derived from the placer sample from Discovery Creek (low Ag-peripheral porphyry) and the vein systems on the Klaza property (high Ag; Fig. 3b), and their placer expression at the Canaan Creek. It seems probable that the higher Cu signature of the Discovery Creek placer Au is also related to a systematic compositional trend, whereas the distribution of Hg within Au alloy appears variable.

Chapman *et al.* (2014) propose a generic relationship between porphyries and associated epithermal mineralization in which some key geochemical signatures of the porphyry system are retained (*e.g.*, a Bi and Te signature in the inclusion suite) whereas the Ag content of the Au grains increases. Studies of the Casino Creek-Canadian Creek drainage and Sonora Gulch-Hayes Creek systems provided the basis for this assertion (Fig. 6a). The similarity of the Ag content of Au grains from Hayes and Nansen creeks is striking, (Fig. 6b) and indicates that the same range of alloy compositions is evident in Au grains formed in these two different mineralizing systems. This similarity is also reflected in the inclusion assemblages (Table 4) by which Hayes Creek placer may be interpreted as derived from several sources, most of which are veins.

CONSIDERATIONS OF FLUID CHEMISTRY

Correlations between the fluid chemistry of a hydrothermal system and the resulting Au alloy compositions has been discussed in general by Morrison et al. (1991), and Gammons and Williams-Jones (1995). The alloy compositions reported above may be considered in terms of the nature of the prevailing and evolving hydrothermal systems. Gold and Ag are transported as their chloride complexes ($AuCl_2^-$, $AgCl_2^-$), in the environment of potassic alteration (Gammons and Williams-Jones, 1997; Williams-Jones and Heinrich, 2005). The most common manifestation of Au in this zone is as tiny exsolved blebs on grain boundaries of bornite and chalcopyrite (Kesler *et al.*, 2002), which are too small to report to the placer inventory. Subsequent remobilization of Cu and Au in propylitic and phyllic environments occurs under a different hydrothermal regime following the collapse of the original hydrothermal system (Gammons and Williams-Jones, 1997) in which Au is transported as the hydrosulphide complex. Depending on specific conditions, Au may be re-precipitated within the porphyry (together with chalcopyrite) or removed into the epithermal environment. In both cases the controls on alloy

composition are the same, *i.e.* $([Au]/[Ag])_{aq}$, temperature, pH, $aHS^-_{(aq)}$ and $aCl^-_{(aq)}$ (Gammons and Williams-Jones, 1995). Decreasing temperature results in a decrease in the Ag content of the alloy, as does decreasing $(Au/Ag)_{aq}$ resulting from the preferential precipitation of Au over Ag. It follows that small temperature variation in the porphyry setting could be expected to generate a relatively small range in Au alloy compositions, and this is observed in the grains from the hypogene environments at Casino, reported by Chapman *et al.* (2014), and in the sample from Discovery Creek reported here. Transition to the epithermal environment would be associated with more variable and generally lower temperature, and rapidly evolving $(Au/Ag)_{aq}$ following precipitation. In addition, there may be influences on fluid composition associated with fluid mixing. The net effect is to generate more Ag-rich Au alloy, and whilst locally the Au alloy signature may be constrained, it could be expected that there would be larger variation over the whole mineralizing system. This hypothesis is consistent with the observed compositional variation in the BRX and western Klaza zones as inferred by the eluvial samples and consideration of Canaan Creek placer sample. In general these observations are compatible with the 'Base-Metal-carbonate' model of Corbett (2002) but equally do not provide diagnostic evidence for that model.

Figure 4 shows two different types of relationship between the Ag and Cu contents of Au alloys. The porphyry mineralization (Discovery Creek) shows a predominant inverse relationship between Ag and Cu. The vein samples and their placer expressions yield Au in which Ag and Cu vary independently. At present, the underlying reasons for this difference in behaviour is not understood, but it has proved a useful discriminant in interpreting the origins of detrital gold in different placer populations. Similarly, the underlying reasons for the sporadic presence of Hg in some grains remain unclear.

The data presented in Table 4 show that the Bi-Pb signature is strong and pervasive. Interpretation of the significance of the abundance of other mineral inclusions is to some extent constrained by the relatively small sample sizes.

IMPLICATIONS FOR EXPLORATION

A study of the microchemical signatures of gold grains derived from the porphyry mineralization at Revenue/Nucleus, Casino and Sonora Gulch reported by Chapman *et al.* (2014) identified a common Pb-Bi-Te signature in the inclusion assemblage. This association is also observed in the present study which has further enhanced the potential for applying microchemical characterization of detrital gold grains in an exploration context. In addition, gold grains from these porphyry environments exhibit concentrations of Cu in the Au alloy consistently higher than gold grains derived from orogenic mineralization. Populations of placer grains from associated epithermal mineralization show wider variations in the concentration of Ag and perhaps substantial variation between the signatures of placer samples collected within a small area if there are multiple vein sources.

The Nansen trend is regionally atypical in the abundance of Au-bearing veins associated with the porphyry systems. Furthermore, the Cu-Au porphyry mineralization is weaker than that observed in broadly equivalent mineralized environments elsewhere. Gammons and Williams-Jones (1995) suggest that collapse of a magmatic hydrothermal system may result in overprinting of the potassic alteration zone by retrograde pyrite-rich phyllic alteration with the associated remobilization of gold in a hydrosulphide-rich fluid. Hart and Langdon (1997) report pervasive strong phyllic alteration and pyrite in a halo surrounding the potassic core of the Cyprus porphyry, and a similar feature is reported in Kelley South. Remobilization of Au provides a source for strongly developed epithermal mineralization which would inherit some of the geochemical signatures of the source mineralization, (e.g., Bi, Pb and Te). It is also highly probable that the particle size of Au within late stage and epithermal veins is larger than that found in the earliest porphyry mineralization. Consequently the size and mineralogy of Au grains within placers may not correspond to the Au particles within the primary ore that are ultimately one of the targets of exploration. Understanding the genetic relationships between evolving porphyry systems and their epithermal expressions in terms of Au mineralogy is therefore key to interpretation of the characteristics of placer grains collected during reconnaissance.

CONCLUSIONS

The mineralogy of the inclusion suite revealed within polished sections of detrital gold grains from weathered outcrop in the BRX zone and the Canaan Creek placer are comparable with that of the Au-bearing stages of the hypogene ore observed in core samples, indicating that gold grains pass from the hypogene to the surface environments unmodified.

In this study, Ag content has proved a useful discriminant between porphyry and vein-derived Au. In general it has been possible to map Ag content onto end members of the porphyry-epithermal transition, and this has facilitated interpretation of the origins of placer Au in the Nansen district. The signature of gold grains collected from the BRX vein outcrop is replicated in the Canaan Creek placer, but a (very) high Ag component of the Canaan Creek placer is probably derived from other vein systems such as Western Klaza Zone. The placer Au in Nansen Creek is primarily of vein origin, although there is likely a strong contribution of Au from the Kelly rather than Cyprus porphyry. The wide range of Ag content observed in the Nansen Creek placer Au corresponds to fluctuations in fineness reported in production records and is interpreted as indicative of influx from several sources. The placer Au in Victoria Creek is predominantly vein derived although the sources remain undiscovered. Overall the study has shown that Au derived from veins is the most important contributor to placer development in the Nansen Creek area. In general the composition of Au in the various placers is consistent with the nature of the potential sources and generic relationships between porphyry and surrounding epithermal mineralization.

The values and variability of Ag and Cu contents of Au derived from porphyry and vein mineralization observed during this study may be correlated with the environment of Au precipitation. Gold veins formed during phyllic alteration from fluids which stripped Au from pre-existing mineralization in the potassic zone yielded Au of high Cu content and low Ag content and range, reflecting the relatively stable environment of mineralization. In contrast the precipitation of Au in the epithermal environment may be in response to abrupt changes in a variety of parameters and this is mirrored in the alloy signature, although the grains exhibit a similar inclusion suite as their porphyry derived counterparts.

This study augments previous work which described a generic Bi-Pb-Te signature of gold from calc-alkaline Cu-Au porphyries in Yukon, and that signature has also been identified in both porphyry and epithermal Au from the Nansen area. The importance of understanding the relationship between a porphyry system and its epithermal expression has been highlighted. The compositional ranges of populations of detrital Au particles collected during reconnaissance stream sediment sampling are more likely to be derived from relatively widespread epithermal mineralization than the relatively geographically constrained porphyry. The epithermal Au may be Cu-poor even though the primary mineralization is a Cu-Au porphyry.

The study has highlighted the need to consider stream order when interpreting Au-grain signatures. Both the Canaan Creek and the Discovery Creek placer samples were collected from first order streams, with geographically well constrained sources. The delicate nature of many Au particles reflects this proximity to source, and these samples were the most useful in developing a placer-lode model for the study area. The morphology of Au grains from Nansen Creek indicate fluvial transport, which raises the potential for multiple sources cited in various tributaries. In cases such as this it is more difficult to develop robust placer-source relationships, unless a large (typically >200) number of Au grains are available which may be considered in terms of both morphology and composition.

ACKNOWLEDGMENTS

This study was made possible by the provision of SINED funding through the Yukon Geological Survey. We are extremely grateful to Rockhaven Resources for providing us with access to the site and to excellent on-site accommodation. Finally we would like to thank Jared Tarswell and Heather Burrell of Archer Cathro; they were enthusiastically engaged with our work and went out of their way to provide maps, background information and samples of hypogene ore.

REFERENCES

Allan M.M., Mortensen J.K., Hart C.J.R., Bailey L.A., Sánchez M.G., Ciolkiewicz W.,McKenzie G.G. and Creaser R.A., 2013. Magmatic and metallogenic framework of west-central Yukon and eastern Alaska. *In:* Tectonics, Terranes, Metallogeny and Discovery in the northern circum-Pacific region, M. Colpron, T. Bissig, B. Rusk and J. Thompson (eds.), Society of Economic Geologists, Special Publication vol. 17. p. 111-168.

Arif, J. and Baker, T., 2004. Gold paragenesis and chemistry at Batu Hijau, Indoneisa: implications for gold-rich porphyry copper deposits. Mineralium Deposita vol. 39, p. 523–535.

Chapman, R.J., Leake, R.C., Moles, N.R., Earls, G., Cooper, C., Harrington, K. and Berzins, R., 2000. The application of microchemical analysis of gold grains to the understanding of complex local and regional gold mineralization: a case study in Ireland and Scotland. Economic Geology, vol. 95, p. 1753-1773.

Chapman, R.J., Mortensen, J.K., Crawford, E.C. and Lebarge, W., 2010a. Microchemical studies of placer and lode gold in the Klondike district, Yukon, Canada: 1. evidence for a small, gold-rich, orogenic hydrothermal system in the Bonanza and Eldorado Creek area. Economic Geology, vol. 105, p.1369-1392.

Chapman, R.J., Mortensen, J.K., Crawford, E.C. and LeBarge, W.P., 2010b. Microchemical studies of placer and lode gold in the Klondike District, Yukon, Canada: 2. Constraints on the nature and location of regional lode sources. Economic Geology, vol. 105, p. 1393-1410.

Chapman, R.J., Mortensen, J.K. and LeBarge, W.P., 2011. Styles of lode gold mineralization contributing to the placers of the Indian River and Black Hills Creek, Yukon Territory, Canada as deduced from microchemical characterization of placer gold grains. Mineralium Deposita, vol. 46, p. 881-903.

Chapman, R.J., Allan, M.M., Grimshaw, M.K., Mortensen, J.K., Wrighton, T.M. and Casselman, S., 2014. Pathfinder signatures in placer gold derived from Au-bearing porphyries. *In*: Yukon Exploration and Geology 2014, K.E. MacFarlane, M.G. Nordling, and P.J. Sack (eds.), Yukon Geological Survey, p. 21-31.

Colpron, M. (compiler), 2006. Tectonic assemblage map of Yukon-Tanana and related terranes in Yukon and northern British Columbia (1:1 000 000 scale). Yukon Geological Survey, Open File 2006-1.

Corbett, G., 2002. Epithermal Gold For Explorationists. Australian Institute of Geoscientists Journal - Applied geoscientific practice and research in Australia, Paper 2002-1.

Gammons, C.H. and Williams-Jones, A.E., 1995. Hydrothermal geochemistry of electrum: Thermodynamic constraints. Economic Geology, vol. 90, p. 420-432.

Gammons, C.H. and Williams-Jones, A.E., 1997. Chemical mobility of gold in the porphyry epithermal environment. Economic Geology, vol. 92, p. 45-49.

Hart, C.J.R. and Langdon, M., 1997. Geology and mineral deposits of the Mount Nansen camp, Yukon. In: Yukon Exploration and Geology 1997, Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p.129-138.

Heinrich, C.A., 2005. The physical and chemical evolution of low-salinity magmatic fluids at the porphyry to epithermal transition: a thermodynamic study. Mineralium Deposita vol. 39, p. 864–889.

Kesler, S.E., Chryssoulis, S. L. and Simon, G., 2002. Gold in porphyry copper deposits: its abundance and fate. Ore Geology Reviews vol. 21, p. 103–124.

LeBarge, W.P., 1995. Sedimentology of Placer Gravels near Mt. Nansen Central Yukon territory. Exploration and Geological services Division, Indian and Northern Affairs Canada, Yukon Region, Bulletin 4, 155 p.

LeBarge, W.P. (compiler), 2007. Yukon Placer Database 2007 - geology and mining activity of placer occurrences. Yukon Geological Survey, CD-ROM.

Morrison, G.W., Rose, W.J. and Jaireth, S., 1991. Geological and geochemical controls on the silver content (fineness) of gold in gold–silver deposits. Ore Geology Reviews, vol. 6, p. 333-364.

Tarswell, J. and Turner, M., 2014. Assessment report describing excavator trenches, geophysical surveys and metallurgical tests at the Klaza property. Prepared by Archer, Cathro & Associates (1981) limited for Rockhaven Resources Ltd., Assessment Report #096667.

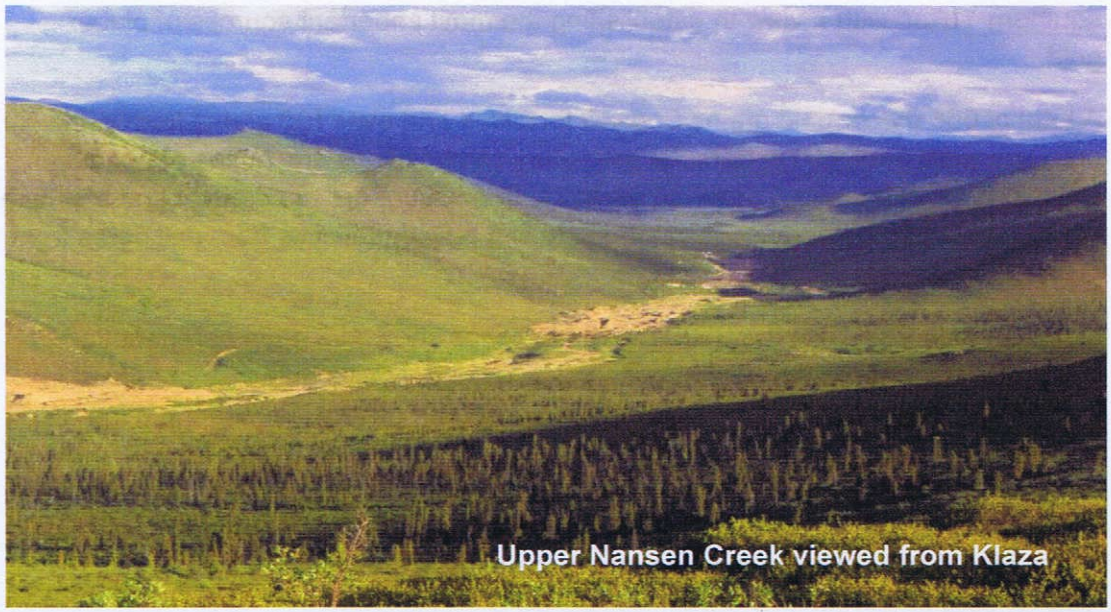
van Loon, S. and Bond, J.D. (compilers), 2014. Yukon Placer Mining Industry 2010-2014. Yukon Geological Survey, 230 p.

Williams-Jones, and A.E., Heinrich, C.A., 2005. Vapor Transport of Metals and the Formation of Magmatic-Hydrothermal Ore Deposits. Economic Geology, vol. 100, no. 7, p. 1287-1312.

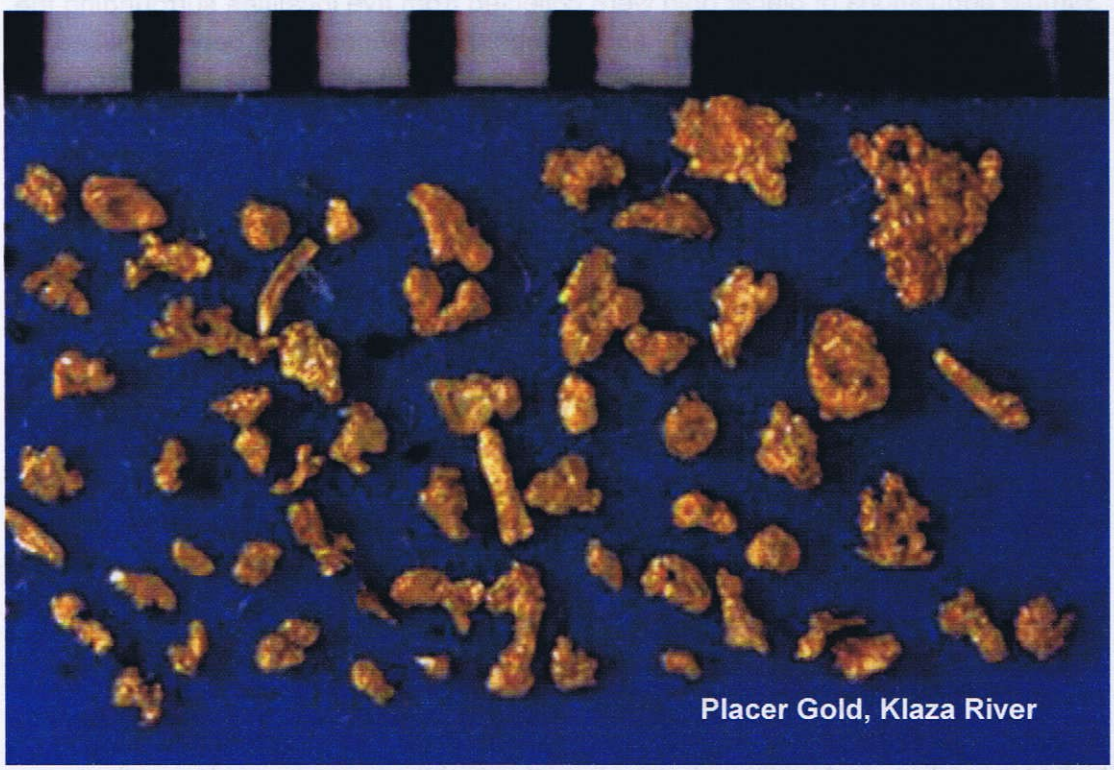
Wrighton, T.M., 2013. Placer gold microchemical characterization and shape analysis applied as an exploration tool in western Yukon. Unpublished MSc Thesis, University of British Columbia, 140 p.

Yukon MINFILE, 2015. Yukon MINFILE - A database of mineral occurrences. Yukon Geological Survey, <http://data.geology.gov.yk.ca> [accessed September 22, 2015].

Placer- Lode Gold Relationships in the Nansen Placer District Yukon



Upper Nansen Creek viewed from Klaza



Placer Gold, Klaza River

Rob Chapman, Matt Grimshaw, University of Leeds

Summary

The focus of the project was to characterize the mineralogy of gold grains derived from porphyry and associated epithermal environments in the Mount Nansen trend, southern Yukon with a view to establishing the most important sources of placer gold.

A total of 608 placer gold grains from six localities and over 100 grains from vein outcrops were analysed in terms of their alloy compositions and suites of opaque inclusions revealed within polished sections. In addition, ore mineralogy and a simple paragenesis was determined through study of 6 polished blocks from drill cores from boreholes adjacent to the outcrops.

Mineralization from both the BRX and Klaza zones showed a main paragenetic sequence of pyrite- (arsenopyrite/sphalerite)- galena. Native gold was observed in the early pyrite and in the later phase associated with galena. Bi- bearing minerals occurred as inclusions in early pyrite. This vein mineralogy was also evident in the suite of inclusions revealed within polished sections of gold grains collected from vein outcrops. The project currently awaits analyses of the alloy compositions of gold grains identified in polished section and in the elluvial grains.

Sample populations of placer gold were collected from five localities surrounding the Klaza property. Two compositional end member populations have been identified, through consideration of the Cu and Ag contents of gold alloys: one from Discovery Creek, (interpreted to represent a single porphyry source) and the other from the Klaza River, (interpreted as derived from the BRX vein in the Klaza property). Other placer localities yielded populations which were a mixture of these two signatures. The suite of mineral inclusions reported within the placer grains is directly comparable to the ore mineralogy of the Klaza zone (as identified in this study) and to the mineralogy of the Cyprus porphyry. Consequently, strong evidence for specific placer- lode relationships exists, which will be further clarified on the receipt of the full data set.

The widespread Au-Ag-Pb-Zn veins appear to comprise the major source of gold in the economic placers of Nansen and Victoria creeks. In addition, consideration of the compositional signature of gold from Victoria Creek suggests a local source which is yet to be identified. The extent to which individual vein systems have contributed to the local placers remains unclear.

The study is the first to investigate systematic variation in gold mineralogy associated with the porphyry- epithermal transition. The study area provides an excellent locality for further detailed investigation underpinned by vein sampling at higher resolution, and additional sampling of autochthonous placers in small drainages.

Introduction

Understanding the relationships between economically important placer gold deposits in the Yukon and their potential lode sources has developed significantly during the last decade. Various studies have characterized gold particles derived both from lode and placers in terms of their alloy compositions and suite of mineral inclusions revealed in polished section. These combined data sets yield a 'microchemical signature' for a specific population of grains. Signatures of lode and placer gold may be compared, both to establish the lode source of the placer, and in some cases to establish typical signatures for different styles of gold mineralization.

Study of the gold signatures at Klaza provides the opportunity to study in detail the variation in gold microchemical signatures associated with an epithermal system and potentially the range of signatures across a porphyry epithermal transition. There have been no studies reported on similar epithermal systems elsewhere. The vein system at Klaza outcrops at surface and has been exposed by trenching. Decomposed vein material is available at surface for collection and processing through panning to recover gold particles. Consequently it has been possible to study the mineralogy of gold within hypogene ore, and to track progress through the elluvial environment and into the placer deposits.

The Klaza property is encircled by placer mining operations and the YGS Placer Database indicates that different gold fineness or fineness ranges has been consistently reported from different creeks. Whilst bulk fineness data is only partially useful, broad correlation between gold composition and geographical location is suggestive of multiple sources. The approach to characterizing placer- lode relationships developed at the University of Leeds has been applied to investigate several aspects of placer-lode relationships in the study area:

1. The variation in microchemical signature within an epithermal system
2. The extent to which the microchemical signature of grains in the surficial environment reflects the lode source
3. The source(s) of placer gold in the various creeks surrounding Klaza
4. The gold endowment of the Cyprus porphyry and associated vein systems

Geology and Mineralization

The regional and local geology of the study area was summarized by Hart and Langdon (1997), and is depicted in Figure 1. Around 30 mineral localities have been identified in a 12km x 3 km NW-SE trending belt referred to as the Mount Nansen trend. The study area is situated at the northern extreme of the Mount Nansen belt and includes various porphyry and vein occurrences.

Hart and Langdon (1997) proposed that the porphyry and vein mineralization comprised a gradational porphyry-epithermal transition and speculated that the most

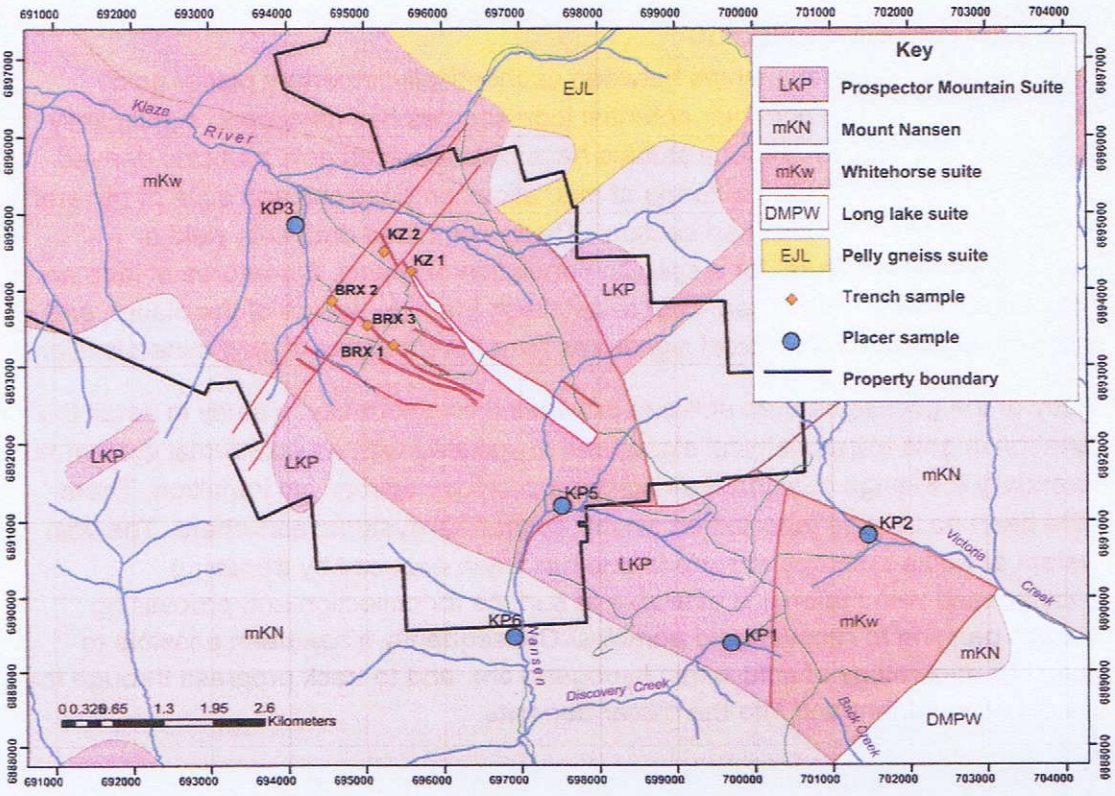


Figure 1. Sample locations and major lithologies

important contribution to the placer inventory was derived from porphyry mineralization

Descriptions of the most important localities in the context of the present study are provided in Table 1, which adopts the overall porphyry-transitional- epithermal classification as Hart and Langdon (1997). Mineralogical descriptions of the various zones show a progressive decrease in Cu content away from the porphyry both to the NW and SE into a Au-Ag-Pb-Zn dominated vein system.

Placer gold

The mount Nansen Area is a historically important placer area. Information concerning production and gold fineness data is available for some creeks in the Yukon Placer database (Lebarge 2005) and has been summarised in Table 2. Placer gold production from Nansen Creek accounts for around 75% of recorded production in the placer mining district. LeBarge (2007) reports that many streams were explored for their placer potential, but only a small number supported sustained activity.

Table 1. Descriptions of mineralized localities in the study area.

Name	Description
Central Porphyry Zone	
Cyprus[1,3]	Quartz monzonite porphyry, Cu-Mo zone: py, cpy, mo, Cu 0.1-0.15%. Au anomalous but erratic
Kelly[1]	0.275 x 2.5km NW trending potassic alteration zone identified by soil geochemistry. Trench sample yielded 0.86 g/T Au and 0.25% Cu. Cpy,Cc Bn and Mo
Peripheral porphyry zone	
Cyprus South[1]	Quartz sulphide veins and stockworks in phyllic zone . Au grade of 0.31g/T recorded in core.
Kelly South[1]	Au recorded in pyrite shell associated with phyllic alteration
Transitional zone	
Eliza Creek extension[1]	Veins and stockworks associated with orphyry stocks breccia and argillic/phyllic alteration. Au grades to 17.5g/T and Ag to 27 g/Tin core
Epithermal veins	
Klaza Zone[2]	Py, Sph, Ars, Ga, Sb, Ss. Au
BRX zone[1]	Py, Sph, Ars, Ga, Sb, Ss. Au
Eliza Creek South[1]	Au-Ag-Zn-Pb . Trench samples of Au to 3.9g/T
Eliza Creek North[1]	Cu content > Eliza Creek North. Au to 10.3g/T
Etzel	Au-Ag-Pb-Zn veins
Willow[1]	3 Au-Ag-Pb-Zn veins containing Au to 3.5g/T

[1]: Hart and Langdon 1997, [2]: Tarswell, 2014, [3]: YGS Minfile, 066, (2013)

Table 2. Placer gold information

Placer Creek	Fineness	Production to 2007 (oz)	Comments
Discovery	820-850	1586	
East Fork Nansen	No data	448	Some dendritic gold
Nansen	805-820	21,251	
Victoria	720-730	1185	Placer operations 3k apart
Back	760-836	3478	'Coarse' pay streak reported
Slate	800	-	Minor trib, no mining
Klaza	750*	Unknown	No data in YPDB

* Mean Ag value form the present study

Methodology

Field activities

Sampling of oxidized vein material from trenches

Decomposed vein material was collected from five localities, (see table 3 and Figure 1). A typical 'bag' (Table 1) comprised 20L of material screened at 1". This material was thoroughly wetted before sluicing using a 'Le Trap' portable sluice. Sluice concentrates were panned to recover a super concentrate containing gold grains. Samples were collected from five localities: three in the BRX zone and two in the Klaza Zone.

Table 3 Trench samples, assays from previous sampling and amount processed

label	Trench	E	N	g/T Au	g/T Ag	intercept (m)	bags sluiced
BRX 1	TR 13-49	382410	6889676	8.4	548	1.31	7
BRX 2	TR 13-47	381715	6890310	87	768	1.15	20
BRX 3	TR 13-58	382142	6889949	50.1	910	3.25	20
KZ 1	TR13-66	382758	6890614	25.7	449	2.27	10
KZ 2	TR 13-70	382462	6890888	16.76	1052	3.03	10

Collection of placer samples.

Samples of placer gold were collected using a combination of panning and sluicing. The details of the sample sites are provided in Table 4 and Figure 1:

Table 2: Locations of placer samples

label	locality	E	N	Comments
KP1	Discovery Ck	386521	6885312	Sample from headwaters of creek
KP2	Victoria Ck	388391	6886630	Side pay
KP3	Klaza R.	381422	6891421	From active cut
KP5	East Fork Nansen	384401	6887398	Sluiced gravel bar in tailings area
KP6	Nansen Ck	383700	6885781	Panned pay in active cut.

Analysis of gold particles revealed in core.

Core samples corresponding to the trench samples were provided by Rockhaven Resources, (Table 3). Intercepts of relatively high gold grades have been bracketed *by adjacent samples. Polished sections were prepared for analysis in Leeds.*

Table 3 location of samples for preparation of polished blocks.

Hole _ID	Close to	Sample Depth m	From_m_	To_m_	Interval_m	Collar		Au_ ppm	Ag_ ppm
						Easting	Northing		
KL-11-12	KZ1	221.7	221	222.6	1.6	382724	6890305	6.81	123
KL-11-33	BRX 1	121.1	120.3	121.64	1.34	382080	6889865	5.51	180
KL-11-37	BRX 3	90.0	88.95	90.17	1.22	381759	6890090	34	298
KL-12-96	BRX 2	342.8	342.46	345.36	2.9	381509	6890034	10.55	92.7
KL-12-115	KZ2	219.7	219.48	221.59	2.11	382340.2	6890627	13.75	357
KL-12-127	KZ2	169	168.11	169.11	1	382418.4	6890581	5.73	204

Analytical work

Gold grains from elluvial and placer samples were isolated from heavy mineral concentrates recovered from panning by picking under a binocular microscope. These grains were mounted according to size according to standard procedures described by Chapman et al. 2000. The extreme small size of some of the gold particles recovered from elluvial samples necessitated the design of a new polishing technique specifically for tiny particles.

Analysis of the Au grains was carried out in two stages. Firstly, qualitative analyses were undertaken using a FEI Quanta 650 FEG-ESEM. This involved inspection of each grain section and recording alloy heterogeneity and the presence of inclusions, either of minerals or intermetallic compounds. Secondly alloy compositions were determined using a Jeol 8230 Superprobe. The element suite analysed was: Au, Ag, Cu, and Hg. Polished blocks of core samples were prepared for inspection by reflected light microscopy and SEM/EMP analysis.

Results

An overview of the mineralogy of the core samples is provided in Appendix 1 .

Inspection of the polished blocks by SEM permitted construction of a simple paragenesis for each vein, which is presented below. It is appreciated that the number of samples examined is relatively small and therefore these results may lack detail. Nevertheless there are some generic features which emerge, together with mineralogical differences between the veins. In this analysis, the effect of variation in mineralization with depth, (as a consequence of examining samples from both upthrown and downthrown blocks) has been ignored, but major differences are higlighted in the text. The purpose of this stage of the project was to identify minerals coeval with gold (to relate to particulate gold signatures) rather than to establish a definitive vein paragenesis.

The three polished blocks from the Klaza zone which were examined all indicate an early pyrite stage, with later arsenopyrite and sphalerite. Chalcopyrite was a minor component of this stage, presenting as chalcopyrite disease in sphalerite. Galena and minor sulphosalts postdate the arsenopyrite and sphalerite. A small amount of gold was observed, which was coeval with the late galena. Barytes was observed as a major late stage but only in the sample from the upthown block, i.e. the barytes mineralization appears to be related to depth.

Samples from the BRX zone exhibited a more complex parageneses, which extends to four stages. Pyrite forms the first phase, but this is coeval with Bi- bearing minerals (telluride, sulphide and Bi-Pb sulphide) and gold. The second stage of mineralization shows some similarities with that at Klaza, but sphalerite was less common, and small amounts of galena were present. Galena is more common in a later stage as well where it infills sphalerite and arsenopyrite. Pyrrhotite was a

second stage mineral, and enargite and chalcopyrite postdated some of the later stage galena.

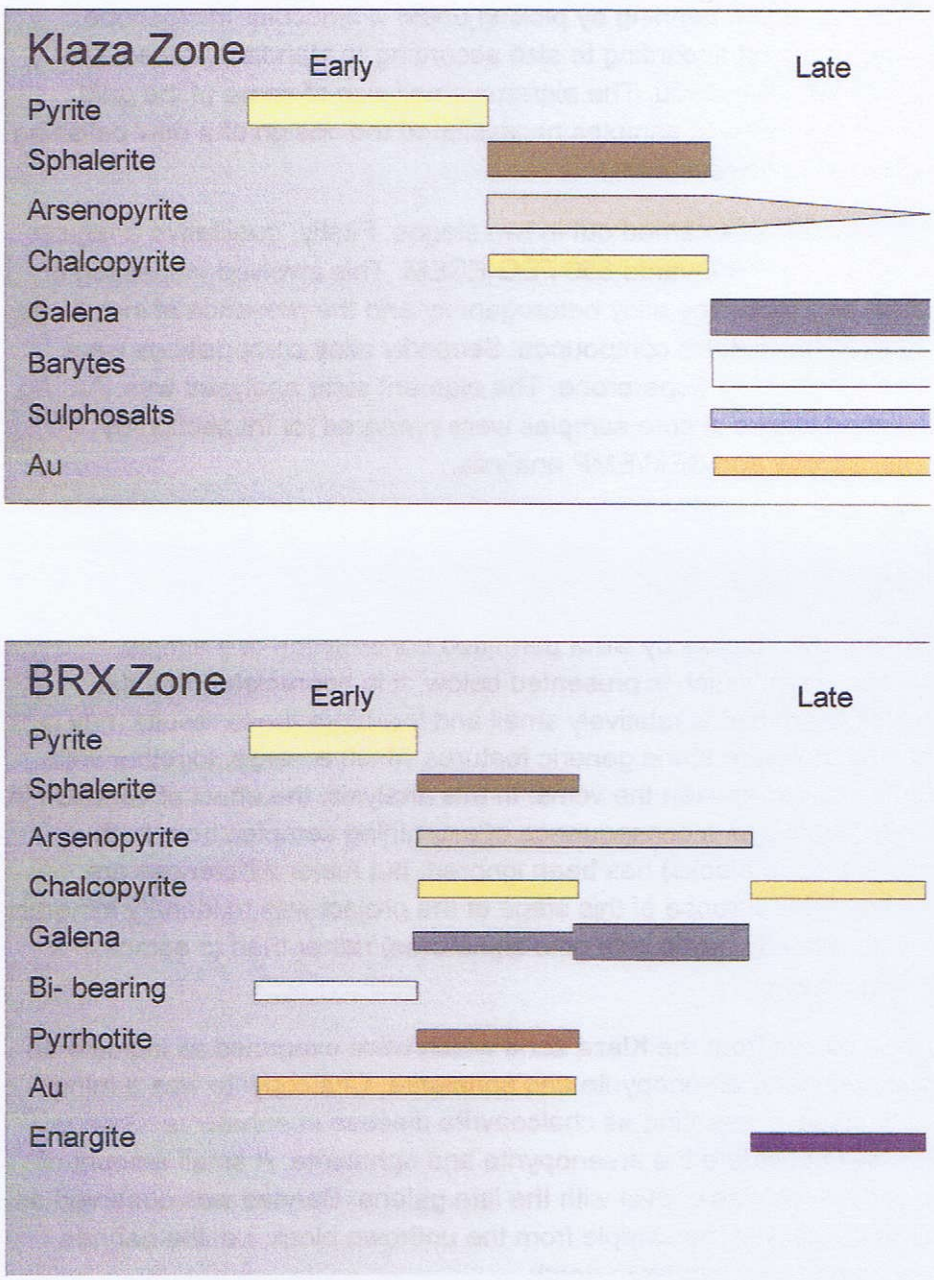


Figure 2. Simple paragenesis of core from the Klaza and BRX zones based on observation of a small number of polished sections

A small number of semi quantitative analyses of the gold particles was undertaken using the EDS facility of the SEM. Gold in sample 12-96 exhibited several gold blebs (1-5 µm) in pyrite, and these are plotted onto Fig 4A for comparison with placer gold from the Klaza River

Samples collected from surface

At the time of writing, analyses of alloy compositions of the gold grains collected from the vein outcrops are incomplete, but are scheduled to be undertaken in late April 2015. The inclusion suites established during SEM analysis are presented in Table 4 below.

The tiny size of most of these gold grains provides an explanation for the low incidence of inclusions, but a variety of minerals were observed as indicated in table 4 . Inclusions of Bi telluride and galena are illustrated in Appendix 2. All gold grains from BRX-1 exhibited a coating of iron oxide, and in section some showed a cloud of fine Au on the periphery of this coating (Appendix 2).

Placer samples.

Morphology

Images of the placer samples collected in this study are provided in Appendix 3, together with comments describing the morphology. The sample KP-5, from East Fork Nansen was not included because this sample was won from placer tailings, in which flaky gold is preferentially concentrated. Sample populations from Discovery Creek and the Klaza River both exhibited morphologies consistent with very limited fluvial transport, whilst the other samples appeared to include a range of morphologies.

Alloy compositions

The Ag content of the placer populations are depicted on the plots in Figure 3A. The sample from the Klaza River (KP3) shows the highest overall Ag values, whilst the sample from the Discovery Creek exhibits the lowest values. Placer samples from Nansen Creek appear to exhibit elements of both these signatures. The sample from Victoria creek resembles that from Klaza River most closely. Figure 3B shows the relationship between Ag and Cu in the Discovery Creek and Klaza River placer populations. Two broad compositional fields are observed although there is a small degree of overlap.

Placer lode relationships in the study area.

1. *Relationship between hypogene ore and gold in the elluvial environment*

At the time of writing the analysis of the alloy compositions of hypogene and elluvial gold grains has not been completed. The evaluation of the data set is made mainly on the basis of the ore mineralogy and inclusion species observed in gold particles weathered out of the veins.

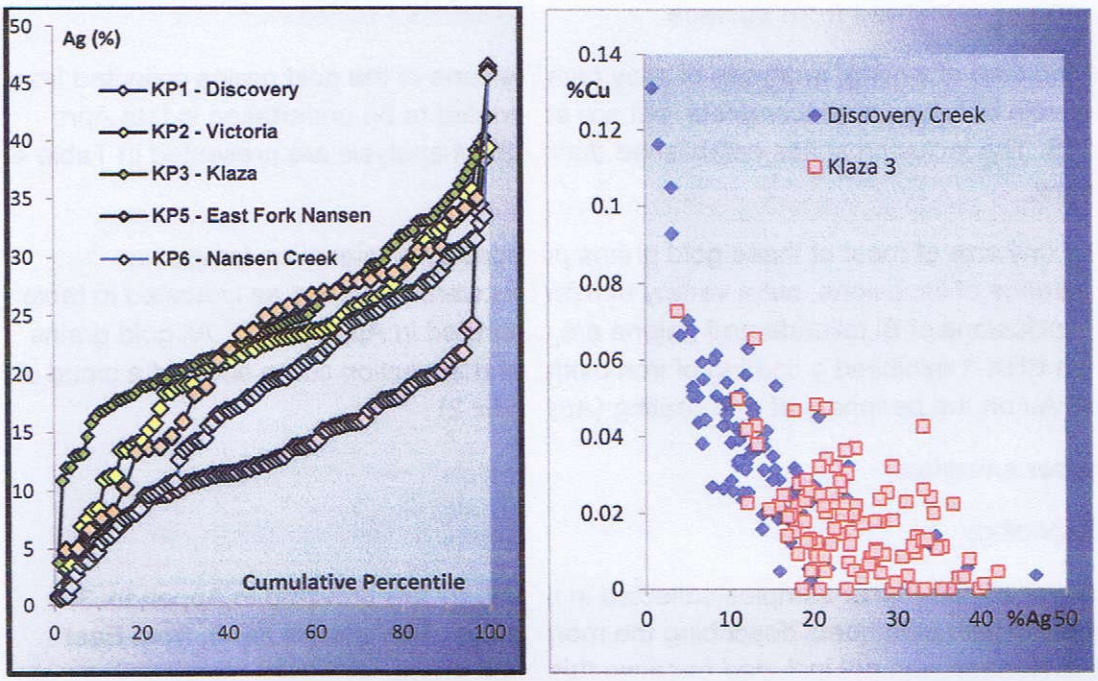


Figure 3. Alloy compositions of placer gold

Table 4. Inclusion assemblages in placer and elluvial gold

	Grains	Py	Po	Cpy	Ga	Sp	Ars	Bi	SS	B	Hs
KP1	102				4		4	2			
KP2	78	1		1	1	1		3			
KP3	104	6		2	2			2			4
KP5	37	1		1	2				1	1	
KP6	101	4			3		1	1	1		
EFN , YGS	97	9		1	5	2	1	3			2
BRX-1		1		1	1		1				
BRX-2		1	1		1	1		2	1	3	
KZ-2					1						

Studies of the ore mineralogy undertaken by SEM and RL microscopy have indicated a broad paragenesis for the two vein systems. There are insufficient samples to evaluate in detail whether the mineralogy varies systematically with either location or depth, but samples from both vein systems exhibit common features in the samples observed and some broad differences can be tentatively proposed.

Both vein systems exhibit an initial stage which involved pyrite deposition. In the BRX zone, this stage also involved deposition of Bi bearing minerals and Au. Similarities also exist in the second stage, which comprises arsenopyrite and sphalerite as major minerals in the Klaza zone, but as more minor components in the BRX zone. Very minor chalcopyrite was observed as chalcopyrite disease in

sphalerite in the Klaza zone. One sample suggests that gold post dates pyrite, but it is not possible to identify the actual stage of emplacement from the observations available, consequently ascribing gold to stage 2 in Figure 2 is tentative.

The third stage of mineralization involved galena, which is commonly observed as infills within pyrite, sphalerite and arsenopyrite. In the Klaza zone, major barytes was observed in the sample from the upthrown block which suggests that the presence of barytes is related to depth. This interpretation suggests a generic process, because barytes was abundant in the pan concentrate of the elluvial sample from BRX-2, (also in the upthrown block). Minor sulphosalts were observed in stage 3 in the Klaza zone samples, and one very small gold grain was present within a grain of galena, itself infilling a crack between pyrite and arsenopyrite, (Appendix 1.1A). Enargite and chalcopyrite postdated galena in one sample from the BRX-zone, and comprise a minor 4th stage.

Table 4 indicates the abundance and mineralogy of the inclusion suites found within the elluvial grains, Inclusions are regarded as coeval with the Au alloy, and hence the inclusions suites can be related to the paragenetic dagrams constructed in Figure 2. Most of the important ore minerals are represented, although this relationship does not always extend to minerals seen to be coeval with gold in the hypogene ore. Inclusions were absent in the sample of gold grains from KZ- 1 and only galena was identified in hypogene ore from KZ-2. In the BRX zone, the Au-Pyrite- Bi mineral association was evident, together with an Au- galena association which was not observed in the hypogene ore at this locality. Further discussion of the hypogene- elluvial relationship will be facilitated by the generation of alloy data.

2. *Placer signatures and their interrelationship*

Figure 4A shows the variation in Ag contents of the gold grains from the various placer localities. The samples from Discovery Creek and the Klaza River represent the most extreme populations of the suite studied. In addition, both populations comprise a single continuum of Ag compositions whereas the placer samples from Nansen Creek generated stepped plots, usually interpreted as indicative of multiple sources. The images in Appendix 2 show that gold grains collected in the Klaza River and Discovery Creek exhibit a rough morphology indicating proximity to source. The Klaza river site is adjacent to the Klaza vein systems whilst the Discovery Creek locality is entirely within the outcrop of the Cyprus porphyry. These observations indicate that populations of Au grains derived from the porphyry mineralization are lower in Ag than their epithermal counterparts.

The headwaters of Nansen Creek (East Fork Nansen) are close to several potential gold sources identified by Hart and Langdon (1997): the Klaza zone, Etzel, and the Cyprus porphyry. Three samples donated by YGS and analysed previously were also available to the present study. Unfortunately their precise sample locations are unknown. The Ag plots of these samples are presented in Figure 4B. All samples

show mixtures of the two end member populations, and the shape of the three curves shows varying proportions of each are present. The hypothesis of variable contributions from two sources at different sampling sites in a small catchment is explained by the position of the Creek with respect to the various potential sources, and possibly also a function of the position of the mining cuts in relation to the creek, i.e. left or right limit.

The placer sample from Victoria Creek generated a Ag plot far more similar to the epithermal signature described above than to that associated with the Cyprus porphyry, (Fig. 4A). The varied morphology of the grains within this sample population suggests multiple sources, and it is proposed that most of these are epithermal in nature, with at least one very close to the sampling locality.

Relationship between hypogene mineralization,elluvial gold grains and placer gold grains.

Whilst detailed examination of this relationship is currently impaired by the lack of gold alloy analyses for hypogene and elluvial gold grains, and the small number of polished blocks examined, there are clear similarities between the gold mineralogy in the hypogene, elluvial and placer settings. The mineral species observed in the hypogene ore are distinctive and are also evident in gold grains collected from the elluvial and placer environments. During examination of the hypogene samples from the BRX zone by SEM, a small number of semi quantitative analyses of gold grains was undertaken using the EDS facility. These analyses are not of the same quality as those produced by EMP, neither is analysis of the small concentrations of Cu possible. Nevertheless the data illustrated in Figure 4A shows an extremely close correlation between the composition of hypogene gold from BRX 2 and that of placer gold from the Klaza River at a sampling locality downslope. It is emphasized that this correlation must be substantiated with larger amounts of higher quality data.

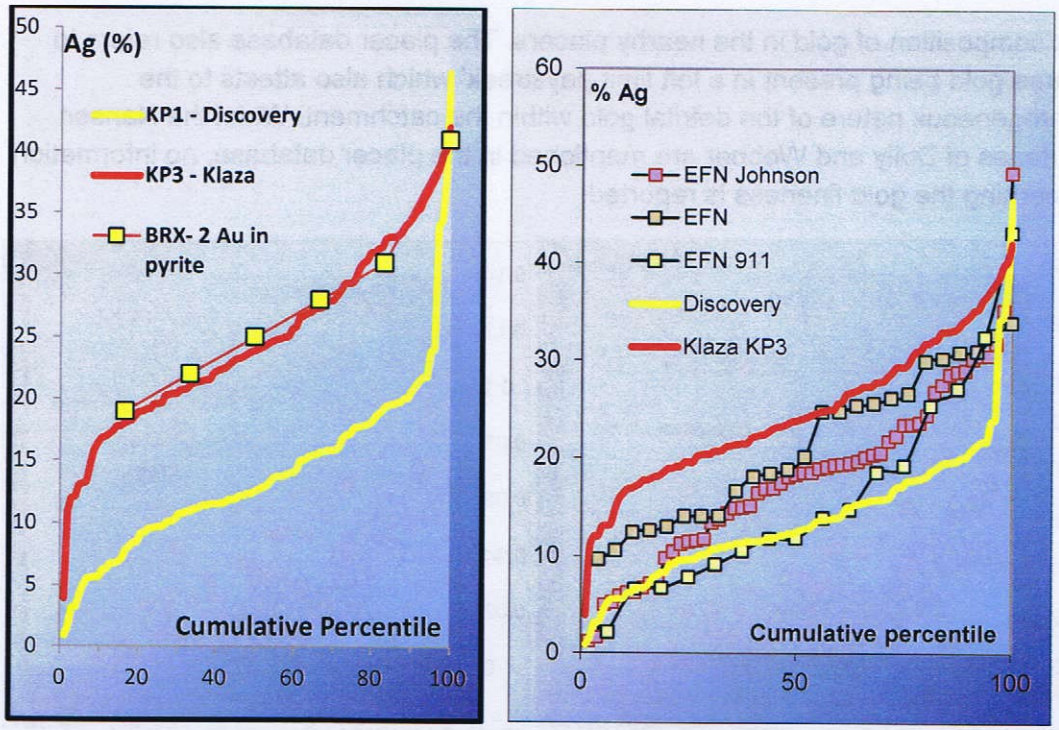


Figure 4 A: Relationship between Klaza River placer gold and gold in the hypogene BRX zone. 4 B Relationship of different samples collected from East Fork Nansen, Klaza River and Discovery Creek.

3. *Implications for source of gold in the placer district.*

The analysis provided in the sections above permits differentiation between gold particles derived from the Klaza zone veins and that originating from the Cyprus porphyry. This difference is evident in the shapes of the Ag curves and the compositional fields with Cu-Ag plots such as Figures 3A and 3B. However it is not possible to establish whether the high Ag, low Cu gold is derived from the Klaza veins or other Au-Ag-Pb-Zn occurrences in the area. Similarly, there is, at present, no signature available to describe gold derived from the Kelly zone. Consequently, whilst it is possible to interrogate placer data sets in terms of the relative amounts of each alloy type it is more difficult to establish clear lode source- placer relationships. Nevertheless, some broad conclusions may be drawn from the data sets available Consideration of the Ag-Cu plot (Fig. 5A) shows that only around third of the grains from Nansen Creek exhibit compositions compatible with derivation from the porphyry. Similarly, the alloy signature of the population of placer gold grains from Victoria Creek is clearly more similar to that of the vein hosted gold, (Fig 5B). The fineness of gold from Victoria Creek (720-730) reported by LeBarge (2007) is in agreement with the data from the present study,(Fig 3A) and therefore the implications of a fineness rage of 760-836 from Back Creek (Fig 1) can be interpreted with confidence. This compositional range suggests the presence of both high and low Ag signatures, and is interpreted to indicate that both porphyry and vein mineralization are present within the catchment and have strongly influenced the

bulk composition of gold in the nearby placers. The placer database also refers to 'coarse gold being present in a left limit paystreak' which also attests to the heterogeneous nature of the detrital gold within the catchment. Whist the Nansen tributaries of Dolly and Webber are mentioned in the placer database, no information concerning the gold fineness is reported.

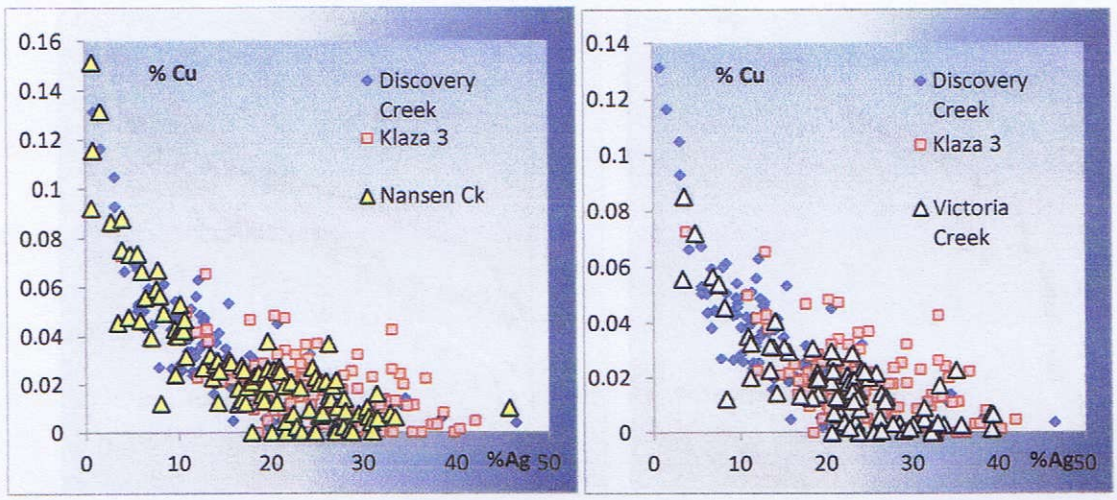


Figure 5. Use of Cu-Ag plots to evaluate the proportion of placer grains derived from porphyry and vein sources

An overview of placer lode relationships is provided in Table 5. The application of gold grain geochemistry to study lode-placer relationships in the study area has revealed the importance of the epithermal vein systems as sources of placer gold. Consideration of the geographical relationship of the major placer (Nansen Creek) with the Cyprus porphyry would suggest that most placer gold has been derived from this source. However the relative abundance of gold grains which exhibit a high Ag/low Cu signature indicates that the overall contribution from vein hosted gold is more important.

Table 5 Summary of lode-placer relationships in the study area

label	locality	Sources
KP1	Discovery Ck	Cyprus Porphyry
KP2	Victoria Ck	Multiple Au-Ag-Pb-Zn veins , locality unknown., but one source very close to the sampling site
KP3	Klaza R.	Klaza zone veins
KP5	East Fork Nansen	Cyprus porphyry, Kelly zone, Etzel occurrence, Klaza zone
KP6	Nansen Ck	Vein hosted gold comprises around 70% of the placer inventory with the balance derived from porphyry mineralization.

There are two caveats that must be applied to this interpretation. Firstly current mining operations on Nansen Creek mine down to a clay layer at a depth of around 10m which acts as false bedrock. Drilling has indicated that a further 40m of material overlaid bedrock. Consequently the amount of gold in the deeply buried channels is

unknown, but the placer was established in a previous fluvial regime, which could have derived gold from a different source, or indeed it may contain no gold at all. Consequently the approach of using placer production figures to interpret the size of the eroded mineralization is not appropriate in this case. Inference of the economic potential of vein systems from the placer occurrences is also problematic, as the amount of gold in the placer is dependent upon the spatial relationship of the veins to the drainage. The amount of gold from the Klaza veins which reports to the Nansen Creek placer is unclear, because gold with a similar signature is probably present in other sources such as Etzel. The placers in the Klaza River which are currently mined appear relatively modest, and give no strong indication of the potential of the adjacent vein system.
It seems likely that there are Au – bearing veins which remain to be discovered. The lode – placer relationships in Back Creek are unclear, but the variation in gold fineness reported previously is a clear indication of at least two sources, which is consistent with the location of the creek with respect to the vein and porphyry mineralization. The presence of coarse, rough gold near the sampling site on Victoria Creek is strong evidence for a local source, probably to the NE of the creek.

This small study is the first to consider variation of gold signatures in the porphyry-epithermal transition, and has highlighted some interesting relationships that have important implications both for the study area and wider investigations. The current data set do not include any lode samples from the transitional zone, some of which are reported as mineralogically distinctive from the vein systems. Study of this mineralizing environment would add to our understanding of metal transport and partitioning, within such systems and recommendations for further studies will be forthcoming.

Conclusions

The mineralogy of the hypogene ore was emplaced in three major stages with the paragenesis of the major minerals conforming to i. pyrite, ii. /sphalerite/arsenopyrite, iii. galena. Native Au was identified both in early stage pyrite and with later stage galena. The mineralogy of the vein material is reflected accurately in the inclusion suite of gold grains collected from elluvial and placer environments. The limited amount of alloy data relating to hypogene gold currently available shows a clear compatibility of the gold the Klaza Zone and the placer gold in the Klaza River.

Alloy signatures of placer gold comprise two end members, one relating to a porphyry origin and the other to the widespread Au-Ag-Pb-Zn veins. These signatures have been ascribed through study of two placer samples whose geographical position limits the influx of gold to a specific source and may be distinguished by considering both Cu and Ag contents of gold grains. The resulting signatures have been used to evaluate the contributions of the gold type to placers where both styles of mineralization are present within the drainage. In this way, previous assumptions that the majority of the placer gold inventory was derived from porphyry sources has been challenged, as the most common signature relates to the vein gold. However, given the number of vein occurrences in the study area it is not

always possible to identify the relative amounts of placer gold originating from specific veins.

References

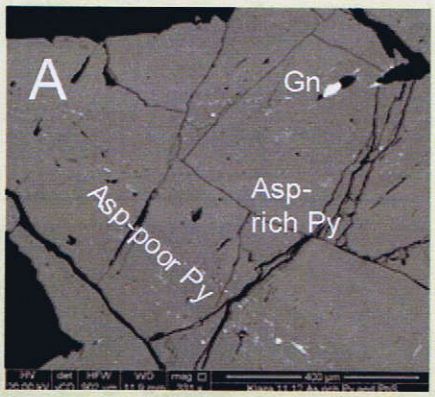
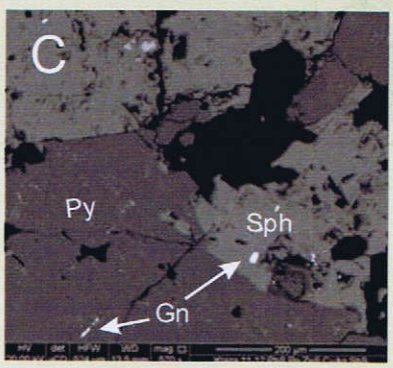
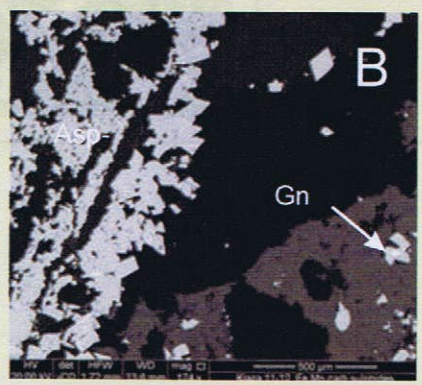
Chapman, R.J., Leake, R.C., Moles, N.R., Earls, G., Cooper, C., Harrington, K., and Berzins, R., 2000, The application of microchemical analysis of gold grains to the understanding of complex local and regional gold mineralization: a case study in Ireland and Scotland: ECONOMIC GEOLOGY, v. 95, p. 1753-1773.

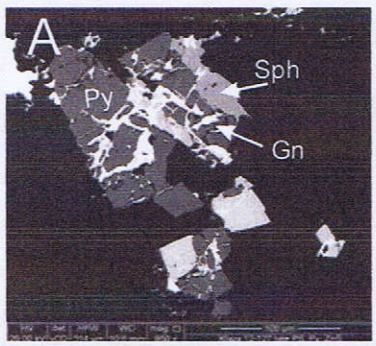
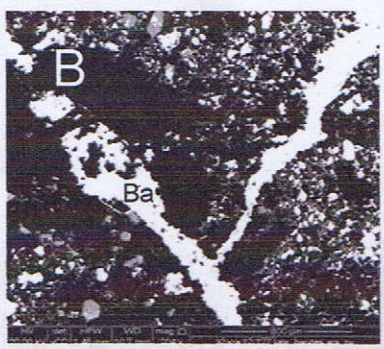
Hart, Craig J.R. and Langdon, Mark. Geology and mineral deposits of the Mount Nansen camp, Yukon. *In:*Yukon Exploration and Geology 1997, Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p.129-138.

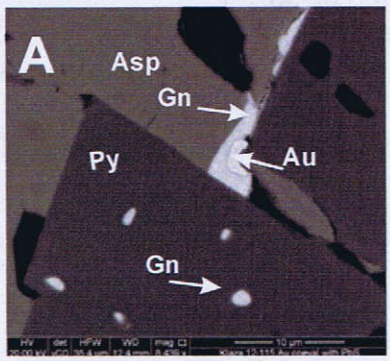
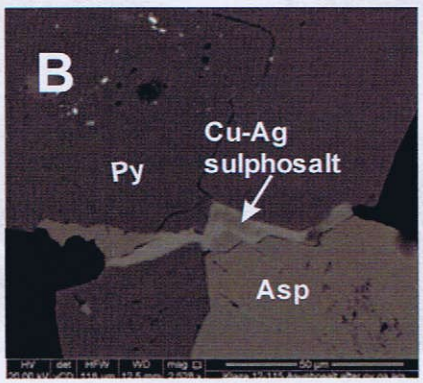
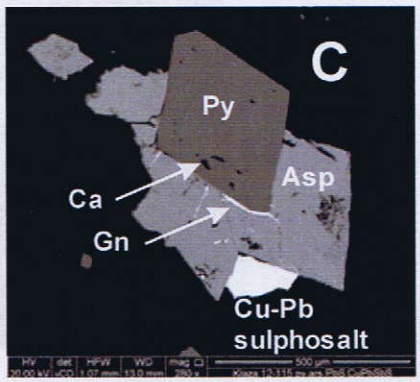
LeBarge, W.P. (compiler), 2007, Yukon Placer Database 2007 - geology and mining activity of placer occurrences; Yukon Geological Survey, CD-ROM.

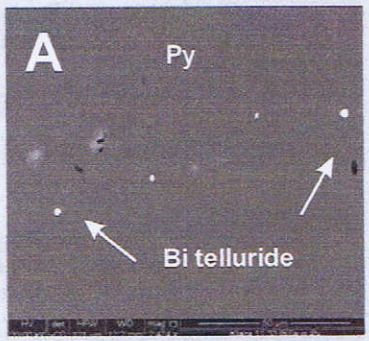
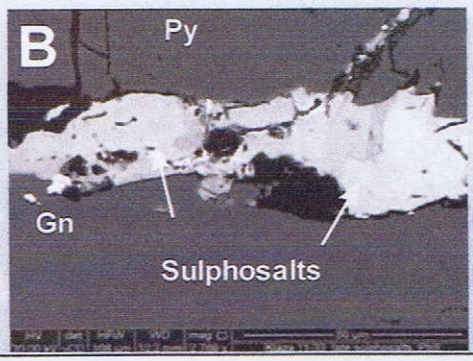
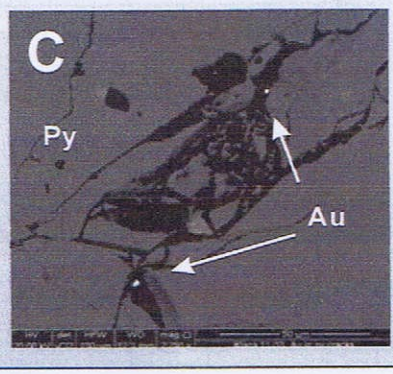
Tarswell, J, Turner, M. 2014. Assessment report describing excavator trenches, geophysical surveys and metallurgical tests at the Klaza property. Prepared by Archer, Cathro & Associates (1981) limited for Rockhaven Resources ltd.

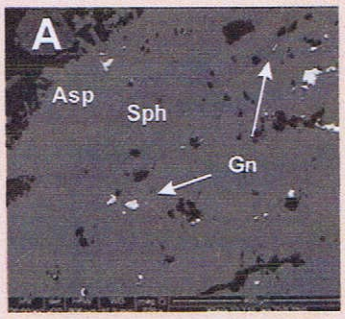
Appendix 1 4 Core mineralogy Abbreviations: Asp=arsenopyrite, Au= gold, En= enargite Ga= galena, Py= pyrite, Su= sulphosalts, Sph= sphalerite,

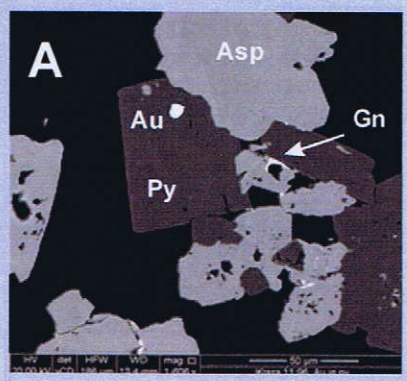
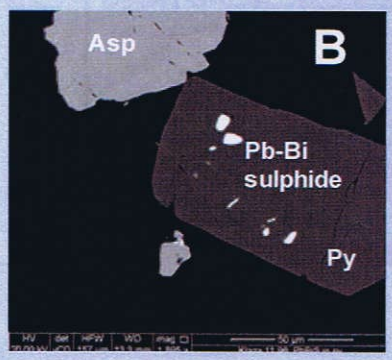
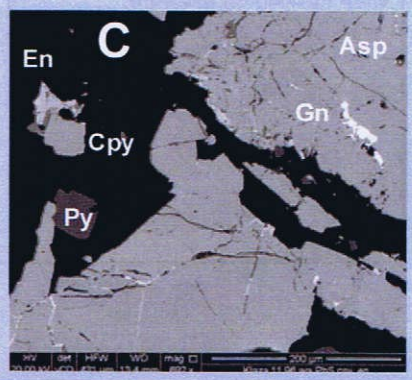
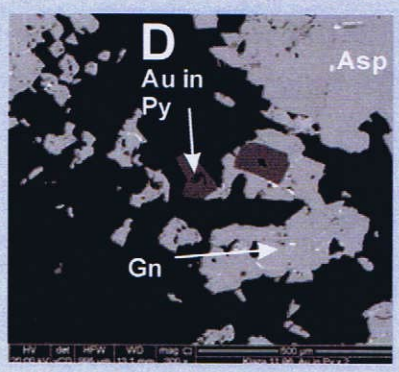
Hole _ID	Mineralogy	
KL-11-12 KZ1 ?	Cubic, subhedral Pyrite cubes to 1.5mm forms the majority of the block, Anhedral sphalerite with chalcopyrite disease Galena infills arsenopyrite and often follow linear trend (A), within As-poor pyrite. Galena blebs in Sphalerite and arsenopyrite (B) Quartz- carbonate gangue including Mn- bearing carbonate.(C) with arsenopyrite and galena	
		

Hole _ID	Mineralogy	
KL-12-127 KZ2	Galena postdates pyrite and sphalerite (A) Galena in bands of As- poor pyrite Late barytes cuts massive pyrite and arsenopyrite (B)	
		

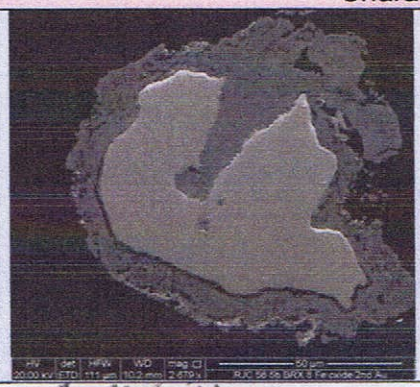
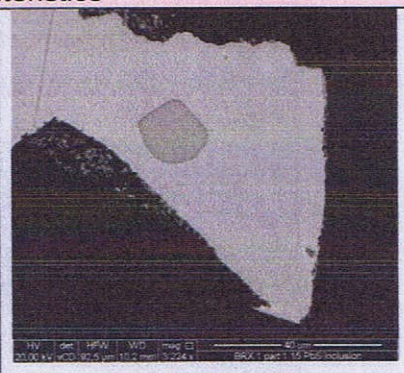
Hole _ID	Mineralogy	
KL-12-115	Arsenopyrite postdates pyrite (A) and galena postdates arsenopyrite Au coeval with galena (A) (CuAg) (SbAsS) postdates pyrite and arsenopyrite(B) Pyrite- arseno[pyrite –(galena/Cu-Pb sulphosalt) sequence in C. Euhedral pyrite with galena and calcite inclusions (C)	
		

Hole _ID	Mineralogy	
KL-11-33 BRX 1	Dominated by pyrite Tiny (3 µm) Bi telluride inclusions in pyrite (A) Galena mainly late stage fracture fill in pyrite sometimes together with Cu-Ag sulphide or Ag-Cu sulphosalts (B) Tiny Au grains n Pyrite (B)	
		

Hole _ID	Mineralogy	
KL-11-37 BRX 3	Spalerite, arsenopyrite and pyrite (stage 1) with later galena. Sphalerite predates arsenopyrite Galena postdates arsenopyrite	

Hole _ID	Mineralogy	
KL-12-96 BRX 2	Au coeval with Py.(A) Pb/Bi sulphide coeval with Py (B) Arsenopyrite postdates pyrite (A,D) Galena postdates arsenopyrite (A,D) Chalcopyrite, enargite and galena postdate arsenopyrite (C)	
		
		

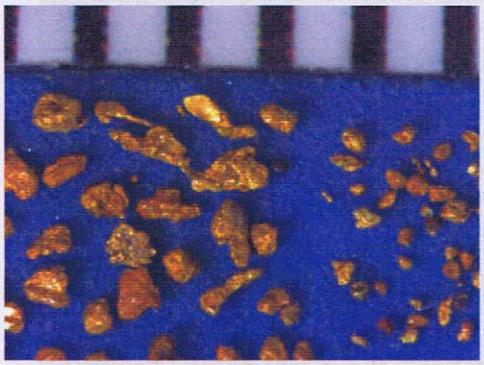
Appendix 2: Features of gold grains from elluvial localities

Sample	Characteristics	
BRX-1 Left: gold grain encapsulate by iron oxide. This film of gold, presumed remobilized on grain surface . Right: Galena inclusion in gold		
BRX-2 Bi telluride inclusions in gold, Dots =polishing medium		

Appendix 3 Samples of placer gold from the Klaza Environs

KP 1 Discovery Creek

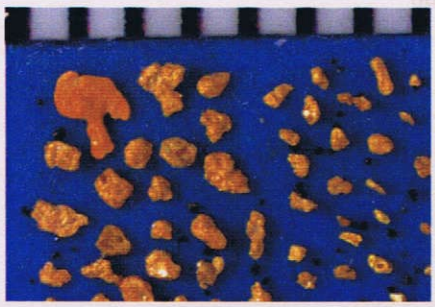
Small rough gold particles indicative of very limited fluvial transport



KP2: Victoria Creek

Top; larger rough grains collected in an area where larger, similar nuggets have been recovered by local placer miners.
Below: Smaller grains, exhibiting both very flaky and rough morphologies.





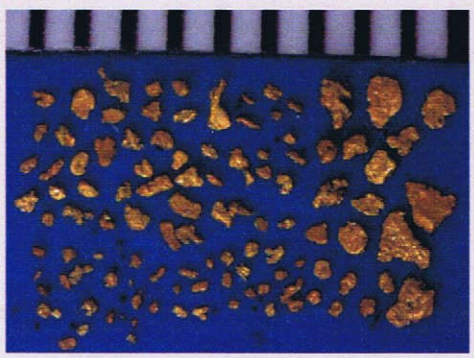
KP3, Klaza River

Mostly small<1mm grains, but all rough showing textures indicative of very limited transport

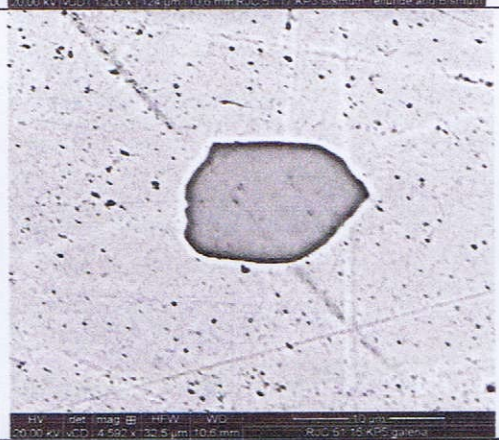
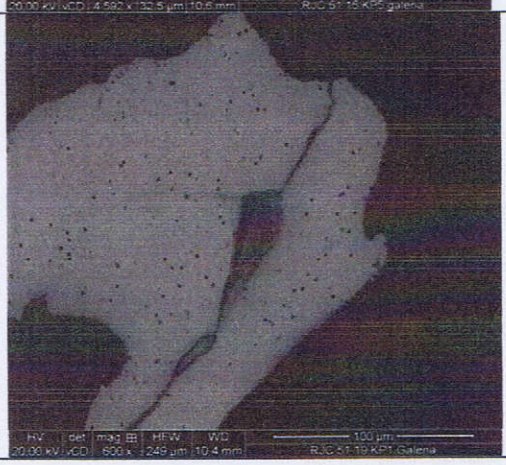


KP5 Nansen Creek

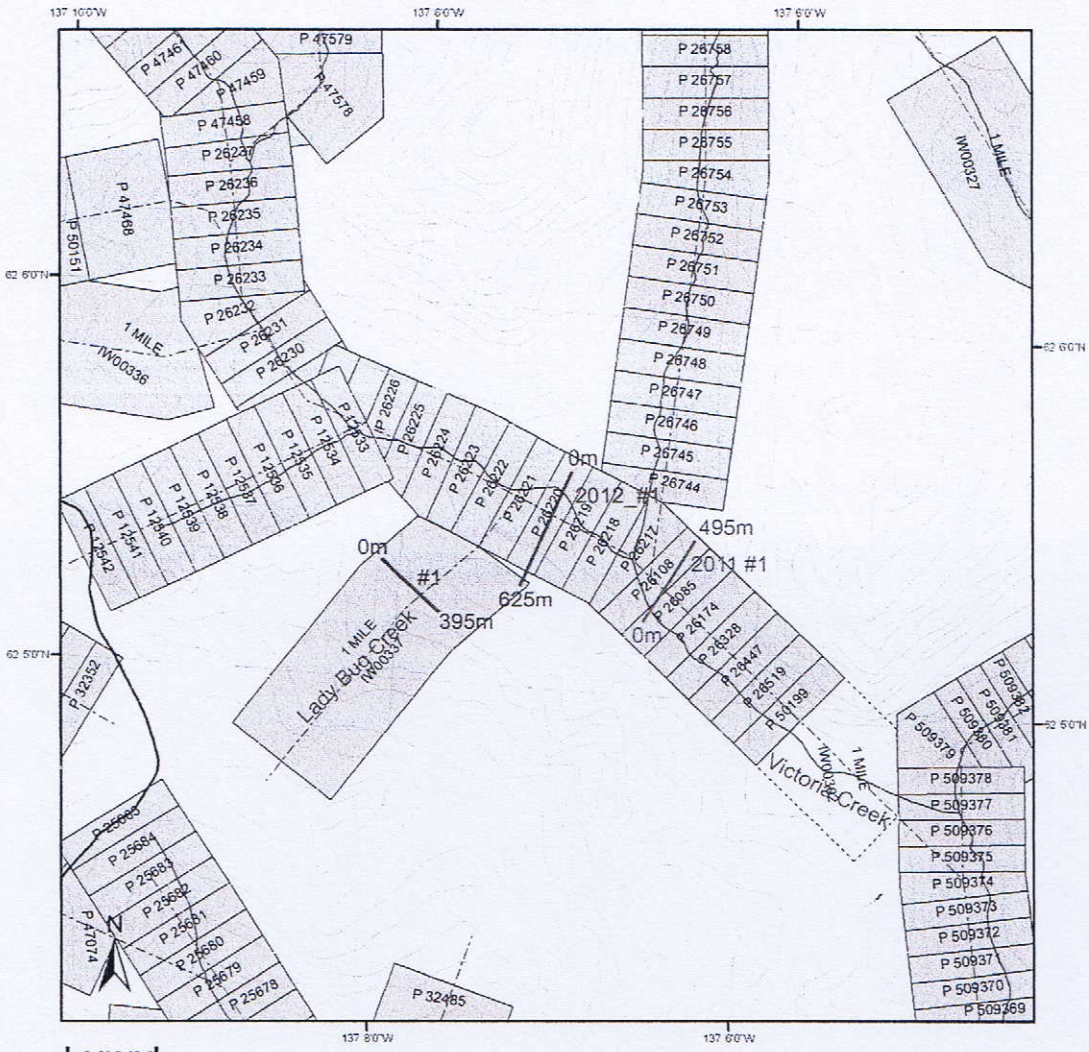
Mixed morphology, occasional rough grains, but many showing evidence of transportation



Appendix 4 Examples of internal features of placer gold grains

KP3 Bi Telluride (mid gray, and Bismuth sulphide (very dark gray) inclusions in gold from The Klaza river	
KP5 Large galena inclusion in gold from East Fork Nansen	
KP1 Galena postdating gold in a placer grain from the Klaza River	

10. Survey Map[7]



Legend

- mining road
- contour line
- watercourse
- water body
- measuring line 2012
- measuring line 2011
- placer baseline

placer claims

- Active
- Expired

prospecting lease

- Active
- Expired

Survey Map

115I03 (Mount Nansen)

Universal Transverse Mercator Zone 8
North American Datum 1983

scale 1:25,000

0 250 500 1,000 1,500 2,000 Meters

[7] Government of Canada, Natural Resources Canada, Centre for Topographic Information ftp://ftp.geomaticsyukon.ca/Mining

11. Bedrock Geology Map – Overview[8]



[8] Gordey, S.P. and Makepeace, A.J. (comp.) 1999: Yukon bedrock geology in Yukon digital geology, S.P. Gordey and A.J. Makepeace (comp.); Geological Survey of Canada Open File D3826 and Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, Open File 1999-1(D)

Legend

QUATERNARY

Q: QUATERNARY: unconsolidated glacial, glaciofluvial and glaciolacustrine deposits; fluviatile silt, sand, and gravel, and local volcanic ash, in part with cover of soil and organic deposits

EARLY TERTIARY

ETfN: NISLING RANGE SUITE: orange and buff weathering light-coloured feldspar porphyry dyke and flow rocks of intermediate to acid composition

LATE CRETACEOUS TO TERTIARY

LKdP: PROSPECTOR MOUNTAIN SUITE: coarsely crystalline gabbro and diorite

LKqP: PROSPECTOR MOUNTAIN SUITE: quartz monzonite, biotite quartz-rich granite; porphyritic alaskite and granite with plagioclase and quartz-eye phenocrysts; biotite and hornblende quartz monzodiorite, granite, and leucocratic granodiorite with local alkali feldspar phenocrysts (Prospector Mountain Suite, Carcross Pluton)

LKfP: PROSPECTOR MOUNTAIN SUITE: quartz-feldspar porphyry

MID-CRETACEOUS

mKgW: WHITEHORSE SUITE: biotite-hornblende granodiorite, hornblende quartz diorite and hornblende diorite; leucocratic, biotite hornblende granodiorite locally with sparse grey and pink potassium feldspar phenocrysts (Whitehorse Suite, Casino granodiorite, McClintock granodiodrite, Nisling Range granodiorite)

mKqW: WHITEHORSE SUITE: biotite quartz-monzonite, biotite granite and leucogranite, pink granophyric quartz monzonite, porphyritic biotite leucogranite, locally porphyritic (K-feldspar) hornblende monzonite to syenite, and locally porphyritic leucocratic quartz monzonite (ML McIntyre Suite, Whitehorse Suite, Casino Intrusions, Mt. Ward Granite, Coffee Creek Granite)

mKyW: WHITEHORSE SUITE: hornblende syenite, grading to granite or granodiorite (Whitehorse Suite)

mKN: MOUNT NANSEN: massive aphyric or feldspar-phyric andesite to dacite flows, breccia and tuff; massive, heterolithic, quartz- and feldspar-phyric, felsic lapilli tuff; flow-banded quartz-phyric rhyolite and quartz-feldspar porphyry plugs, dykes, sills and breccia (Mount Nansen Gp., Byng Creek Volcanics, Hutshi Gp.)

UPPER CRETACEOUS

uKC1: CARMACKS: augite olivine basalt and breccia; hornblende feldspar porphyry andesite and dacite flows; vesicular, augite phyric andesite and trachyte; minor sandy tuff, granite boulder conglomerate, agglomerate and associated epiclastic rocks (Carmacks Gp., Little Ridge Volcanics, Casino Volcanics)

uKC2: CARMACKS: acid vitric crystal tuff, lapilli tuff and welded tuff including feeder plugs and necks; felsic volcanic flow rocks and quartz feldspar porphyries; green and purple massive tuff-breccia with feldspar phyric fragments (Carmacks Gp., Donjek Volcanics, some rocks formerly mapped as Mt. Nansen Gp.; the felsic part of the Carmacks Gp. is difficult to distinguish from similar Tertiary and mid-Cretaceous (Mt. Nansen) felsic volcanic strata)

UPPER JURASSIC AND LOWER CRETACEOUS

uJKT: TANTALUS: massive to thickly bedded chert pebble conglomerate and gritty quartz-chert-feldspar sandstone; interbedded dark grey shale, argillite, siltstone, arkose and coal; at one locality includes red-weathering dacite to andesite flows at base (Tantalus)

EARLY JURASSIC

EJgA: AISHIHIK SUITE: medium- to coarse- grained, foliated biotite-hornblende granodiorite; biotite-rich screens and gneissic schlieren; foliated hornblende diorite to monzodiorite with local K-feldspar megacrysts; may include unfoliated monzonite of the Long Lake Suite (Aishihik Suite)

EJyL: LONG LAKE SUITE: resistant, dark weathering, massive, coarse- to very coarse- grained and porphyritic, mesocratic hornblende syenite; locally sheared, commonly fractured and saussuritized; locally has well developed layering of aligned pink K-feldspar tablets (Big Creek Syenite)

EJqL: LONG LAKE SUITE: massive to weakly foliated, fine to coarse grained biotite, biotite-muscovite and biotite-hornblende quartz monzonite to granite, including abundant pegmatite and aplite phases; commonly K-feldspar megacrystic (Long Lake Suite)

LOWER AND MIDDLE JURASSIC, HETTANGIAN TO BAJOCIAN

JL: LABERGE: poorly sorted, medium bedded to massive arkosic sandstone and minor shale with interbeds and thick members of resistant heterolithic pebble and boulder conglomerate; recessive, dark brown weathering, thin bedded, dark brown to greenish, silty shale (Laberge Gp.)

LOWER JURASSIC, PLEINSBACHIAN TO TOARCIAN

lJN: NORDENSKIOLD: resistant, reddish brown weathering, massive, khaki-green dacite tuff with fresh plagioclase, hornblende and biotite; grades locally to pale green, punky weathering, salt and pepper textured, massive sandstone; interbedded conglomerate (Nordenskiold Dacite)

UPPER TRIASSIC, CARNIAN TO NORIAN

uTrAK2: AKSALA: massive to thick bedded limestone; minor thin bedded argillaceous to sooty limestone; coarsely crystalline, massive dolostone; minor laminated chert; massive to poorly bedded, limestone conglomerate debris flows and fanglomerate (Hancock mb. of Aksala)

UPPER TRIASSIC, CARNIAN AND OLDER (?)

uTrP: POVOAS: augite or feldspar phyric, locally pillowed andesitic basalt flows, breccia, tuff, sandstone and argillite; local dacitic breccia and tuff with minor limestone; greenschist, chlorite schist, chlorite-augite-feldspar gneiss, amphibolite (Povoas)

PROTEROZOIC AND PALEOZOIC

PPa: AMPHIBOLITE: metamorphosed mafic rocks including amphibolite (1) and ultramafic rocks (2) of unknown association; i.e.) may belong in part or entirely to Nisling, Nasina, and Slide Mountain assemblages and (3), mafic-ultramafic intrusions within Nasina assemblage

LATE DEVONIAN TO MISSISSIPPIAN

DMgPW: PELLY GNEISS SUITE - SOUTHWEST: foliated medium grained, homogeneous biotite granite gneiss to biotite or hornblende granodiorite gneiss; massive to strongly foliated dioritic to granodioritic gneiss; includes interfoliated amphibolite, quartz-mica schist and phyllite (Selwyn Gneiss, Pelly Gneiss, N. Fiftymile Batholith, Moose Creek Orthogneiss)

DEVONIAN, MISSISSIPPIAN AND(?) OLDER

DMN3: NASINA: quartzite, micaceous quartzite, quartz muscovite (chlorite; feldspar augen) schist, and minor metaconglomerate and metagrit as in (1), but may locally include significant Nisling Assemblage

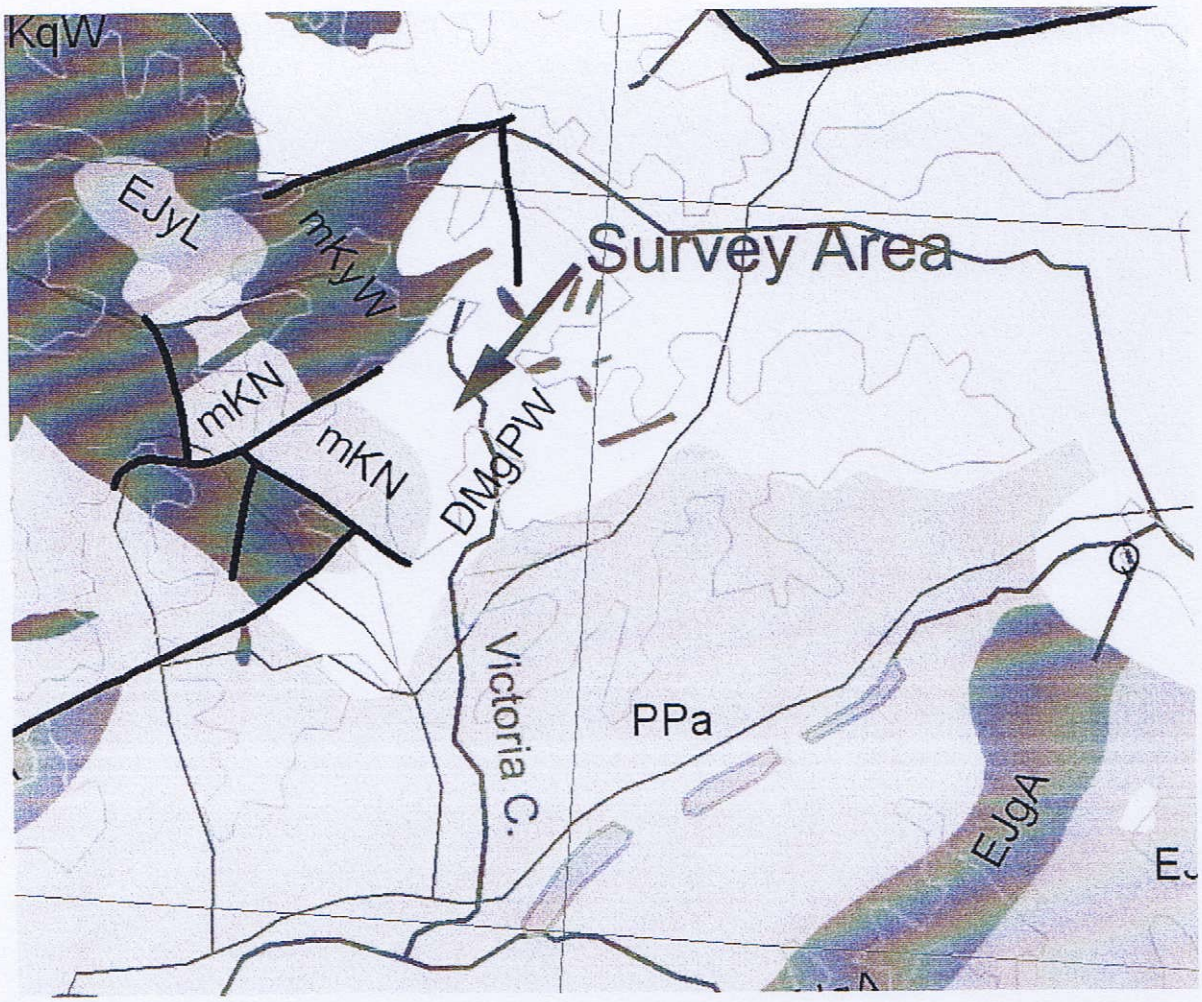
DMN4: NASINA: quartzite, micaceous quartzite, quartz muscovite (chlorite; feldspar augen) schist, and minor metaconglomerate and metagrit as in (1), but may locally include significant Klondike Schist Assemblage

LATE PROTEROZOIC AND PALEOZOIC

PPN1: NISLING: dark grey to brown, biotite-muscovite-quartz-feldspar schist, quartzite and micaceous quartzite, garnetiferous; felsic chlorite-biotite orthogneiss; rare amphibolite; minor(?) two-mica gneiss and hornblende diorite gneiss; may include Nasina Assem. (Nisling assem.)

PPN2: NISLING: bleached white-weathering, white to grey, coarsely crystalline, flow banded, fetid marble; graphite, chert, metabasite and calc-silicate lamina are common (Nisling assem.)

12. Bedrock Geology Map – Survey Area



13. Geology

13.1. Bedrock

In the survey area of **Victoria Creek**, the bedrock basically shows resistivity data between 500-2000 Ohm meters. 95% of the bedrock shows around 200 Ohm meters: This data would basically fit with Pelly Gneiss Suite seen in the Bedrock Geology Map.

The bedrock in the profiles shows patterns with highly varying resistivity, which might be caused by changes of the bedrock type and/or mineral composition, and changing amounts of weathering and water saturation in the rock.[9]

13.2. Physiography / Glaciation / Placer Gold Deposits

The overburden measured in this survey consists of virgin material.

In the survey area the overburden shows heterogeneous resistivity data. The heterogeneity of the data might be caused by different kinds/shapes of the sediments: The local deposits might be dominated by glacial till in addition to glaciofluvial, possibly glaciolacustrine deposits, and modern stream-gravels, and colluvium. Furthermore, the overburden shows different amounts of groundwater and permafrost.

The known creek systems and the glaciation of the valley can result in highly developed placer deposits with potentially high grade. Pre-glacial river gravel, most likely bearing placer gold, was eroded by the glacier. The glacier might have produced large deposits of till. When the ice started thawing, till was transported by melt-water creating glaciofluvial deposits, which could have re-concentrated the pre-glacial placer gold. The glacial melt-water drainage could have played a significant role even this far in the head-waters of Victoria Creek: First, melt-water from up the slope could have run down the streambed. Second, melt-water which was hindered to flow down valley by ice damming could have run perpendicular to Victoria valley. These scenarios could have produced bedrock channels bearing valuable placer gold deposits in Victoria Creek. Alternatively, those auriferous glaciofluvial deposits could sit in till instead of bedrock. The bedrock sources are estimated to be richer.

The general case is that glacial till will incorporate placer gold into it and dilute placers into a larger volume lower grade deposit which may be un-economic. So placer gold in till is actually fairly rare in most settings, and usually only occurs when the glacial activity is right on top of a bedrock gold source. But this actually may be the case in Victoria Creek. Due to their depth and limited horizontal extend, the possible channels, found in the Victoria Creek Valley, act as geological traps, which catch and hold heavy minerals.

---

[9] Weathering significantly changes the conductivity of rocks. Bedrock gets fractured by frost wedging, faults, and other mechanical influences in the subsurface. The fractures produce cavities which get filled with water. This increases the conductivity and decreases the resistivity. Fractured bedrock starts chemical weathering which increases the pore volume of the rock that is filled with (stationary) water collecting high amounts of solved minerals. The resistivity is reduced even more. Larger fractures in the rock can become penetrated by water saturated sediments. – All these factors could have significantly decreased the resistivity of the local bedrock. All these influences might have controlled the varying resistivity in the bedrock measured in the profiles.

With a lower probability silt- and/or clay-rich layers of glaciolacustrine origin could appear in the survey area at Victoria Creek. Those glaciolacustrine deposits could have been created in melt-water basins caused by ice damming in Victoria Creek. Clay layers protect the deposits underneath from glacial erosion. So, the material in and below clay-rich layers ("false bedrock") could have preserved older placers.

Each new sediment discovered when doing physical prospecting would be worth sampling.

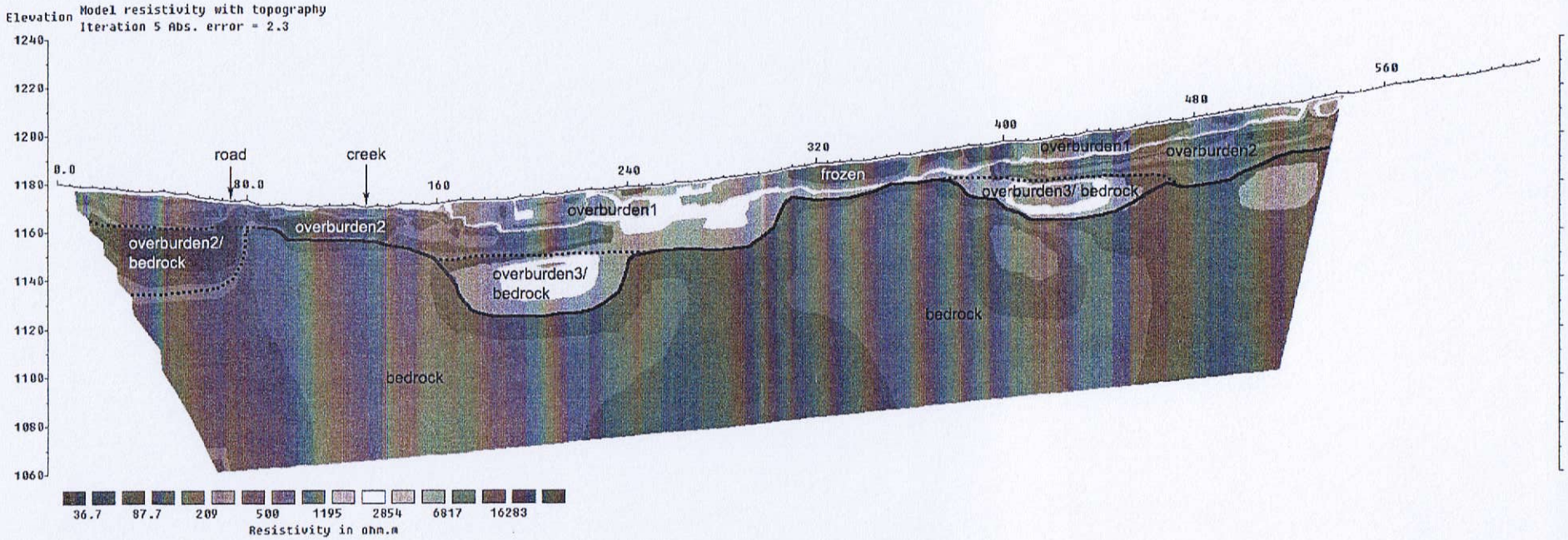
14. Profile – Interpretation

Victoria Creek Line 01
2D Resistivity/IP, Schlumberger array
126 Electrodes: spacing 5m, Horizontal resolution 2.5m
Horizontal and vertical measure in [meter], Iteration error in [%]
Vertical exaggeration in model section display = 1.00
Data acquisition: Stefan Ostermaier, Franz Piechotta 27th June 2012
Processing: Stefan Ostermaier, 27th June 2012
Arctic Geophysics Inc., Yukon

Arctic Geophysics Inc.

Geophysical Surveys • Prospecting • Consulting

www.arctic-geophysics.com
Box 747, Dawson City Y.T., Y0B-1G0, Canada
Phone: 867-993-3671 (Cell), info@arctic-geophysics.com



overburden1: continiously frozen overburden(permafrost)
overburden2: thawed water saturated gravel or clay(groundwater table)
overburden3: mostly thawed gravel
bedrock: most likely intermidiate and mafic magmatites

——— bedrock interface
..... alternate bedrock interface

Interpretation
This resistivity profile might show 8.5-45m of overburden on top of bedrock. The overburden shows up to three layers representing different resistivity data.

At 0-80m a paleochannel, roughly 37m deep at 50m on the measuring line, could be located. The overburden on top of this channel is double-layered referring to the resistivity of the ground materials. The upper overburden layer (bright green) is most likely dominated by glacial till, possibly associated with lower amounts of glaciofluvial gravels - both moderately saturated with groundwater. The overburden layer below (overburden2, blue) is considered to be thawed, water-saturated, glacial till, likely part of the ground-water table, or a glaciolacustrine clay-rich deposit.
Alternatively there is no channel at all; in this case the bedrock interface could be found at about 12m depth. And the blue layer below would likely be fractured, weathered bedrock filled with stationary water, rich in solved minerals.

At 80-160m the overburden is single-layered on top of a bedrock bench; the sediment (overburden2) is considered to again be water-saturated glacial till, possibly associated with glaciofluvial sediment zones, or glaciolacustrine clay.

At 160-240m the overburden is triple-layered, covering a bowl-shaped paleochannel, approx. 48m, deep at 200m. The topmost overburden layer (overburden1) is likely a continuously frozen glacial till or glaciofluvial gravel (permafrost). The layer underneath (green/blue, overburden2) most likely consists of the same materials as interpreted above, but seems to contain less water than on the left hand side. The bottom layer (green/yellow, overburden3) might be a partly frozen glacial till, probably deposited while an older glacial cycle, or (less likely) could represent a pre-glacial frozen fluvial gravel which has been preserved from glacial erosion.

At 240-310m there is a double-layered overburden. Just like before, overburden1 represents the topmost layer. The layer underneath would be a less clay-rich or frozen variation of overburden2.

At 310-375m the overburden is single-layered, it is interpreted as overburden1, same material as described above.

At 375-470m the overburden is triple-layered. The topmost layers are overburden1 and 2 as described above. The deepest layer is again overburden3 (brown, yellow) which filled up a possible channel at 425m. This channel would be 32m deep.

At 470-545m the overburden is double-layered, consisting of overburden 1. The layer underneath (blue/green, overburden2) is interpreted as the same clay-rich variation as described above.

The bedrock data are mostly homogeneous, slight changes in limited areas are likely an effect of decomposition, or mineral changes in the hypothetic Pelly Gneiss.

Conclusion
The Victoria Creek valley has been scoured likely by different glacial periods. Pre-glacial river gravel was eroded and re-deposited. Only overburden layer3 could be remaining in the possible channels which could have protected those sediments from glacial abrasion.
Overburden1 and overburden2 seem to be syn[10]- or post- glacially deposited sediment layers.
Another interpretation, thought to be likely, could be a solely glacial deposition scenario in this section of Victoria Creek valley: The deposits could have been completely reworked including the material in the possible channels. This means overburden3 is estimated to be glacial till with possible glaciofluvial gravel instead of original river gravel.

[10] syn-glacial sedimentation - deposition *during* the glaciation

The potential channels that can be found at 200m and 425m seem to be at least as old as the lowermost (oldest) sediment layer, since it looks like they are filled with this material.

The possible channel at 40m seems to be younger than the first two channels, but older than overburden2.

An alternative interpretation of the channel at 425m is that it belongs to Ladybug Creek, which intersects with Victoria Creek. This interpretation is estimated to be less likely.

15. Recommendation

Geophysical results should be confirmed by drilling, shafting or digging.

Possible points of interest for advanced placer prospecting are shallower parts of the profile, for example at 360m (estimated depth 9.4m) to confirm the results of the 2D Resistivity measurements.

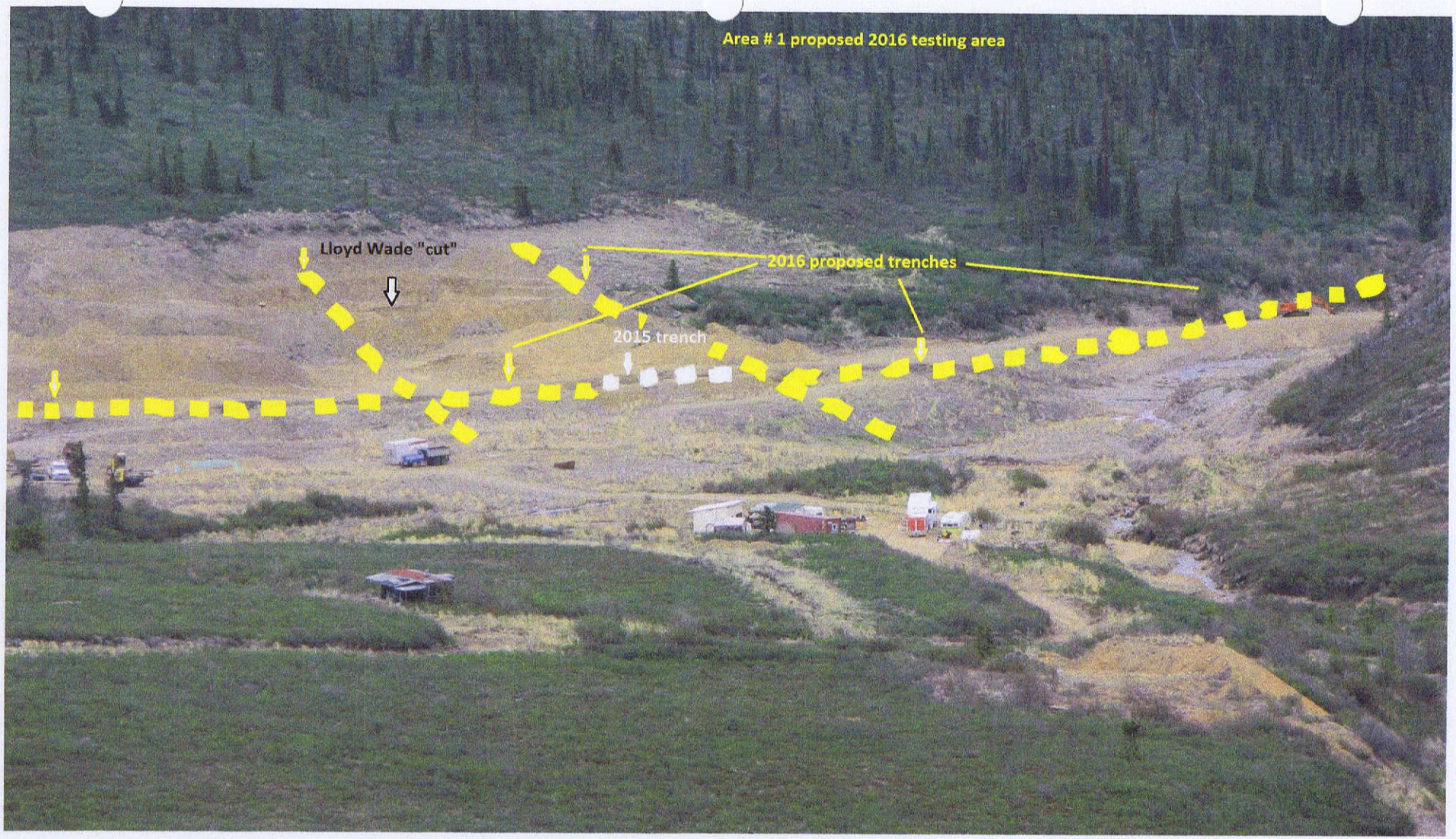
Another point of interest is the possible channel at 40m, with an estimated depth of 37m.

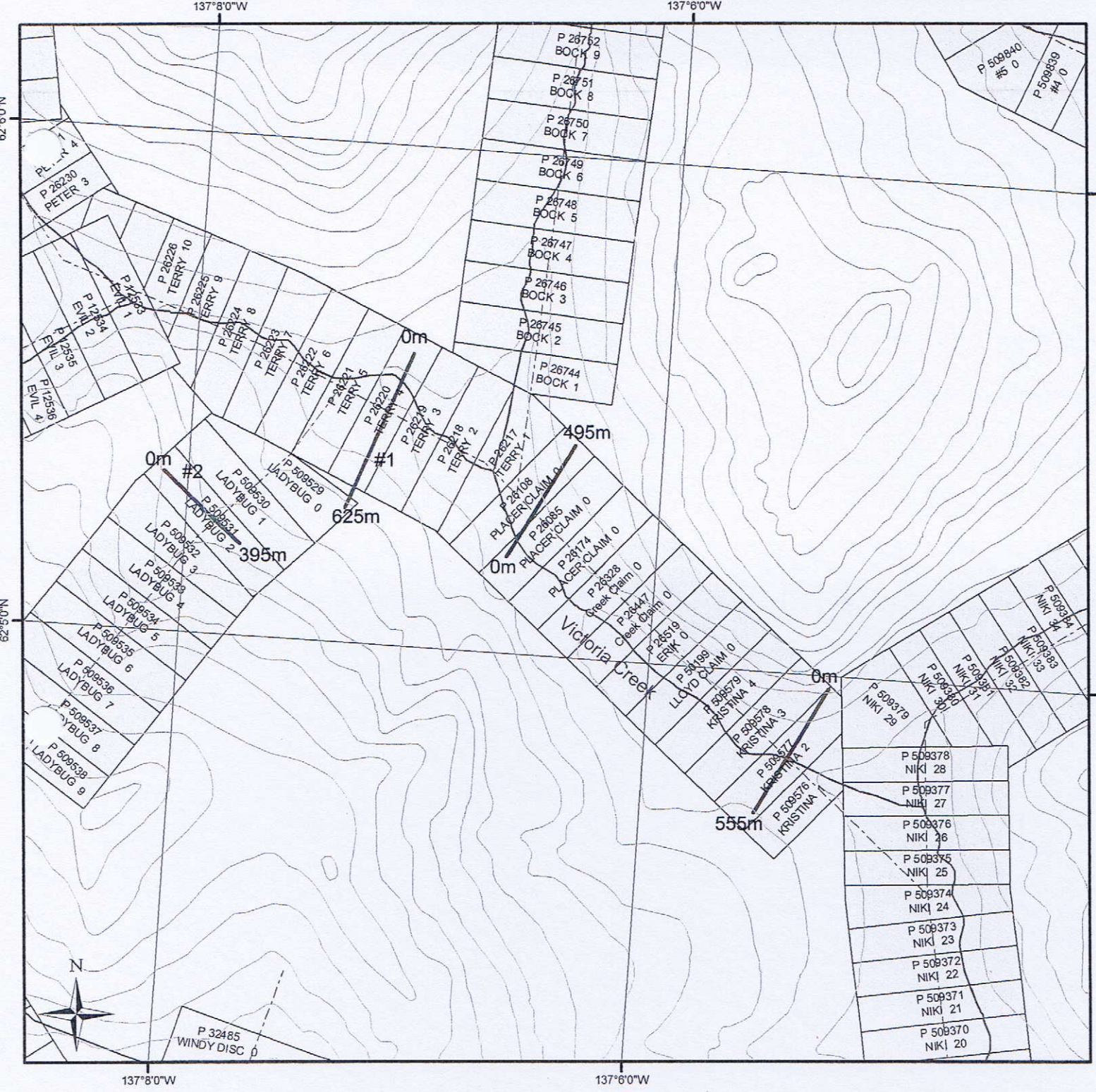
The channels that are likely to be found at 200m, with a depth of 48m, and at 425m, with a depth of 32m, might be interesting drill targets as well.

Drilling these targets is recommended to confirm their depth and verify gold deposits, which are assumed to be found in these channels.

Another point of interest might be at about 160m on the measuring line to get an impression of overburden2's composition and the border between overburden2 and overburden3, which should be found in an approximated depth of 5m.


Wade "cut" on the upper left bank, above the conflux of Victoria Creek and Eva Creek.
Area # 1 target exploration area
Bedrock outcrops
2015 trench location
Eva Creek
Victoria Creek Mining Camp
Upper Victoria Creek


Area # 1 proposed 2016 testing area
Lloyd Wade "cut"
2016 proposed trenches
2015 trench



Legend

- contour line
- watercourse
- placer baseline
- measuring line 2011
- measuring line 2012
- measuring line 2014

placer claims

- Active
- Expired

Survey Map

115I03 (Mount Nansen)

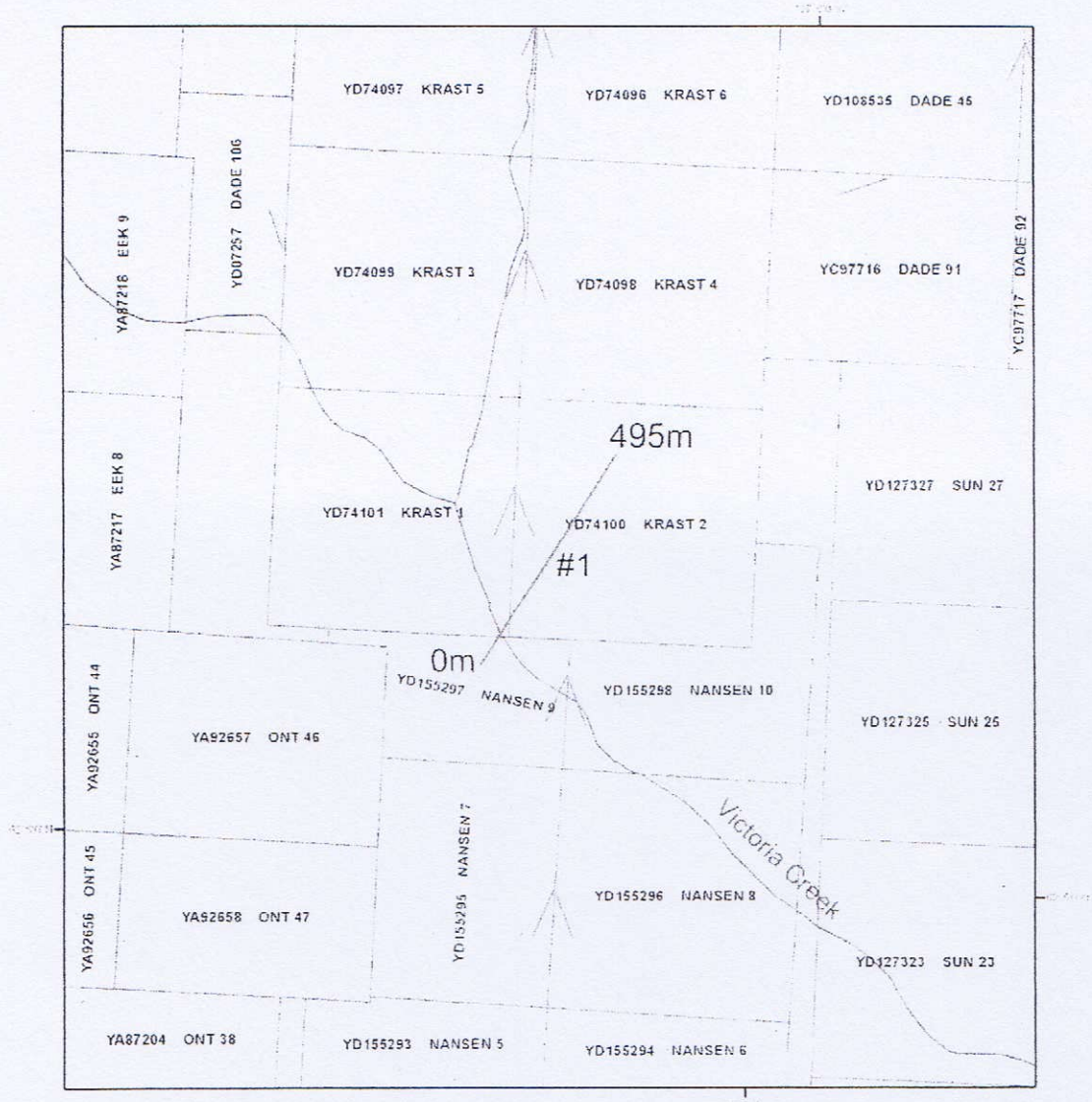
Universal Transverse Mercator Zone8
North America Datum 1983

Scale 1:20.000

0 162,5 325 650 975 1.300 Meters

Pg6

9. Survey Map



Legend

- measuring line
- contour line
- road
- water course
- Claims

Survey Map

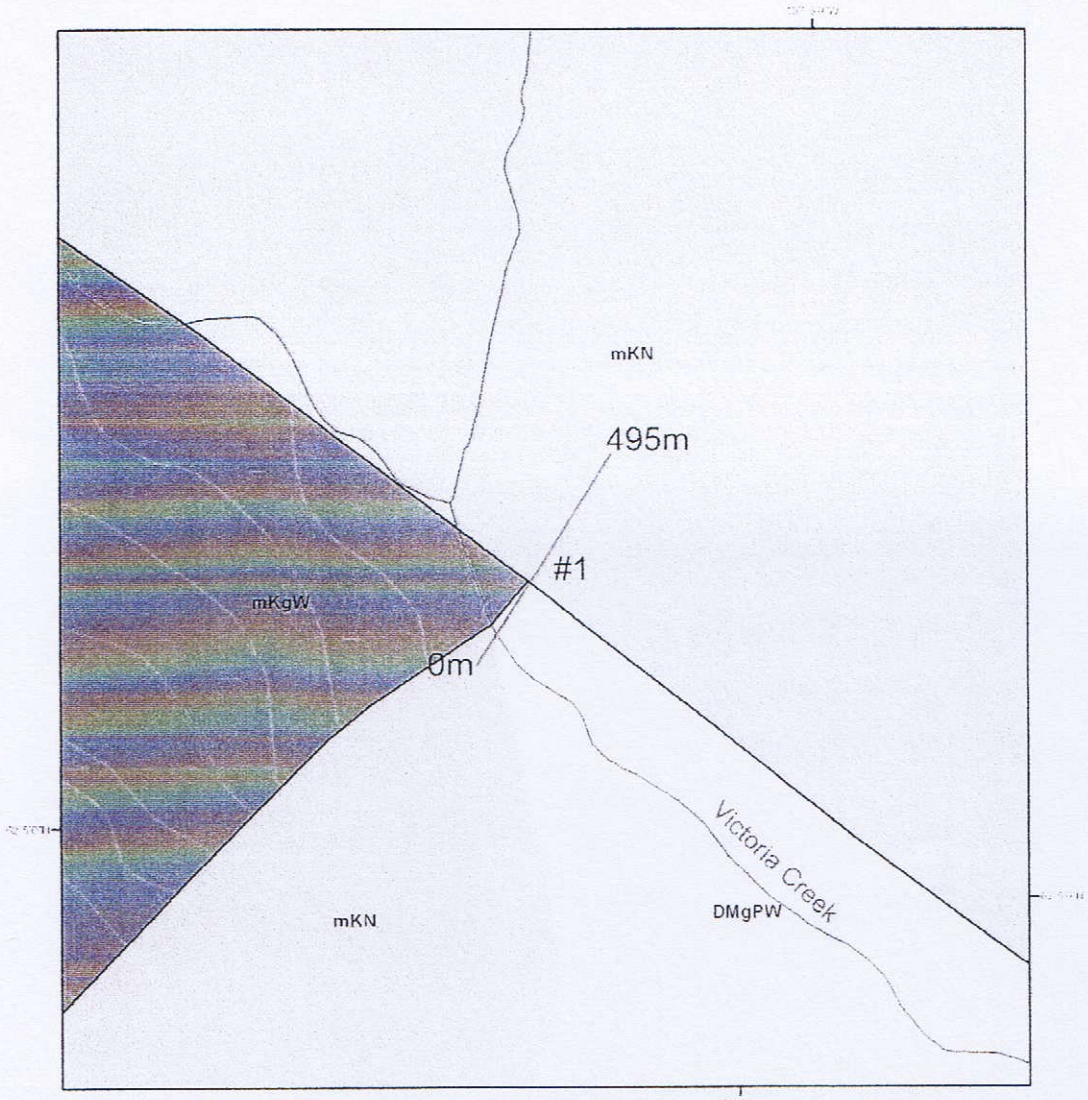
115I03 (Victoria Creek)

Universal Transverse Mercator Zone 8
Northern American Datum 1983

Scale 1:10 000

250 125 0 250 Meters

10. Bedrock Geology Map



Legend

- measuring line
- contour line
- water course
- mKN
- mKgW
- DMgPW
- Fault

Geology Map

115I03 (Victoria Creek)

Universal Transverse Mercator Zone 8
Northern American Datum 1983

Scale 1:10 000

250 125 0 250 Meters

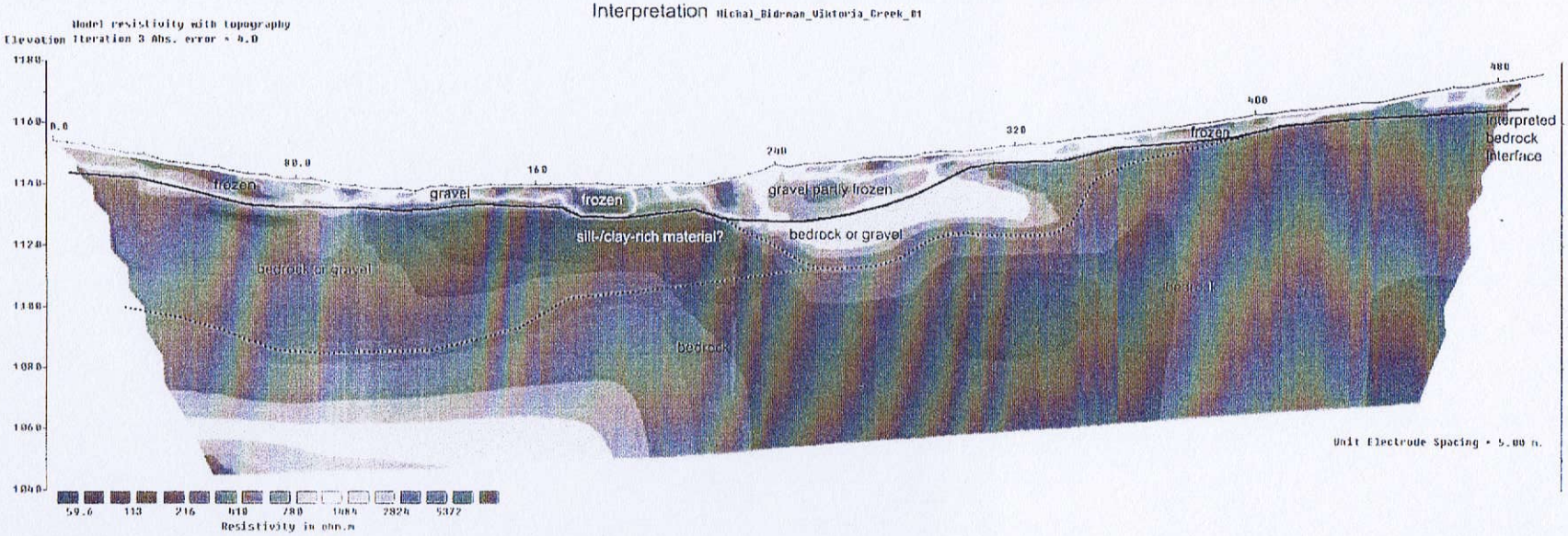
mKN: MOUNT NANSEN: massive aphyric or feldspar-phyric andesite to dacite flows, breccia and tuff; massive, heterolithic, quartz- and feldspar-phyric, felsic lapilli tuff; flow-banded quartz-phyric rhyolite and quartz-feldspar porphyry plugs, dykes, sills and breccia (Mount Nansen Gp., Byng Creek Volcanics, Hutshi Gp.)

DMgPW: PELLY GNEISS SUITE - SOUTHWEST: foliated medium grained, homogeneous biotite granite gneiss to biotite or hornblende granodiorite gneiss; massive to strongly foliated dioritic to granodioritic gneiss; includes interfoliated amphibolite, quartz-mica schist and phyllite (Selwyn Gneiss, Pelly Gneiss, N. Fiftymile Batholith, Moose Creek Orthogneiss)

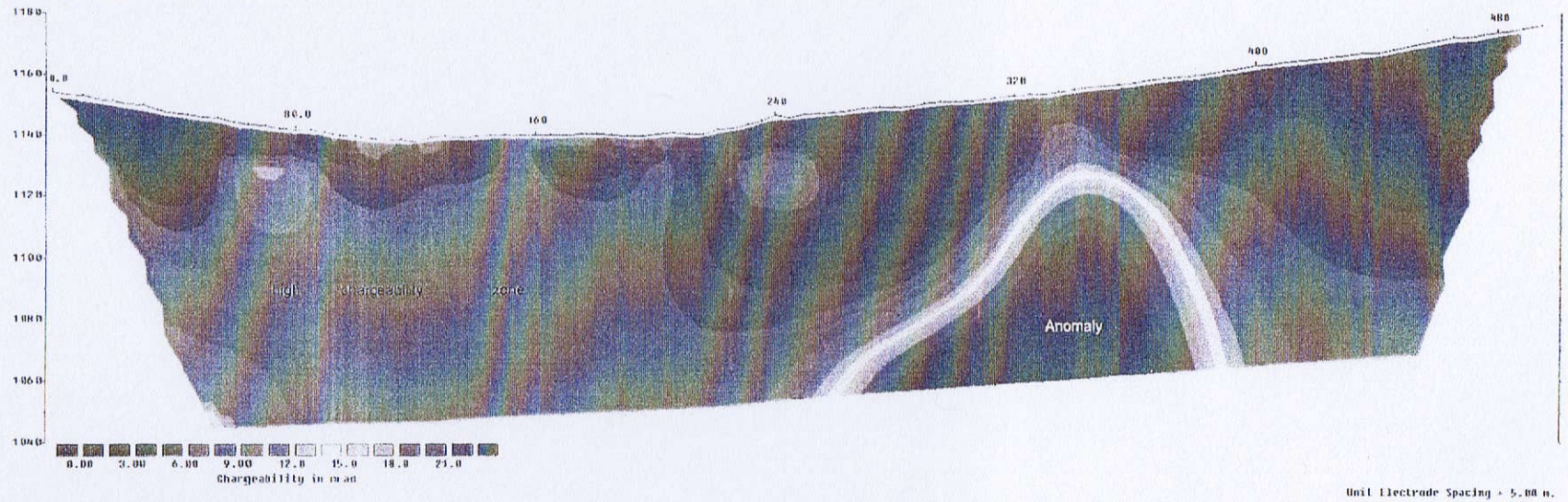
mKgW: WHITEHORSE SUITE: biotite-hornblende granodiorite, hornblende quartz diorite and hornblende diorite; leucocratic, biotite hornblende granodiorite locally with sparse grey and pink potassium feldspar phenocrysts (Whitehorse Suite, Casino granodiorite, McClintock granodiodrite, Nisling Range granodiorite)

11. Profile – Interpretation

Interpretation Michal_Bidrman_Viktoria_Creek_01



Horizontal scale is 10.58 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 m.
Last electrode is located at 495.0 m.



Horizontal scale is 10.58 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 m.
Last electrode is located at 495.0 m.

Interpretation

The profile shows 3-21m of **overburden** on top of bedrock. At around 100m in the profile a paleo-channel in the bedrock with a depth of 21m seems to be located. The overburden might be dominated by post-glacial deposits being rich in clay and ground water (low resistivity zones, blue).

The **bedrock** shows heterogeneous resistivity and chargeability which would be a sign for changing type and shape of the rocks. Around 340m a very high chargeability zone (anomaly) was detected.

From 0-200m the bedrock shows high chargeability and high resistivity. Both Pelly Gneiss and Whitehorse Suite granodiorite (suggested by the bedrock map) would explain this data. Since this rock contains IP-active accessory minerals the existence of metamorphic gneiss seems to be more likely. The Resistivity of the bedrock decreases to the depth. This is possibly because of the fractured, weathered shape of the upper portions of the bedrock containing mineral-rich, stationary water. The solid bedrock below has higher data.

Around 200m in the profiles the bedrock data change. This data transition might indicate a fault line being the border of different bedrock types, seen in the bedrock map.

From 200m to the end of the profile the resistivity of the bedrock is low. This might be caused by fractures and weathering of igneous rocks suggested by the bedrock map (grano-/diorite, biotite) in the neighbourhood of the fault.[8] Alternatively it could be a breccia or tuff.

At 340m the IP model shows a massive anomaly in a depth of roughly 50m.[9] This anomaly could indicate an intrusive body whose origin could correlate with the fault line. This possible ore zone would most likely be rich in sulphides all creating strong chargeability effects. The IP anomaly could indicate lots of different ore types. A content of pyrite or native cupper might be plausible since the resistivity is low in this zone.

[8] Solid igneous rocks would have much higher resistivity.

[9] The spatial arrangement of the ground zones is roughly shown by IP models.

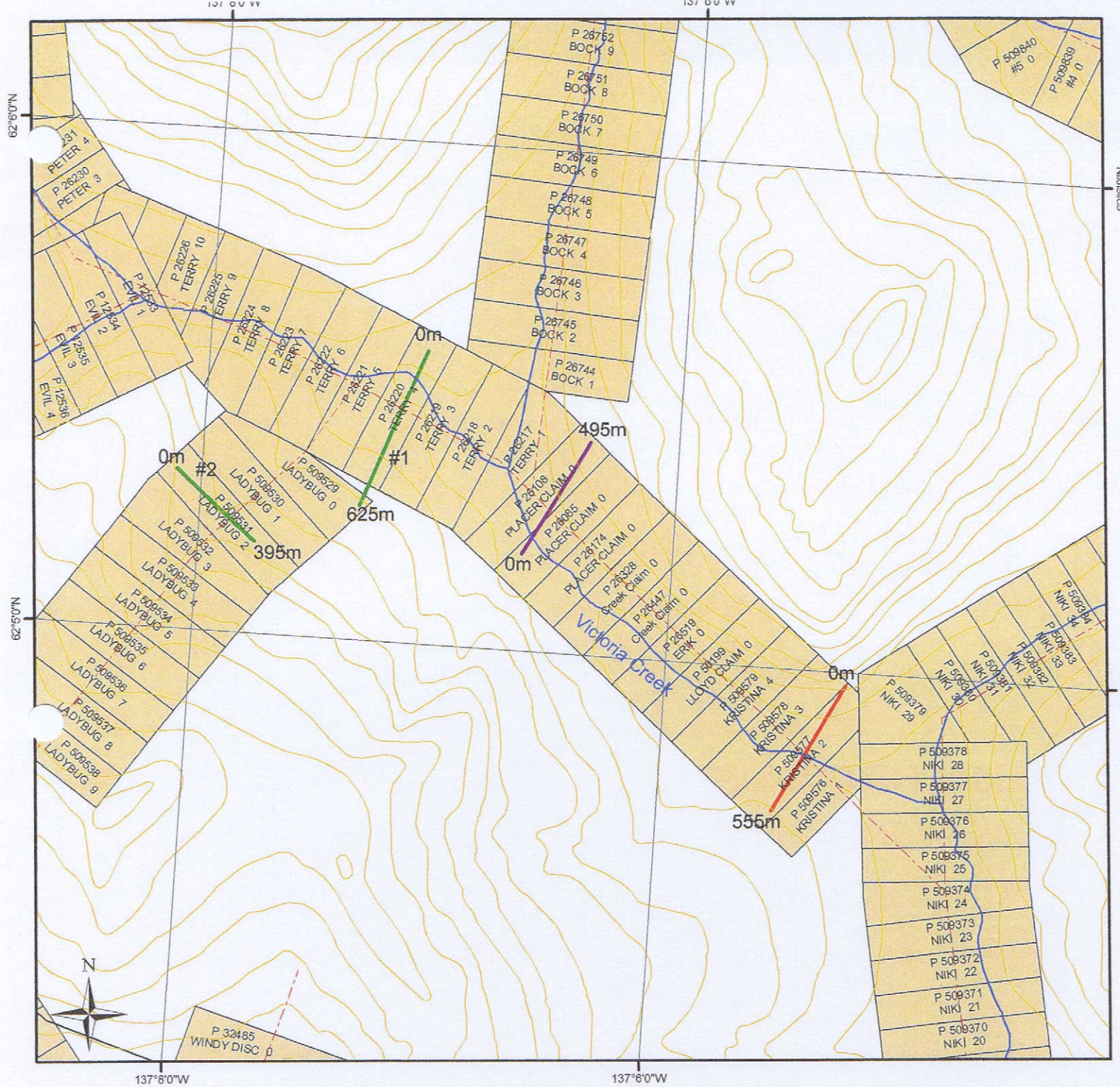
12. Recommendation

It is recommended to investigate the rock zone of the IP anomaly along the hypothetic fault line by running additional Resistivity/IP profiles using a data acquisition mode which optimises the IP reading. Those lines should be done parallel and in close neighbourhood of the existing RES/IP profile: perhaps one line 30m north-westerly from the existing line, and one line 30m south-easterly from the existing line. This way the shape, seize, and location of the possible ore zone can be imaged.

A drill program would be the logical next step to test the rock zone of the anomaly.

The existence of a bedrock change creating the IP anomaly is likely since the Arctic Geophysics team has detected several IP anomalies in other profiles run nearby.

Important note: The geoelectrical technology used in this survey has tendency to show anomalies larger than the dimensions of the inducing rock zone. Consequently a drill should hit right into the middle of such an anomaly and make sure it has sufficient depth.



Legend

- contour line
- watercourse
- placer baseline
- measuring line 2011
- measuring line 2012
- measuring line 2014

placer claims

- Active
- Expired

Survey Map

115I03 (Mount Nansen)

Universal Transverse Mercator Zone8
North America Datum 1983

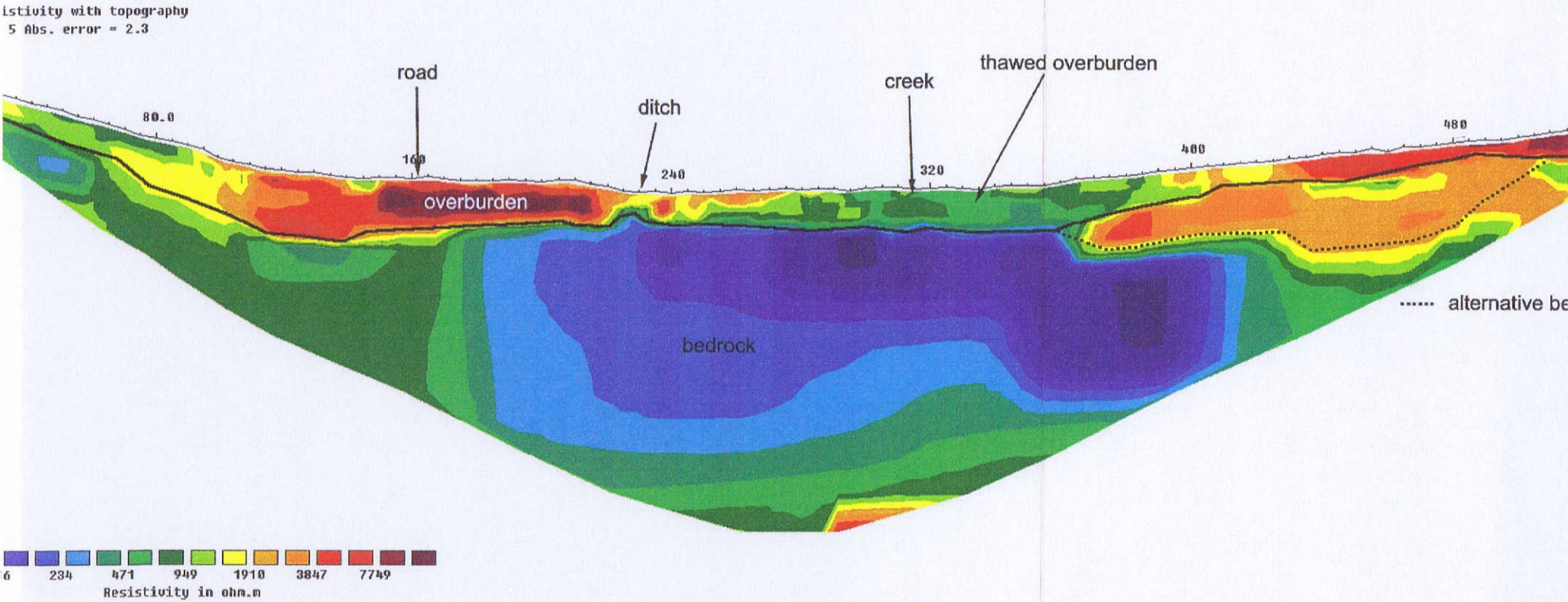
Scale 1:20.000

Meters
0 162,5 325 650 975 1.300

nberger array
ing 5m, Horizontal resolution 2.5m
al measure in [meter], Iteration error in [%]
in model section display: RES 1.0
fan Ostermaier, 12th June 2014
stermaier, 13th June 2014

Arctic Geophysics Inc.
Geophysical Surveys • Pr
www.arctic-geophysics.com
Box 747, Dawson City, Yukon Territory, Y
Phone: 867-993-3671 (Cell), info@arctic-

Interpretation



how the ground-layers up to approximately 15% thicker
ality.

This 2D Resistivity measuring result is an interpretation of geo
We recommend the verification of the profile by drilling or trenc

Early Pleistocene glaciation and implications for placer gold deposits in Back Creek, Mount Nansen area, Yukon

P.O. Englehardt[1], Brent C. Ward
Earth Sciences, Simon Fraser University

Jeffrey D. Bond
Yukon Geological Survey

Mark J. Coleman
Earth Sciences, Simon Fraser University

Englehardt, P.O., Ward, B.C., Bond, J.D. and Coleman, M.J., 2015. Early Pleistocene glaciation and implications for placer gold deposits in Back Creek, Mount Nansen area, Yukon. *In:* Yukon Exploration and Geology 2015, Yukon Geological Survey, p. 111-129.

ABSTRACT

Yukon has over a century of placer mining history, predominately in unglaciated regions. However, as these targets are exploited, focus turns to more complex landscapes where glaciation has buried, eroded and incorporated placer gold. This study examines how Early Pleistocene glaciation in the Mount Nansen area, central Yukon, has affected placer gold deposits. Detailed stratigraphic analysis and sample collection has focused on Back Creek, where placer mining has exposed a 22 m section with several gold bearing units. In the section, sediment from two glacial advances cap sporadically preserved pre-glacial gravel. The section is variably dissected by younger placer gold bearing fluvial gravel with enrichment related to intersection of inter-glacial or pre-glacial placer gold deposits. Analysis at Back Creek reveals the potential for deeply buried placer gold deposits in other glaciated regions of Yukon.

[1]*pengleha@sfu.ca*

INTRODUCTION

Beyond the influence of glaciation in Yukon, several lucrative placer deposits were exploited during the 1897 Gold Rush (LeBarge, 1995). As these prospects are exhausted exploration has shifted to more complex landscapes where glaciation may have obscured, eroded, and incorporated placer gold deposits (LeBarge, 1995). Several phases of Northern Cordilleran Ice Sheet (NCIS) glaciation, in Yukon, have modified the landscape (Duk-Rodkin, 1999; Duk-Rodkin *et al*., 2001; Jackson, 1993; 2000; Ward *et al*., 2007), producing the palimpsest landscape present today. The earliest phases of glaciation were the most extensive in central Yukon (Fig. 1) and likely had the largest effect on placer gold deposits. To understand the effect of early glaciation on placer gold development, the Mount Nansen Placer Mining District (NTS115/I) was investigated during the summer of 2015, to determine the stratigraphy at Back Creek, derive the geologic history, and to relate this to placer gold preservation and formation. Previous work in the Mount Nansen area is discussed and the current understanding of bedrock geology, glacial history, and placer gold development is summarized. This research is a synthesis of academic interest (early Pleistocene glacial behavior) and economic importance (placer gold development) that may be used as an analogue for future studies of placer gold in glaciated terrains.

BEDROCK GEOLOGY

Large gold deposits in Yukon formed during the repeated accretion of several terranes throughout the Mesozoic era (Colpron *et al*., 2007; Knight *et al.,* 2013; Monger *et al.,* 1972; Coney *et al.,* 1980). The Yukon Tanana terrane (YTT) formed as an island-arc back-arc basin with extensive porphyry/epithermal gold deposits, and the study area is underlain by these rocks (Colpron *et al*., 2007; Selby *et al.,* 1999). The Mount Nansen area is underlain by Proterozoic-Cenozoic bedrock, and major units are further described below (Fig. 2; Hart and Langdon, 1998; Saager and Bianconi, 1971; Tempelman-Kluit, 1984). The Proterozoic-Paleozoic metamorphic Yukon Group rocks consist of the following: chlorite schist, biotite schist, feldspathic quartzite, amphibolite, quartz-biotite gneiss and biotite-hornblende gneiss (Hart and Langdon, 1998; Mortensen *et al*., 2002; Saager and Bianconi, 1971). The metamorphic rocks host several intrusions including: the early Jurassic Long Lake Suite (hornblende-biotite granodiorite-monzogranite), mid-Cretaceous Dawson Range batholith (hornblende-biotite-quartz diorite, and granodiorite), late Cretaceous Prospector Mountain suite (quartz monzonite) and the Casino Plutonic suite (leucocratic granite, quartz monzonite and alaskite; Hart and Langdon, 1998; Johnston, 1996; Mortensen *et al*., 2002; Saager and Bianconi, 1971; Selby *et al.,* 1999; Wengzynowski *et al.,* 2015). Extensive volcanic deposits formed contemporaneously with the plutonic complexes and include the Mount Nansen Volcanic Group which comprises andesite, dacite, minor rhyolite and minor Cenozoic intrusions of quartz feldspar porphyries (Saager and Bianconi, 1971; Hart and Langdon, 1998; Mortensen *et al*., 2002). Mineralization in the Mount Nansen area is hosted within Paleozoic metamorphic rocks and Mesozoic intrusive rocks (Hart and Langdon, 1998; Mortensen *et al*., 2002). Late phase hypabyssal parts of the Mount Nansen volcanic rocks (quartz feldspars porphyries, dikes and minor pyroclastic flows) are related to significant mineralization (Hart and Langdon, 1998).

Several gold bearing porphyry-epithermal complexes are concentrated within a 3 by 12 km, northwest oriented, steeply dipping corridor called the Nansen trend (Hart and Langdon, 1998). These porphyry-epithermal complexes are the likely source for the placer gold deposits in the Mount Nansen area (Hart and Langdon, 1998; Jackson, 1993; LeBarge, 1995).

GLACIAL HISTORY

The NCIS first developed in Yukon during the late Pliocene (~2.6 Ma), and several advances produced the palimpsest surficial sedimentary record present today (Fig. 1; Barendregt *et al*., 2010; Duk-Rodkin *et al*., 2001; 2004 Hidy *et al.,* 2013). The development of the NCIS glaciation is related to complex atmospheric-oceanic interactions, Milankovitch Cycles, atmospheric composition and precipitation (Burn, 1994; Guthrie, 2001; Harris, 2005; Haug *et al*., 2005; Ward *et al*., 2008). Dawson (1889) first recognized evidence for glaciation in Yukon in 1887; however, multiple glacial advances were not recognized until Bostock (1936) worked in the Mount Nansen Area. Based on this early work there are three morphostratigraphic glacial surfaces widely recognized in Yukon: the pre-Reid, Reid/Gladstone, and McConnell (Fig. 1); each represents a discrete surface associated with a maximum extent, some of which represent two (Reid/Gladstone) or multiple (pre-Reid) NCIS advances (Bostock, 1966; Demuro *et al*., 2012; Duk-Rodkin *et al*., 1999; Hughes *et al.,* 1969; Jackson *et al.,* 1999; Jackson and Clague, 1991; Westgate *et al*., 2000; and Ward *et al*., 2007).

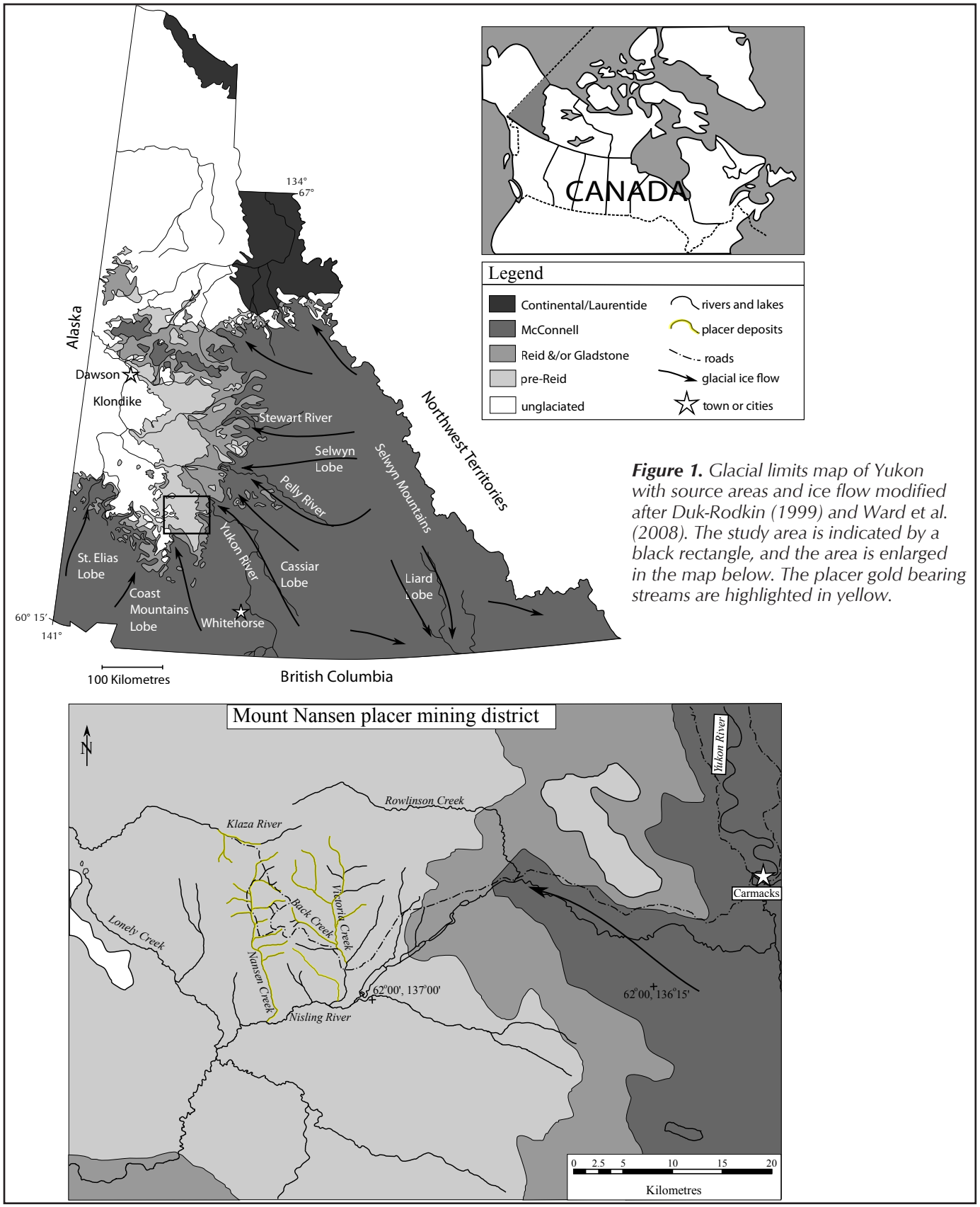


Figure 1. *Glacial limits map of Yukon with source areas and ice flow modified after Duk-Rodkin (1999) and Ward et al. (2008). The study area is indicated by a black rectangle, and the area is enlarged in the map below. The placer gold bearing streams are highlighted in yellow.*

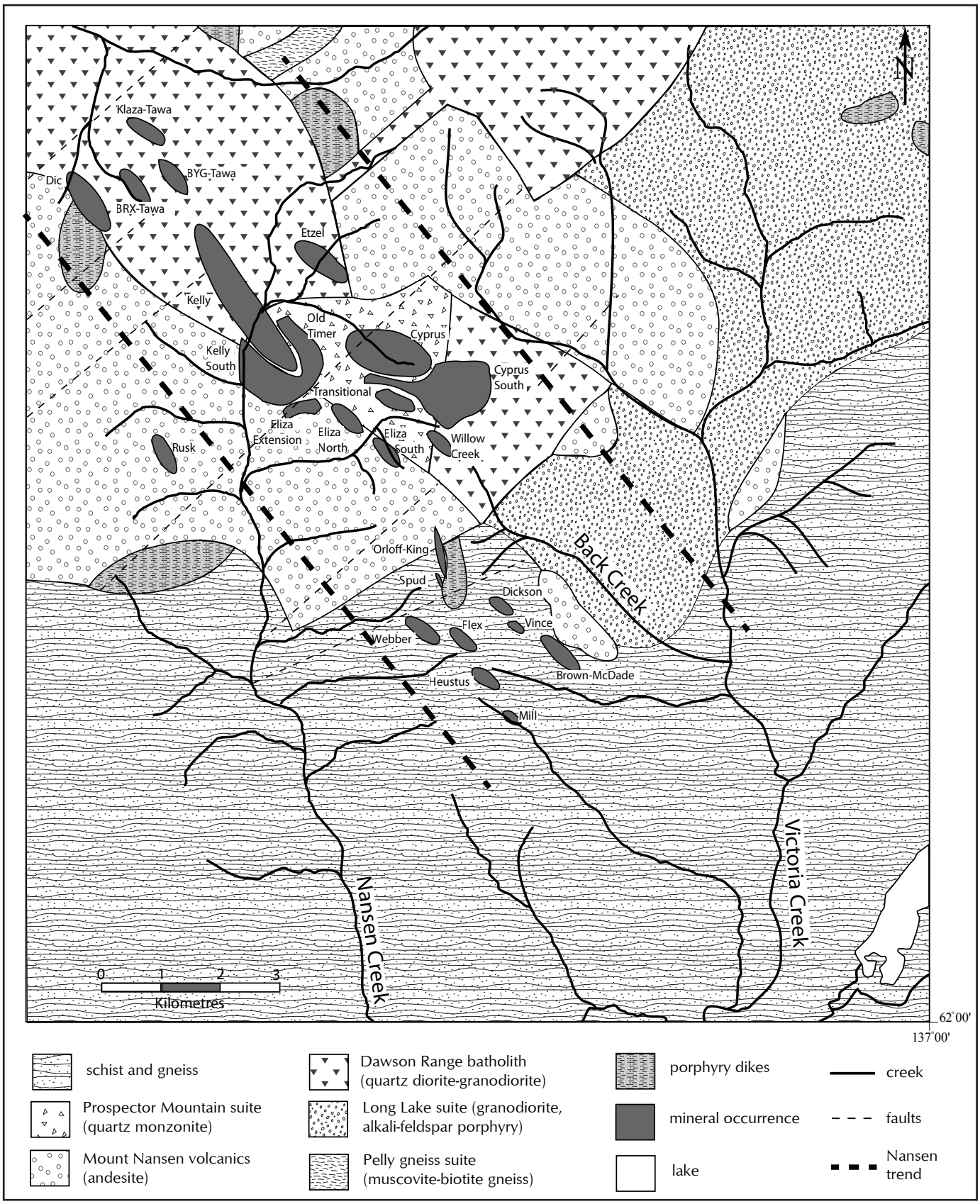


Figure 2. *Bedrock geology map of the Mount Nansen area modified after Hart and Langdon 1998.*

Glaciation in the Mount Nansen area has long been known (Cairnes, 1915), and placer mining occasionally provided insight that older glaciation had affected the area (Bostock 1966). Bostock (1966) assigned the two earliest phases of Yukon glaciation to be the Nansen (older) and the Klaza (younger) based on field observations in the 1930s. Subsequent work by Hughes *et al.* (1969), grouped the Nansen and the Klaza glacial events into the pre-Reid morphostratigraphic surface due to the challenge of separating the two advances in other areas. While several glacial periods are mapped in the Mount Nansen region only two pre-Reid glaciation events (the Nansen and Klaza) are known to have affected Back Creek (Fig. 1; Bostock, 1966; Jackson, 1993; 2000; LeBarge, 1995). The Nansen and Klaza glaciation likely advanced into the Mount Nansen area from the east and south and were part of the Cassiar and Coast Mountain ice lobes (Fig. 1; Bostock, 1966; Duk-Rodkin; 1999; Guerts and Dewes, 1993). The Nansen glaciation was extensive (affecting elevations below 1400 m), and landform evidence is restricted to meltwater channels and patchy till (Jackson, 2000; LeBarge, 1995). The antiquity of the Nansen till is reflected by the deeply weathered schist and granitic clasts contained in the till (Bostock, 1966). The timing of the Nansen glaciation is poorly constrained; however, it may be correlated to the most extensive NCIS *ca.* 2.64 Ma (Hidy *et al.*, 2013). The younger Klaza glaciation is thought to begin with local cirque glaciers developing in the Dawson Range and expanding into the valleys (Jackson, 1993; LeBarge, 1995). Further evidence of the Klaza glaciation was observed west of the study area in Lonely Creek where Bostock (1966) noted landscape modifications associated with glaciation. The Klaza glaciation may correlate to an advance in the Fort Selkirk region where basalt overlying till has been dated to greater than 1 Ma (Jackson, 2000; Jackson *et al.,* 1991; Naeser *et al.,* 1982). During subsequent mid-late Pleistocene glaciation (Reid, Gladstone and McConnell) the area was unglaciated and subjected to intense periglacial conditions (Fig. 1; Jackson, 2000; LeBarge, 1995). During the Reid and Gladstone glaciation events the Coast Mountains ice lobe dammed the Nisling River causing a glacial lake to develop. This increased the base level of the Nisling River and its tributaries Victoria and Nansen creeks (Guerts and Dewes, 1993; LeBarge, 1995). Gravel terraces associated with this episode of sedimentation are common in these tributaries to the Nisling River and are a good example of the indirect effect of more recent glaciation. This research focuses on the earliest phases of glaciation (pre-Reid) that directly affected the landscape and the associated placer gold deposits in Back Creek.

PLACER GOLD DEVELOPMENT

Placer gold deposits require mineralized bedrock and a mechanical concentration mechanism, typically colluvial and fluvial; however, it can also be glacial, eolian, or lacustrine (Els and Eriksson, 2005). In Yukon, the warmer temperatures (>4°C of current Mean Annual Temperature, MAT) and increased precipitation (>550 mm of current Mean Annual Precipitation, MAP) of the Paleogene to Neogene (66 to 2.6 Ma) produced deeply weathered bedrock mantles (>75 m) that facilitated the development of placer deposits and where lode gold became available for concentration (Ager *et al.*, 1994; Anderson and Stroshein, 1997; Dampier *et al.*, 2011; Foscolos *et al.,* 1977; Jackson, 2000; LeBarge, 1995). Beyond the reach of glaciation, placer gold deposits remained relatively undisturbed and continued accumulating throughout the Quaternary; however, in glaciated areas placer gold deposits were significantly affected by erosional and/or depositional processes (Goldfarb *et al.,* 2015; Herail *et al.,* 1989; Jackson 1993; LeBarge 1995; Levson and Blyth, 2001; Lowey, 2006).

More than 27,000 crude ounces of placer gold have been mined from several creeks in the Mount Nansen area and from various sediment types (LeBarge, 1995). A likely cause of this placer gold concentration is the abundance of mineralized bedrock in the region (Hart and Langdon, 1998; Jackson, 1993) and stable Cenozoic tectonic history that allowed residual deposits to accumulate. There are several known porphyry/epithermal deposits that may be the source of placer gold in Back Creek (Fig. 2; Hart and Langdon, 1998). Most placer mining in the Mount Nansen area extracts gold concentrated on the pervasive 'false bedrock' (till) developed on early Pleistocene pre-Reid glacial deposits (Bostock, 1966; LeBarge, 1995). These placer deposits have formed from weathering of bedrock slopes subsequent to the last regional glaciation to affect the area, and therefore, are considered relatively young. Exploitation of pre-glacial placer deposits situated on bedrock is limited due to the depth of glacial sediment cover. Recently, placer mining has exposed deeply buried deposits, which provides an important opportunity to

document stratigraphic and sedimentological information regarding multiple zones of placer gold development. This study investigates one of these deeper excavations that exposes valley bottom bedrock, pre-glacial sediment, and overlying Quaternary deposits. Information presented here may provide an analogue for future placer gold exploration in neighboring drainages, such as Nansen and Victoria creeks, and in other in glaciated areas.

METHODS

During the 2015 field season several locations in the Mount Nansen Area were visited; however, this study focuses on the stratigraphy of Back Creek due to its exceptional exposure of potential pre-glacial gravel and pre-Reid glacial sediment (Figs. 3 and 4). To understand the stratigraphy at Back Creek, sediment descriptions, clast orientation measurements, and paleomagnetic samples were collected. Several units (2, 3, 4, 6 and 11) were also sampled for placer gold to characterize gold provenance.

Sedimentary analysis was completed in the field where estimates of clast character (size, shape, orientation and surface features), and matrix character (size, abundance, compaction and structures) aided in assigning separate units (Table 1 and Fig. 5). Samples from several of these units were collected for further analysis. The presence of unique features including: 'decomposed clasts', cryoturbation, iron/manganese staining and organics were noted. The term 'decomposed clasts' refers to clasts that are pervasively weathered and may be easily broken by hand; Bostock (1966) used similar terminology (rotten clasts) when describing clasts from the Mount Nansen area.

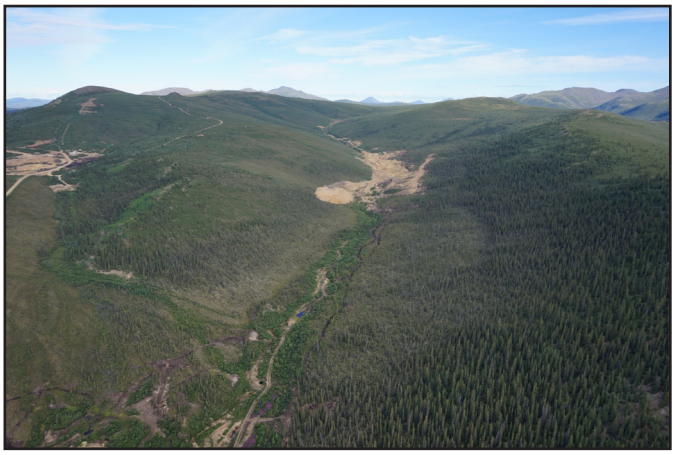


Figure 3. *A view of Back Creek looking northwest; current placer mining is in the centre of the valley.*



Figure 4. *A view of the deep (>22 m) placer mining exposure at Back Creek. The lowest unit visible is the deeply weathered bedrock (Unit 1). In the center of the section are two till units (Units 3 and 5) separated by interglacial sediments (Unit 4). Above this is cover sediment that includes various amounts of colluviated material (Unit 9), organics (Unit 8), tephra (Unit 9), and anthropogenic sediment (Unit 12).*

Table 1. *Unit interpretations and descriptions with respective landscape evolution phases.*

Unit	Interpretation	Description	Landscape Evolution Phase
12	Anthropogenic Sediment	All of the material that has been disturbed by mining. Characteristics, contacts and lateral extent all vary based on style of formation.	Cover Development (G)
11	Modern Gravel	Moderately stratified, poorly-consolidated, clast-supported gravel with ~70% clasts and a silty sand matrix. Clasts are subrounded to rounded and clast lithology is variable but local. Lower contact is sharp and erosive, and the unit forms the base of the modern creek.	
10	White River Tephra	Pale grey-white, finely laminated, fine-medium sand sized glass shards.	
9	Colluvium	Brown, poorly stratified to massive, organic-rich, matrix-supported, diamicton with ~30% clasts, variable lithologies. Lower contact is sharp and erosive, and the unit is laterally extensive.	
8	Colluviated Organics	Organic-rich, matrix-supported, poorly-consolidated, colluviated organics, with clay to fine sand, and abundant macrofossils. Lower contact is sharp and erosive, and this unit is laterally extensive.	
7	Fluvial Sand	Tan, sub-horizontally bedded silty-sand, with minor organics. Lower contact is erosive and unit is not laterally extensive.	
6	Fluvial Gravel (pay)	Variably Fe/Mn stained, stratified, poorly-consolidated, clast-supported gravel with ~80% boulder, cobble pebble clasts. Clasts are subrounded, imbricated with variable lithologies. Lower contact is erosive and unit is laterally extensive.	Pay Gravel Development (F)
5	Klaza Till	Dark grey, massive, over-consolidated, matrix-supported, diamicton with ~20% clasts, and a clayey silt matrix. Clasts were commonly decomposed, striated and or exotic.	Klaza Glaciation (E)
4	Paleosol/ inter-glacial gravel	Sediment present includes: i) an over-consolidated, matrix-supported diamicton with a clayey silt matrix ii) yellowish red disorganized pebbly gravel with Fe/Mn staining; iii) an organic bearing normal and reversely magnetized silt/clay (Fig. 8b,c).	Inter-Glaciation (D)
3	Nansen Till	Yellowish brown, massive, over-consolidated, matrix-supported, diamicton with ~20% clasts and a clay silt matrix (Fig. 7). Clasts are commonly decomposed, striated and/or exotic. Clast fabrics indicate a shift in ice flow direction from parallel to valley to orthogonal to valley which separates the two Nansen glacial phases (Landscape Evolution Phase B and C). Lower contact is sharp erosive and unit is laterally extensive.	Maximum Nansen Glaciation (C) Early Nansen Glaciation (B)
2	Pre-Glacial Gravel	Yellowish brown, weakly stratified, matrix/clast supported, poorly-consolidated gravel, with a ~50% clasts and a variably iron stained silty sand matrix (Fig. 6). The clasts are commonly decomposed and have variable but local lithologies. Within this unit a fine-grained magnetically reversed silty clay is also present (Fig. 8a). Lower contact is gradational and lateral extent is unknown.	Cenozoic Weathering (A)
1	Long Lake Suite	Buff coloured, variably weathered (highly fractured - completely decomposed), granitoid with some sulphide mineralization.	

Clast orientations were measured to reconstruct paleo-flow directions (Fig. 5). In diamictons only clasts with a greater than 2:1 length (A): width (B) were measured and utilized for trend analysis. Trend and plunge measurements were plotted using a Stereonet Program (version 9.3.3 by Dr. Allmendinger; website www.geo.cornell.edu/geology/faculty/RWA/programs.html). This technique is used to determine the direction of ice flow and the style of deposition (*cf*., Hicock *et al*., 1996). The A:B plane orientation was also measured in stratified gravel, to determine the approximate flow direction during deposition.

Paleomagnetic dating is very useful for late Pliocene-early Pleistocene glaciation (Duk-Rodkin *et al*., 1996), and several paleomagnetic samples collected from fine-grained units were analyzed by Dr. N. Roberts at the University of Lethbridge. The Earth's magnetic field can align magnetic minerals in sediment and rocks, recording polarity changes (Walker, 2005). Recognition of polarity changes can be used to assign ages to the sediment analyzed (Walker, 2005). Analysis first determined the bulk magnetic susceptibility, with a Sapphire Instruments Model SI-2B magnetic susceptibility and anisotropy meter. The natural remnant magnetism (NRM) was determined using an AGICO JR-6A spinner magnetometer and samples were incrementally demagnetized to determine their detrital remnant magnetism (DRM) acquired during deposition. Too few paleomagnetic samples were collected for a detailed determination of sediment age; however, analysis reveals the original polarity present during deposition which may indicate approximate ages.

Organic samples were collected for paleoenvironmental reconstructions and radiocarbon dating. Samples were sent to Alice Telka at Paleotec services for analysis. Organic material thought to be within the range of radiocarbon ages were dated while other samples were analyzed for macrofossil identification in an attempt to understand the environment at the time of deposition. Results from this analysis will be presented in a later publication.

Chemical characterization of gold grains is being completed from strategic placer-bearing facies in Back Creek. Sediment was sieved and panned to separate the heavy minerals and gold grains. The gold grains will be submitted for later laboratory analysis. At this time only the presence of placer gold grains in a unit are noted (Fig. 5).

RESULTS

Large exposures (>22 m) at Back Creek (Fig. 4) reveal a complex Quaternary history. During the 2015 field season twelve sections were analyzed at Back Creek, and these data were synthesized into an idealized stratigraphic column (Fig. 5) containing 12 units. The following is a brief synopsis of the stratigraphy and sedimentology present at Back Creek (Table 1 and Fig. 5).

The lowermost unit in the section is a variably weathered (minor jointing to highly decomposed) granite with sporadic sulphide mineralization (Unit 1). Based on previous mapping, Unit 1 is interpreted to be part of the Long Lake suite (Fig. 2) and is a potential source for gold mineralization in the drainage (Fig. 5 and Table 1).

Unit 2 is a matrix/clast-supported, poorly-consolidated gravel (Fig. 6). Unit 2 is less than 1 m thick with a gradational lower contact with Unit 1. This unit is locally exposed and lateral extent is unknown. The matrix is silty sand with variable iron staining and the colour is yellowish brown (10YR 5/6). There are ~50% clasts that are dominantly rounded to subrounded. The clasts are commonly decomposed and have variable, but local lithologies. The unit is crudely stratified in some exposures and a fine-grained clayey silt layer ~15 cm thick was sampled for paleomagnetic dating. Unit 2 contains placer gold, but due to the limited volume exposed it was not the main target for placer development.

Unit 3 is an over-consolidated, matrix-supported diamicton (Fig. 7). The lower contact is sharp and erosive with Units 1 or 2. Unit 3 is 5 to 10 m thick and laterally extensive across the valley bottom of Back Creek. The unit is thickest towards the valley margins and thinnest towards the valley center. The matrix is clayey-silt with minor sand, and yellowish brown (10YR 5/4) at the base and brown (7.5YR 5/4) at the top (7.5YR 5/4; brown). It contains 20-25% subrounded clasts that range from pebbles to boulders and many are striated or decomposed. Diverse clast lithologies are present in this diamict, including some not found within the Back Creek basin (sedimentary). Clast orientation changes upsection from parallel to orthogonal to the valley (Fig. 5). Based on the consolidation, extent, striated clasts, erosional lower contact, diverse clasts lithologies and fabric orientation, Unit 3 is interpreted as a regionally extensive glacial diamict. Since this represents the oldest known glaciation in the Mount Nansen area it is assigned to the Nansen glaciation.

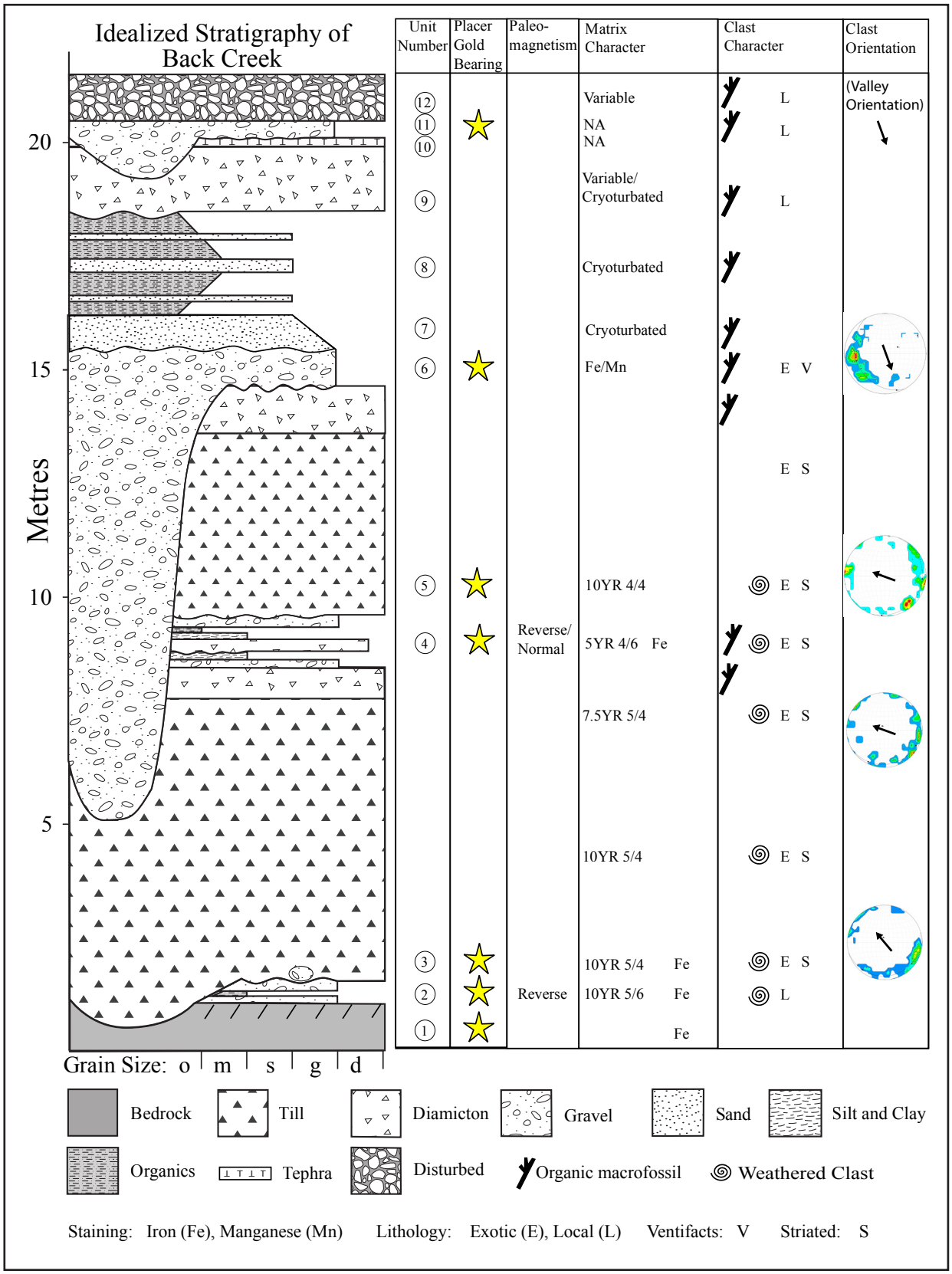


Figure 5. *Idealized stratigraphy of Back Creek. Each unit is numbered (1-12) and is further described in the results.*

Unit 4 is less than 2 m thick, laterally extensive and has a sharp, erosional lower contact. The materials and stratigraphic relationships of the sediment in Unit 4 are variable and include diamict, gravel, silt/clay and organic material (Fig. 8b,c). One sediment type is an over-consolidated, matrix-supported diamict with an erosional lower contact. The diamict has a clayey silt matrix, with 20-30% pebble-boulder sized, and subrounded to subangular clasts (Fig. 8c). Two clast-supported gravel beds are variably present in Unit 4 (Fig. 8b,c). The gravel has a silty sand matrix that is variably iron and manganese-stained. Clasts are greater than 55% pebble-cobble sized and subrounded to subangular. Furthermore, some of the clasts in the gravel are decomposed. Bedded silt/clay sediment is variably present in Unit 4 (Fig. 8b,c). Two sets of paleomagnetic samples were collected from this Unit 4 and normal (N) and reversely (R) magnetized sediment is present. Due to the small number of paleomagnetic samples collected and stratigraphic complexity it is unknown whether sediment records an N-R or an R-N-R sequence. There is an organic rich layer interstratified with silty clay. This layer was sampled for macrofossil analysis. Based on the presence of several sediment types, weathering representing potential paleosol processes and organics, Unit 4 is interpreted as inter-glacial sediment.

Unit 5 is an over-consolidated, matrix supported diamict. The lower contact is sharp and erosional. It is 3 to 6 m thick, and laterally extensive. The matrix is a clayey-silt with minor sand. It contains 15-20% subrounded clasts that range from pebbles to boulders, and have diverse lithologies. Striated and decomposed clasts are abundant, and several exotic lithologies are present. The clast fabric measured in this unit indicates ice flow orthogonal to the valley (Fig. 5). Based on the exotic lithologies, extent and striated clasts, Unit 5 is interpreted as a regionally extensive till. Since this represents the second oldest known glaciation in the Mount Nansen area, and it is beyond the Reid limit, it is assigned to the Klaza Glaciation.

Unit 6 is a poorly-consolidated, clast-supported gravel. The bottom contact is sharp and erosive, and this unit incises the pre-existing stratigraphy to Nansen till (Unit 3). Unit 6 is approximately 20 m wide and is presumed to



***Figure 6**. Pre-glacial gravel (Unit 2) exposed in lower Back Creek. Gravel is pervasively weathered and iron-stained. Clasts are variable in lithology but local in source.*



***Figure 7.** Nansen Till (Unit 3), containing striated and weathered clasts. Clasts can be quite large and several exotic clast lithologies are present indicative of regional glaciation.*



Figure 8. *Paleomagnetic sample locations. (a) Paleomagnetic samples of the pre-glacial gravel (Unit 2). Pervasive iron staining is visible in this photo. (b) Paleomagnetic samples of the interglacial sediment (Unit 4) right below an organic rich horizon. (c) Several inter-glacial sediments (Unit 4) and paleomagnetic sample locations are shown.*

extend down valley for some distance. The matrix is predominately sand with minor silt, and it is variably iron and manganese stained. It contains 60 to 70% subrounded to subangular clasts that range in size from boulder to pebble. Fabric measurements in Unit 6 indicate paleo-flow direction is approximately parallel to the modern creek valley (Fig. 5). This unit is the target of current placer mining and the gold character will be analyzed and presented in a later publication.

Unit 7 is a poorly-consolidated, with sub-horizontal bedded silty sand with minor organics. It is ~1 m thick and has a sharp erosive contact. This unit is not laterally extensive. Based on the sub-horizontal bedding, organics and sharp erosive lower contact Unit 7 is interpreted to be fluvial sand.

Unit 8 is matrix-supported, poorly-consolidated clay to fine sand colluviated organics. This unit is 2 to 3 m thick and laterally extensive. The unit has interstratified sand and it contains well-preserved macrofossils. Unit 8 contains several cryoturbation features (cryoturbated sediment and ice wedges) and the unit is predominately frozen. Based on the presence of organics and the interstratification of silt/clay, and sand Unit 8 is interpreted as a valley bottom floodplain deposit.

Unit 9 is a variably thick (1-4 m), matrix/clast-supported, moderately-consolidated diamicton. Unit 9 has an erosive lower contact and is laterally extensive. This unit contains organics and it has crude stratification. Based on these features it is interpreted to be a colluvium.

Unit 10 is a variably thick (5-50 cm), pale grey, silty sand, composed of tephra. This unit has a sharp non-erosive lower contact and it is laterally extensive. Based on the sediment location and previous work in the Mount Nansen area (LeBarge, 1995), Unit 10 is interpreted as the White River Tephra (WRT).

Unit 11 is a clast-supported, poorly-consolidated gravel. The gravel has a sharp erosive lower contact, and it is variably thick (0.5-2 m). The unit has a silty sand matrix with ~70% clasts. Clasts are cobble to pebble sized, and subrounded. The unit forms the base of the modern stream and this unit contains a minor amount of placer gold; however, it is not the current target of exploration. Based on these features, Unit 11 is interpreted as the modern/recent fluvial gravel.

Unit 12 includes all material that has been disturbed during mining. This includes a variety of sediment types such as diamictons or bedded silt and sand, depending on how the material was affected. Furthermore the thickness and lateral variability of this unit is highly variable.

LANDSCAPE EVOLUTION

By synthesizing the stratigraphy of Back Creek a seven phase landscape evolution model was created (Table 1 and Fig. 10). The following interpretations relate to the model, and explain the concentration mechanisms, preservation potential, and timing of placer gold development in relation to the landscape evolution of Back Creek.

CENOZOIC WEATHERING

The first phase of development was dominated by deep weathering and fluvial concentration of placer gold (Fig. 10a). The bedrock exposed at Back Creek is highly oxidized suggesting pervasive weathering occurred over a significant time period. The pre-glacial development of placer gold is theoretically the period of greatest gold accumulation in Back Creek due to long periods of weathering and tectonic stability. The presence of highly weathered bedrock (>2 m thick) suggests that it was sub-aerially exposed for a significant amount of time. Weathering is so intense that many of the feldspar grains have become pervasively stained and decomposed in the bedrock. Pre-glacial gold concentration developed as mineralized bedrock present at the surface, weathered, and incorporated in fluvial deposits of paleo-Back Creek.

The mineralized bedrock that supplied gold in Back Creek may be from several mineral occurrences (*eg.,* Willow Creek, Orloff-King and Dickson; *see* Fig. 2), and further analysis is required to determine its origin. Weathered bedrock is commonly in contact with, and incorporated into the Nansen till (Unit 3). Unit 2 (pre-glacial gravel) is only exposed in the deepest part of the valley and has a very limited lateral extent, likely related to variable paleo-bedrock topography. The valley bottom may have once had more extensive pre-glacial fluvial deposits; however, erosion during the first glaciation effectively removed most of these deposits.

NANSEN GLACIATION

The second phase of landscape evolution is during the Nansen glaciation (Fig. 10b,c). Reversely magnetized sediment sampled from overlying Unit 4 indicate the Nansen till is >780 ka, and normally magnetized sediment is interpreted to have formed during the Jaramillo (0.90-1.06 Ma) or Olduvai (1.78-2.00 Ma) subchron (Fig. 9). There are two phases during the Nansen glaciation, the advance phase (Fig 10b) and the maximum phase (Fig. 10c); these phases are based on changes in till characteristics and ice flow reconstruction from till fabric data. During the advance phase, ice flowed up-valley and likely produced a glacial lake (Fig. 10b). The ice was significantly erosive to incorporate highly weathered bedrock and pre-glacial gravel. The incorporation of oxidized bedrock produced a visible colour change from the base (10YR 5/4; yellowish brown) to the top (7.5YR 5/4; brown) of the Nansen till. As glaciation continued, ice thickened and flow became orthogonal to the valley unconstrained by underlying topography (Fig. 10c). During Nansen glacial maximum it is likely that large parts of the region were covered in ice. Both advance and maximum phases were likely significantly erosive depending on the topographic position. The glacial advance was parallel with the valley and therefore eroded the valley bottom, whereas at glacial maximum, ridge tops were likely eroded and the valley bottom remained protected.

INTER-GLACIATION

The next phase of landscape evolution occurred during a non-glacial or inter-glacial period (Fig. 10d). Unit 4 contains organic material, and a zone of weathering resembles a paleosol. These attributes suggest a period of stability following the Nansen glaciation. Two sets of paleomagnetic samples were collected from this unit

and normal and reversely magnetized sediment are present. The reversely magnetized sediment suggests a minimum age of deposition >780 ka, forming when the Earth's magnetic field last had a reversed polarity. Due to the number of samples collected and the complex stratigraphic relationships between samples, the exact age of the sediment remains unresolved (Fig. 9). It is likely however, that the paleomagnetic results record the Jaramillo or Olduvai subchron (Fig 9), due to suggested age (>1 Ma) of the overlying sediment from the Klaza glaciation (Jackson, 2000). The gravel from the inter-glacial unit has pervasive staining and several weathered clasts that represent fluvial activity over a significant period of time. This inter-glacial gravel may be another target for placer exploration, although its volume is limited particularly near the valley sides where it is exposed. It is possible this gravel sub-unit is larger towards the valley center; however, it was only seen in the left limit.

KLAZA GLACIATION

The Klaza glaciation (Fig. 10e) produced till with similar sedimentological characteristics to the Nansen till; however, clast orientations have a larger range in value that may be related to post-glacial disturbance or to the primary depositional environment. This unit is laterally extensive on the side of the valley, but placer excavation in the center of the valley effectively removed most of this unit. The preserved paleosol (Unit 4) below the Klaza till suggests that ice was largely non-erosive, which is encouraging for preserving inter-glacial placer gold deposits. The Klaza till is likely the 'false bedrock' that is pervasive throughout the Mount Nansen area and is known to have placer gold concentrated on it or in it.

PAY GRAVEL DEVELOPMENT

The next phase of landscape evolution (Fig. 10f) is the formation of post-glacial fluvial gravel. Fluvial incision following the Klaza glaciation eroded into the Nansen till, and potentially into the pre-glacial gravel. Currently, this gravel is the main placer gold target at Back Creek. Placer gold has four potential sources in the area i) bedrock; ii) till enriched with placer gold; iii) inter-glacial fluvial gravel; or iv) pre-glacial gravel. Additional studies into gold character may highlight the amount of reworked gold that is contributing to the placer deposit.

COVER DEVELOPMENT

The final phase of landscape evolution is the formation of cover (Fig. 10g). Hillslope colluviation, periglacial weathering and eolian processes were all dominant after glaciation. These processes produced thick cover (>5 m)

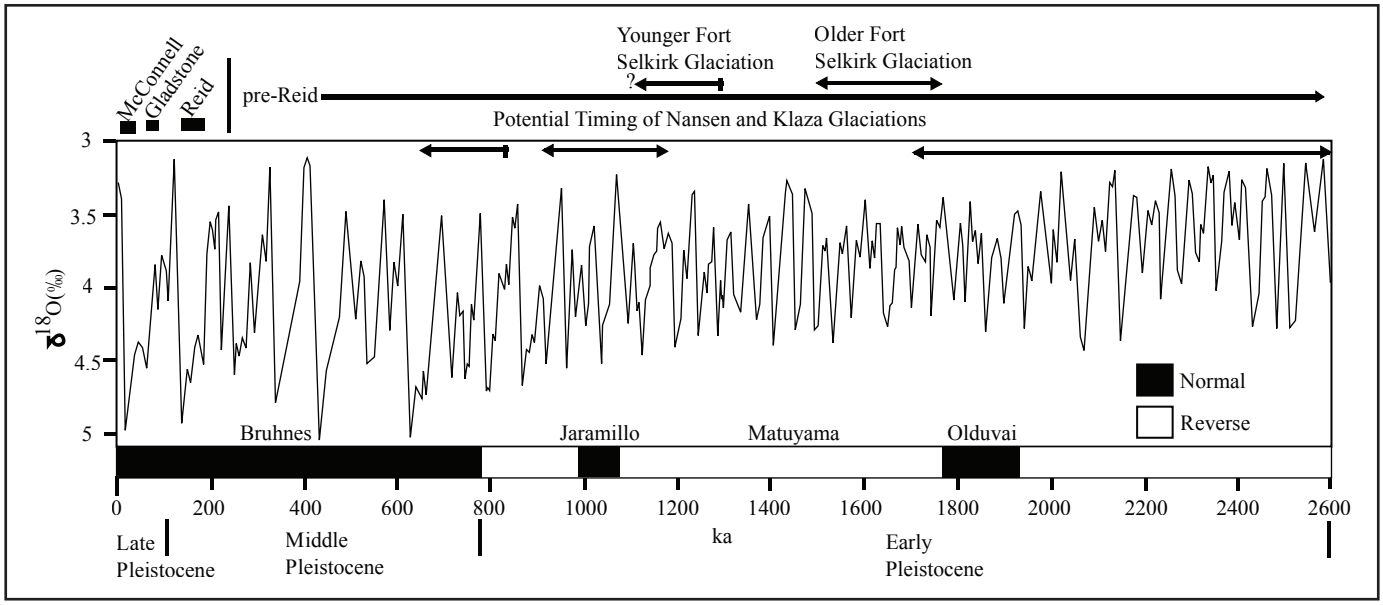


Figure 9. *Paleomagnetic timescale and the oxygen isotope ($\delta^{18}O$) curve modified from Lisieki and Raymo, 2005. The ($\delta^{18}O$) curve fluctuations indicate climate changes, where troughs denote glacial stages and the peaks are non-glacial. The timing of local glaciation is summarized for reference (after Nelson et al., 2009; Bond and Lipovsky, 2010), and the potential timing of the glaciation of Nansen and Klaza are highlighted*

with a variety of characteristics. The cover sediment is generally depositional in nature and therefore has not removed the underlying units. The presence of marker horizons such as the White River tephra (Unit 10) deposited ~1200 years ago (*cf.*, Clague *et al.,* 1995), indicate sediment has remained undisturbed since deposition. Most cover sediment contains little placer gold (Unit 11) and is not a placer mining target.

PLACER POTENTIAL

Two distinct tills are present at Back Creek and based on their extent, striated clasts, diverse clasts lithologies, and an intercalated paleosol, they are interpreted to represent Nansen and Klaza glaciation. This assignment is consistent with earlier glacial stratigraphy work in the region (Bostock, 1966; LeBarge, 1995). Nansen and Klaza glaciation has significantly impacted placer gold deposits in Back Creek. To understand the evolution of placer gold deposits at Back Creek, concentration mechanisms, preservation potential and a timing of placer gold deposits were synthesized into a model (Fig. 10) which highlighted three main placer gold targets (pre-glacial, inter-glacial, and post-glacial fluvial sediment). The influences of the Nansen and Klaza glaciation on these deposits are examined below.

PRE-GLACIAL DEPOSITS

Pre-glacial placer deposits should contain the highest gold concentrations because these deposits formed over a sustained period during the Paleogene and Neogene when climate was warmer, resulting in significant weathering of mineralized bedrock and fluvial concentration of gold (Ager *et al*., 1994; Anderson and Stroshein, 1997; Dampier *et al*., 2011; Foscolos *et al.,* 1977; Jackson, 2000; LeBarge, 1995). Channel avulsion may have resulted in laterally extensive pre-glacial placer deposits across Back Creek valley. Significant erosion likely occurred during the Nansen glaciation because Nansen till is in direct contact with bedrock near the valley side and incorporates weathered bedrock. Therefore, extensive removal of pre-glacial placer deposits likely occurred during this glaciation. Variable bedrock topography would decrease the efficiency of glacial erosion and this may preserve placer gold deposits. In Back Creek, gold-bearing pre-glacial placer deposits are most likely preserved in valleys oriented at a high angle to ice flow and where local bedrock topographic features like paleo-canyons or bedrock highs provide protection from glacial erosion. For exploration, preserved pre-glacial placer gold deposits could be anticipated by identifying areas of undulatory bedrock (canyons or ledges) using geophysics. Highlighting these areas might increase the chance of successfully drilling into a pre-glacial gravel. The discontinuous nature of these pre-glacial placer deposits in valleys aligned with regional ice flow makes them a challenging exploration target.

INTER-GLACIAL DEPOSITS

Inter-glacial gold deposits are another target for placer gold exploration. In these deposits gold must be sourced from either mineralized bedrock or from the Nansen till. LeBarge (1995), found that till may contain large quantities of gold grains, so the Nansen till could be a significant source of placer gold. In addition the Nansen till provides a false-bedrock for placer gold deposits to accumulate on. The Klaza glaciation did not result in significant erosion of these inter-glacial placer gold deposits. The deposits may be extensive and represent a favorable exploration target due to their shallow depth relative to pre-glacial deposits. Drilling and geophysical surveys could be employed to identify these inter-glacial targets within the Mount Nansen area.

POST-GLACIAL DEPOSITS

Post-glacial placer gold deposits have historically been the primary exploration targets in the Mount Nansen area, and they are most continuous deposits present in Back Creek. Gold in the post-glacial deposits may be sourced from (i) bedrock; (ii) till enriched with placer gold; (iii) inter-glacial fluvial gravel; or (iv) pre-glacial gravel. The gold abundance in post-glacial deposits may reflect various sources. Significant increase in gold abundance likely reflects intersection of underlying placer gold deposits, and should warrant detailed study to determine if intersected deposit is an extensive target. Sand, organics, colluvium, tephra, gravel, and anthropogenic deposits cover the post-glacial placer gold deposits. The thickness of this overlying material dictates the economic viability of mining post-glacial placer deposits.

DISCUSSION

This research shows that the early Pleistocene Nansen and Klaza glaciation had a significant impact on placer gold concentration in Back Creek. Three placer gold targets exist in the Back Creek area including the pre, inter and post-glacial deposits. Although historical exploration

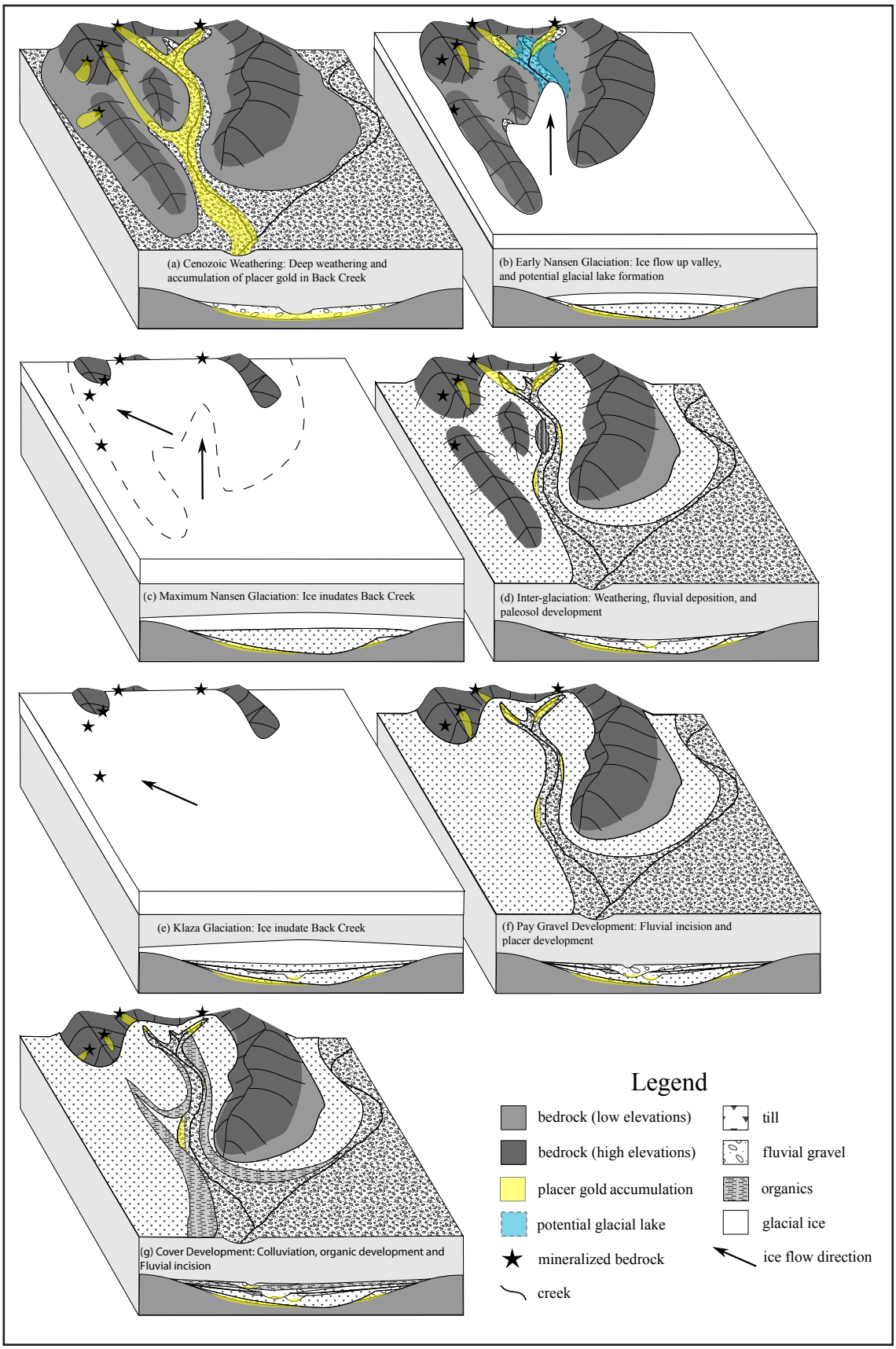


Figure 10.
The landscape evolution of Back Creek is described in these 7 block diagrams. This model illustrates both the spatial and stratigraphic distribution of placer gold from pre-glacial to modern time.

has focused on the post-glacial deposits, it is likely that lucrative pre-glacial and inter-glacial deposits exist at depth where glacial erosion was minimal. The landscape evolution model presented here is for Back Creek (Fig. 10); however, could be applied to other placer gold exploration targets in the Mount Nansen district and in early Pleistocene glaciated fringe of Yukon (Fig. 1).

CONCLUSION

Early Pleistocene glaciation had a significant effect on placer gold deposits in Back Creek. Two phases of glaciation are present and were separated by a period of weathering and pedogenesis. These two glacial events likely represent the Nansen and Klaza and are interpreted to have occurred before the Jaramillo or Olduvai subchron based on paleomagnetic results. The Nansen glaciation destroyed much of the earliest placer gold deposits leaving little evidence of pre-glacial gravels, only where bedrock topography permitted preservation. The Nansen glaciation was pervasive in the landscape and till fabrics recorded ice thickening and changing directions. Between periods of glaciation, a long period of pedogenesis occurred and inter-glacial placer gold deposits formed. The Klaza glaciation did not result in significant erosion of these inter-glacial placer gold deposits, and they may represent an important target for placer exploration. Post-glacial fluvial gravels are the main target for placer gold mining in Back Creek and variable gold abundance is likely related to incision of previous concentrations of placer gold. The thickness of sediment covering the post, inter or pre-glacial placer gold deposits has a significant impact on the economics of the deposit and should be considered during exploration. In conclusion, analysis at Back Creek reveals the potential for deeply buried placer gold deposits in other glaciated regions of Yukon.

ACKNOWLEDGEMENTS

First, I would like to thank the Canadian Northern Economic Development Agency for graciously providing the funding for this project. I would like to thank Ross Agnosti for access to the section and insightful information. I appreciate the Yukon Geological Survey for providing funding, training and guidance. I would also like to thank the Geological Survey of Canada, specifically Jim Ryan, for logistical support and guidance. I would also like to thank Nick Roberts for processing the paleomagnetic samples, and providing insight into Early Pleistocene glaciation. Furthermore, this research would not be possible without the countless hours of help from Mark Coleman and Kyle Orr. Further thanks go to Alice Telka for analysis of the macrofossil analysis and radio carbon dating. Finally, I want to thank my esteemed colleges Anna Haiblen and Gioachino Roberti who helped review my work and provided feedback on several ideas.

REFERENCES

Ager, T.A., Matthews, J.V. and Yeend, W., 1999. Pliocene terrace gravels of the ancestral Yukon River near Circle, Alaska: Palynology, paleobotany, paleoenvironmental reconstruction and regional correlation. Quaternary International, vol. 22/23, p. 185-206.

Anderson, F. and Stroshein, R., 1997. Geology of the gold-silver vein system, Mount Nansen area, Yukon. *In*: Yukon Exploration and Geology 1997, C.F. Roots and D.S. Emond (eds.), Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, p. 129-143.

Barendregt, R.W., Enkin, R.J., Duk-Rodkin, A. and Baker, J., 2010. Paleomagnetic evidence for multiple late Cenozoic glaciations in the Tintina Trench, west-central Yukon, Canada. Canadian Journal of Earth Science, vol. 47, p. 987-1002.

Bond, J.D., Lipovsky, P.S., and Gaza, P., 2007. Surficial geology investigations in Wellesley basin and Nisling Range, southwestern Yukon. In: Yukon Exploration and Geology 2007, D.S. Emond, L.L. Lewis and G.D. Bradshaw (eds.), Yukon Geological Survey, p. 125-138.

Bostock, H.S., 1936. Carmacks District, Yukon. Geological Survey of Canada, Memoir 189.

Bostock, H.S., 1966. Notes on glaciation in central Yukon Territory. Geological Survey of Canada, Paper 65-36, p. 18.

Burn, C.R., 1994. Permafrost, tectonics, and past and future regional climate change, Yukon and adjacent Northwest Territories. Canadian Journal of Earth Science, vol. 33, p. 182-191.

Cairnes, D.D., 1915. Summary Report 1914, Part A. Geological Survey of Canada, Memoir 284, p. 25-30.

Clague, J.J., Evans, S.G., Rampton, V.N. and Woodsworth, G.J., 1995. Improved age estimates for the White River and Bridge River tephras, western Canada. Canadian Journal of Earth Science, vol. 32, p. 1172-1179.

Colpron, M., Nelson, J.L. and Murphy, D.C., 2007. Northern Cordilleran terranes and their interactions through time. GSA Today, vol. 17, p. 4-10.

Coney, P.J., Jones, D.L. and Monger, J.W.H., 1980. Cordilleran suspect terranes. Nature, vol. 288, p. 329-333.

Dawson, G.M., 1889. Report on an exploration in the Yukon District, N.W.T. and adjacent northern portion of British Columbia, 1887. Geological Survey of Canada, Annual Report, 1887-88.

Dampier, L., Sanborn, P., Smith, S., Bond, J. and Clague, J.J., 2011. Genesis of upland soils, Lewes Plateau, central Yukon. Part 2: Soils formed in weathered granitic bedrock. Canadian Journal of Soil Science, vol. 91, p. 579-594.

Demuro, M., Froese, D.G., Arnold, L.J. and Roberts, R.G., 2012. Single-grain OSL dating of glaciofluvial quartz constrains Reid glaciation in NW Canada to MIS 6. Quaternary Research, vol. 77, p. 305-316.

Duk-Rodkin, A., 1999. Glacial limits map of Yukon Territory. Geological Survey of Canada, Open File 3694, Indian and Northern Affairs Canada Geoscience Map 1999-2, scale 1:1 000 000.

Duk-Rodkin, A., Barendregt, R.W., Froese, D.G., Weber, F., Enkin, R., Smith, I.R., Zazula, G.D., Waters, P. and Klassen, R., 2004. Timing and extent of Plio-Pleistocene glaciations in north-western Canada and east-central Alaska. Quaternary Glaciations-Extent and Chronology, Part II, p. 313-342.

Duk-Rodkin, A., Barendregt, R.W., Tarnocai, C., and Phillips, F.M., 1996. Late Tertiary to late Quaternary record in the Mackenzie Mountains, Northwest Territories, Canada: stratigraphy, paleosols, paleomagnetism, and chlorine-36. Canadian Journal of Earth Science, vol. 33, p. 875-895.

Duk-Rodkin, A., Barendregt, R.W., White, J.M. and Singhroy, V.H., 2001. Geologic evolution of the Yukon River: implications for placer gold. Quaternary International, vol. 82, p. 5-31.

Els, G. and Eriksson, P., 2005. Placer formation and placer minerals. Ore Geology Review, vol. 28, p. 373-375.

Foscolos, A.E., Rutter, N.W. and Hughes, O.L., 1977. The use of pedological studies in interpreting the Quaternary history of central Yukon Territory, Geological Survey of Canada, Bulletin 271.

Geurts, M. and Dewez, V., 1993. Le lac glaciaire Nisling et le Pleistocene dans le basin superieur de la Nisling River, au Yukon. Geographie physique et Quaternaire, vol. 47, no. 1, p. 81-92.

Guthrie, R.D., 2001. Origin and causes of the mammoth steppe: a story of cloud cover, wolly mammal tooth pits, buckles and inside-out Beringia. Quaternary Science Reviews, vol. 20, p. 549-574.

Goldfarb, Y.I., Petrov, A.N., Preis, V.K. and Skurida, D.A., 2015. Geological prerequisites for differentiated approach to prospecting and exploration of alluvial gold placers: an example from the northeast of Russia. Russian Journal of Pacific Geology, vol. 9, p. 166-177.

Harris, S.A., 2005. Thermal history of the Arctic Ocean environs adjacent to North America during the last 3.5 Ma and a possible mechanism for the cause of the cold events (major glaciations and permafrost events). Progress in Physical Geography, vol. 29, p. 218-237.

Hart, C.J.R. and Langdon, M., 1998. Geology and mineral deposits of the Mount Nansen camp, Yukon. *In:* Yukon Geology and Exploration 1997, Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, p. 129-138.

Haug, G.H., Ganopolski, A., Sigman, D.M., Rosell-Mele, A., Swann, G.E.A., Tiedemann, R., Jaccard, S.L., Bollmann, J., Maslin, M.A., Leng, M.J. and Eglinton, G., 2005. North Pacific seasonality and the glaciation of North America 2.7 million years ago. Nature, vol. 433, p. 821-825.

Herail, G., Fornari, M., Viscarra, G., Laubacher, G., Argollo, J. and Miranda, V., 1989. Geodynamic and Gold Distribution in the Tipuani-Mapiri Basin (Bolivia). International Symposium on Intermontane Basins: Geology and Resources, p. 342-352.

Hidy, A.J., Gosse, J.C., Froese, D.G., Bond, J.D. and Rood, D.H., 2013. A latest Pliocene age for the earliest and most extensive Cordilleran Ice Sheet in northwestern Canada. Quaternary Science Reviews, vol. 61, p. 77-84.

Hicock, S.R., Goff, J.R., Lian, O.B. and Little, E.C., 1996. On the Interpretation of Subglacial Till Fabric. Journal of Sedimentary Research, vol. 66, p. 928-934.

Hughes, O.L., Campbell, R.B., Muller, J.E. and Wheeler, J.O., 1969. Glacial limits and flow patterns, Yukon Territory, South of 65 Degrees North Latitude. Geological Survey of Canada, Paper 68-34, p. 1-9.

Jackson, L.E. Jr., 1993. Origin and stratigraphy of Pleistocene gravels in Dawson Range and suggestions for future exploration of gold placers, southwestern Carmacks map area, Yukon Territory. Current Research, part A; Geological Survey of Canada, paper 93-1A, p. 1-10.

Jackson, L.E. Jr., 2000. Quaternary geology of the Carmacks map area, Yukon Territory. Geological Survey of Canada, Bulletin 539, p. 1-74.

Jackson, L.E. Jr. and Clague, J.J., 1991. The Cordilleran Ice Sheet: one hundred and fifty years of exploration and discovery. Geographie physique et Quaternaire, vol. 45, p. 269-280.

Jackson, L.E. Jr., Tarnocai, C. and Mott, R, J., 1999. A middle Pleistocene paleosols sequence from Dawson Range, Central Yukon Territory. Geographie physique et Quaternaire, vol. 53, p. 313-322.

Johnston, S.T., Mortenson, J.K. and Erdmer, P., 1996. Igneous and metaigneous age constraints for the Aishihik metamorphic suite, southwest Yukon. Canadian Journal of Earth Sciences, vol. 33, p. 1543-1555.

Knight, J.B., Morison, S.R. and Mortensen, J.K., 1999. The relationship between placer gold particle shape, rimming, and distance of fluvial transport as exemplified by gold from the Klondike district, Yukon Territory, Canada. Economic Geology, vol. 94, p. 635-648.

Knight E., Schneider, D.A. and Ryan, J., 2013. Thermochronology of the Yukon-Tanana Terrane, west-central Yukon: Evidence for Jurassic extension and exhumation in the northern Canadian Cordillera. The Journal of Geology, vol. 121, p. 371-400.

LeBarge, W.P., 1995. Sedimentology of Placer Gravels near Mt. Nansen, Central Yukon Territory, Bulletin 4, Exploration and Geological Services Division, Indian and Northern Affairs Canada, Yukon Region, p. 155.

Levson, V.M. and Blyth, H., 2001. Formation and preservation of a Tertiary to Pleistocene fluvial gold placer in northwest British Columbia. Quaternary International, vol. 82, p. 33-50.

Lisiecki, L.E. and Raymo, M.E., 2005. A Pliocene-Pleistocene stack of 57 globally distributed benthic $\delta 18O$ records. Paleoceanography, vol. 20, PA 1003.

Loen, J.S., 1994. Origin of placer gold nuggets and history of formation of glacial gold placers, Gold Creek, Granite County, Montana. Economic Geology, vol. 89, p. 91-104.

Lowey, G.W., 2006. The origin and evolution of the Klondike goldfields, Yukon, Canada. Ore Geology Reviews, vol. 28, p. 431-450.

Monger, J.W.H., Souther, J.G. and Gabrielse, H., 1972. Evolution of the Canadian Cordillera: a plate-tectonic model. American Journal of Science, vol. 272, p. 577–602.

Mortensen, J.K., Appel, V.L. and Hart, C.J.R., 2002. Geological and U-Pb age constraints on base and precious metal vein systems in the Mount Nansen area, eastern Dawson Range, Yukon. *In:* Yukon Exploration and Geology 2002, D.S. Emond and L.L. Lewis (eds.), Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, p. 165-174.

Naeser, N.D., Westgate, J.A., Hughes, O.L. and Pewe, T.L., 1982. Fisson-track ages of late Cenozoic distal tephra beds in the Yukon Territory and Alaska. Canadian Journal of Earth Sciences, vol. 19, p. 2167-2178.

Nelson, F.E., Barendregt, R.W. and Villeneuve, M., 2009. Stratigraphy of the Fort Selkirk Volcanogenic Complex in central Yukon and its paleoclimatic significance: Ar/Ar and paleomagnetic data. Canadian Journal of Earth Science, vol. 46, p. 381-401.

Saager, R. and Bianconi, F., 1971. The Mount Nansen gold-silver deposit, Yukon Territory, Canada. Mineralium Deposita, vol. 6, p. 209-224.

Selby, D., Creaser, R.A. and Nesbitt, B.E., 1999. Major and trace element compositions and Sr-Nd-Pb systematics of crystalline rocks from the Dawson Range, Yukon, Canada. Canadian Journal of Earth Science, vol. 36, p. 1463-1481.

Tempelman-Kluit, D.J., 1984. Geology of the Laberge (105E) and Carmacks (115I) map areas. Geological Survey of Canada, Open File 1101, maps with legends, 1:250 000 scale.

Ward, B.C., Bond, J.D., Froese, D. and Jensen, B., 2008. Old Crow tephra (140±10 ka) constrains penultimate Reid glaciation in central Yukon Territory. Quaternary Science Reviews, vol. 27, p. 1909-1915.

Walker, M., 2005. Quaternary Dating Methods. John Wiley and Sons Ltd. London. p. 1-286.

Ward, B.C., Bond, J.D., Froese, D., Jensen, B., (2008). Old Crow tephra (140±10 ka) constrains penultimate Reid glaciation in central Yukon Territory. Quaternary Science Reviews 27, 1909-1915.

Ward, B.C., Bond, J.D. and Gosse, J.C., 2007. Evidence for a 55-50 ka (early Wisconsin) glaciation of the Cordilleran Ice Sheet, Yukon Territory, Canada. Quaternary Research, vol. 68, p. 141-150.

Wengzynowski, W.A., Giroux, G.H., and Martin, C.J., 2015. Geology mineralization, geochemical surveys, geophysical surveys, diamond and percussion drilling, metallurgical testing and mineral resources on the Klaza property Yukon, Canada. NI43-101 technical report. <http://www.rockhavenresources.com/projects/klaza-project> [accessed November 20, 2015].

Westgate, J.A., Preece, S.J., Froese, D.G., Walter, R.C., Sandhu, A.S. and Schweger, 2000. Dating early and middle (Reid) Pleistocene glaciations in central Yukon by tephrochronology. Quaternary Research, vol. 56, p. 335-348.