

Ministry of Energy and Mines  
BC Geological Survey

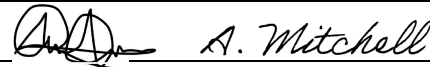
Assessment Report  
Title Page and Summary

TYPE OF REPORT [type of survey(s)]: Airborne Magnetic Geophysics

TOTAL COST: \$33,628.81

AUTHOR(S): Arron M. Albano & Andrew J. Mitchell

SIGNATURE(S):



NOTICE OF WORK PERMIT NUMBER(S)/DATE(S):

YEAR OF WORK: 2018

STATEMENT OF WORK - CASH PAYMENTS EVENT NUMBER(S)/DATE(S): 5737040.

PROPERTY NAME: Keithley Creek

CLAIM NAME(S) (on which the work was done): 1060385, 1060388, 1060795, 1060797, 1060798, 1060799

COMMODITIES SOUGHT: Au, Ag, Zn, Pb, Cu

MINERAL INVENTORY MINFILE NUMBER(S), IF KNOWN:

MINING DIVISION: Cariboo

NTS/BCGS: 093A/13,14

LATITUDE: 52° 46' 20.12" LONGITUDE: 121° 30' 45.67" (at centre of work)

OWNER(S):

1) Davison, James Gregory

2)

MAILING ADDRESS:

PO BOX 604, 921 7th Street, Montrose, BC, Canada, V0G1P0

OPERATOR(S) [who paid for the work]:

1) Hawkeye Gold and Diamond Inc.

2)

MAILING ADDRESS:

M 202-1985 Alberni Street, Vancouver, BC Canada, V6G0A2

PROPERTY GEOLOGY KEYWORDS (lithology, age, stratigraphy, structure, alteration, mineralization, size and attitude):

Auriferous quartz vein and replacement styles of mineralization, with lesser volcanogenic massive sulphide (VMS) mineral occurrences.

Keithley Creek property is mostly underlain by the Snowshoe Group and lesser Devonian to Carboniferous orthogneiss and Upper Carboniferous to Permian serpentinite ultramafic rocks.

REFERENCES TO PREVIOUS ASSESSMENT WORK AND ASSESSMENT REPORT NUMBERS:

27954, 24989, 25904, 36449

TYPE OF WORK IN THIS REPORT	EXTENT OF WORK (IN METRIC UNITS)	ON WHICH CLAIMS	PROJECT COSTS APPORTIONED (incl. support)
GEOLOGICAL (scale, area)			
Ground, mapping	_____	_____	_____
Photo interpretation	_____	_____	_____
GEOPHYSICAL (line-kilometres)			
Ground			
Magnetic	_____	_____	_____
Electromagnetic	_____	_____	_____
Induced Polarization	_____	_____	_____
Radiometric	_____	_____	_____
Seismic	_____	_____	_____
Other	_____	_____	_____
Airborne Helicopter-Borne Aeromagnetic - 282 Line Km			\$33,628.81
GEOCHEMICAL (number of samples analysed for...)			
Soil	_____	_____	_____
Silt	_____	_____	_____
Rock	_____	_____	_____
Other	_____	_____	_____
DRILLING (total metres; number of holes, size)			
Core	_____	_____	_____
Non-core	_____	_____	_____
RELATED TECHNICAL			
Sampling/assaying	_____	_____	_____
Petrographic	_____	_____	_____
Mineralographic	_____	_____	_____
Metallurgic	_____	_____	_____
PROSPECTING (scale, area)			
PREPARATORY / PHYSICAL			
Line/grid (kilometres)	_____	_____	_____
Topographic/Photogrammetric (scale, area)	_____	_____	_____
Legal surveys (scale, area)	_____	_____	_____
Road, local access (kilometres)/trail	_____	_____	_____
Trench (metres)	_____	_____	_____
Underground dev. (metres)	_____	_____	_____
Other	_____	_____	_____
		TOTAL COST:	\$33,628.81

**ASSESSMENT REPORT**  
on  
**AIRBORNE MAGNETIC SURVEYING**  
at the  
**Keithley Creek Property**

Central British Columbia  
Cariboo Mining Division

(N.T.S. 093A/13, 14)

Latitude 52°46'20.12"N, Longitude 121°30'45.67"W  
UTM, Zone 10, Northing 5,848,391, Easting 599,144

Prepared for  
**Hawkeye Gold and Diamond Inc.**

by  
Arron M. Albano, B.Sc., GIT,  
Andrew J. Mitchell, B.Sc., P. Geo

of  
C.J. Greig & Associates Ltd.  
Penticton, British Columbia

Date: May 14, 2019

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## **1.0 Summary and Introduction**

The Keithley Creek property is located in central British Columbia within the Cariboo Mining Division. The mineral tenures are approximately 15 km north of Likely, 31 km south of Barkerville and 65 km southeast of Quesnel.

The Keithley Creek property is predominantly underlain by Neoproterozoic to Paleozoic Snowshoe Group metamorphic rocks of the Barkerville Subterrane which are host to gold-rich quartz veins and replacement style deposits. The southwestern most part of the property is underlain by Carboniferous to Permian serpentinite ultramafic rocks of the Crooked Amphibolite. Further west of the property boundary are Middle to Upper Triassic Nicola Group volcanic and sedimentary rocks of the Quesnel Terrane.

The 2018 magnetic survey has outlined a number of areas of focus for ground-based exploration. The first phase of work should consist of prospecting, and stream sediment and grid-based soil geochemical sampling. Phase two, if warranted, should comprise additional geochemical and ground-based IP (Induced Polarization) geophysical surveys, with the goal of outlining potential vein and replacement style mineralization.

## **2.0 Location, Access, Physiography, Climate and Vegetation**

The Keithley Creek property is located in central British Columbia within the Cariboo Mining Division. The mineral tenures are approximately 15 km north of Likely, 31 km south of Barkerville and 65 km southeast of Quesnel (Figures 1, 2 and 6). Keithley Creek passes through the easternmost part of the property and flows southeast into Cariboo Lake. The claims are centered on 52°46'20.12"N latitude and 121°30'45.67"W longitude (Figures 2 and 3).

The property is situated within the central part of the Quesnel-Shuswap Highland between the eastern edge of the Interior Plateau and the western foothills of the Columbia Mountains. This area comprises rolling plateaus, with a transition between rounded to rugged mountains to the east. Elevations on the property range from 800 m in the east part of the property to over 1600 m in the central part of the property.

The property is occupied by mature stands of spruce, pine, fir, hemlock and cedar with an understory of thick alder. Extensive timber harvesting has been ongoing on and in the vicinity of the Keithley Creek property.

The area has a humid continental climate, with mild summers and cold winters. Summer temperatures range from about 15 degrees to a high of 20 degrees Celsius and winter temperatures range from about -3 degrees to as low as -10 degrees Celsius. Average precipitation for the area is approximately 700 mm with about 200 cm of snowfall during the winter months.

The Keithley Creek property is most easily accessed by four wheel drive vehicle on a network of logging roads approximately 30 km from the town of Likely (Figure 2). Crews have not attempted to access the property, and it may require an all terrain vehicle to access it if logging roads are deactivated.

In 2018, the geophysical survey was completed using an Aerospatiale A-Star 350 B2 helicopter, operated by Yellowhead Helicopters Ltd, stationed in the town of Likely, BC.

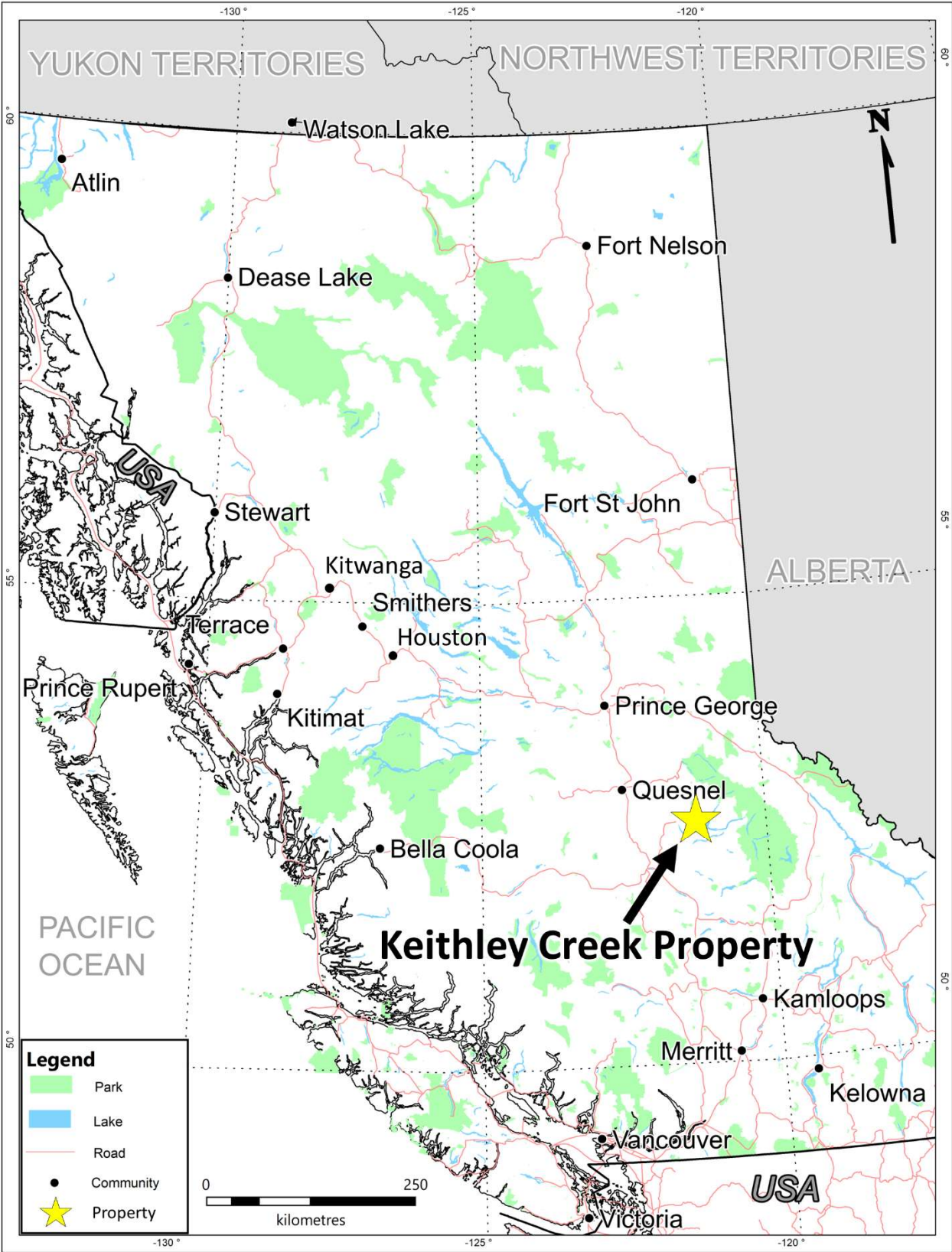


Figure 1. British Columbia, Keithley Creek property location map

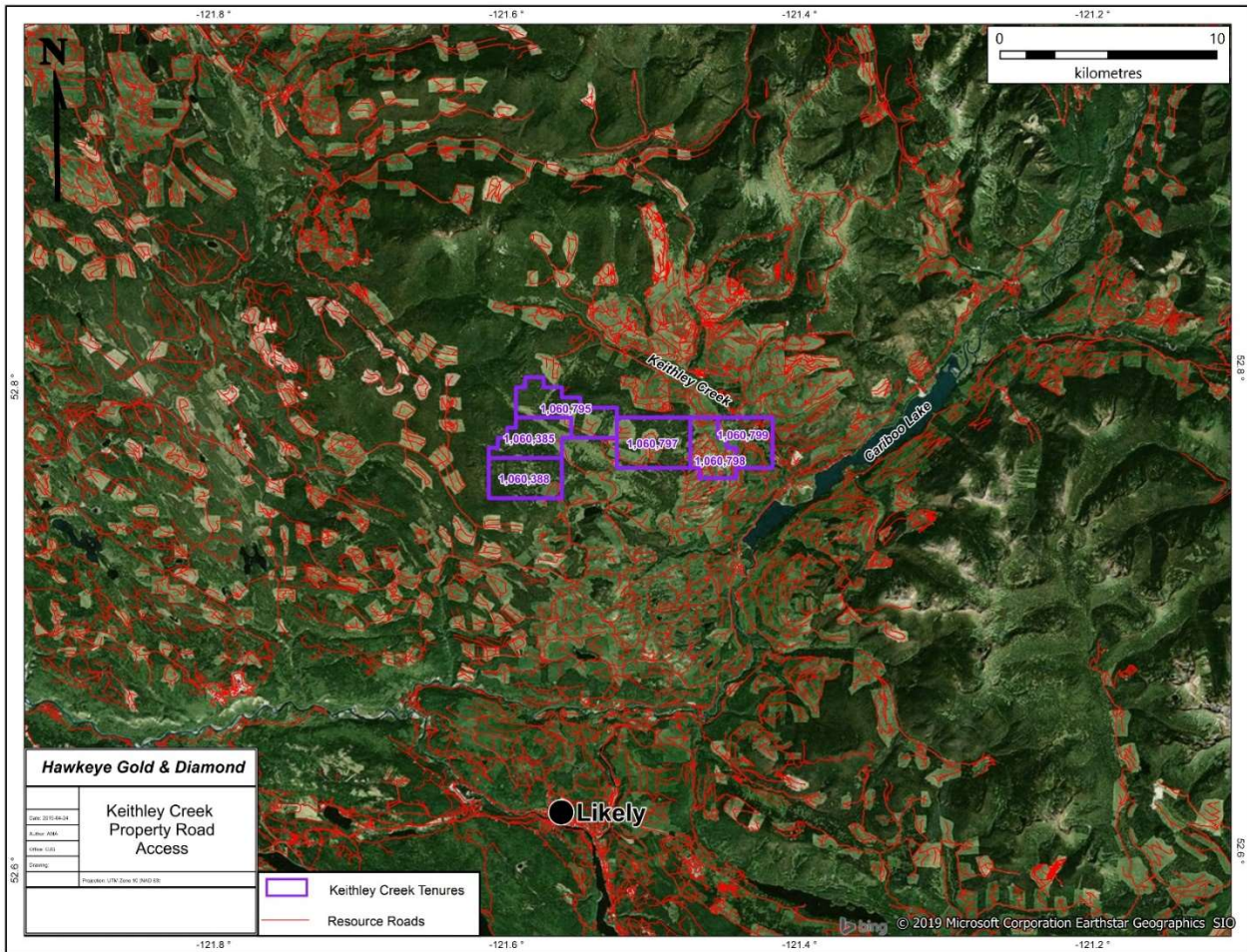


Figure 2. Keithley Creek mineral tenure location map on satellite imagery with resource roads

### 3.0 Claim Location and Description

The Keithley Creek property consists of 6 mineral tenures covering a total area of 3598.75 hectares (ha). The mineral tenures were optioned by Hawkeye from the vendor in 2017. Specifics concerning the mineral tenures are tabulated on Table 1, while the locations of individual tenures are shown on Figures 2 and 3.

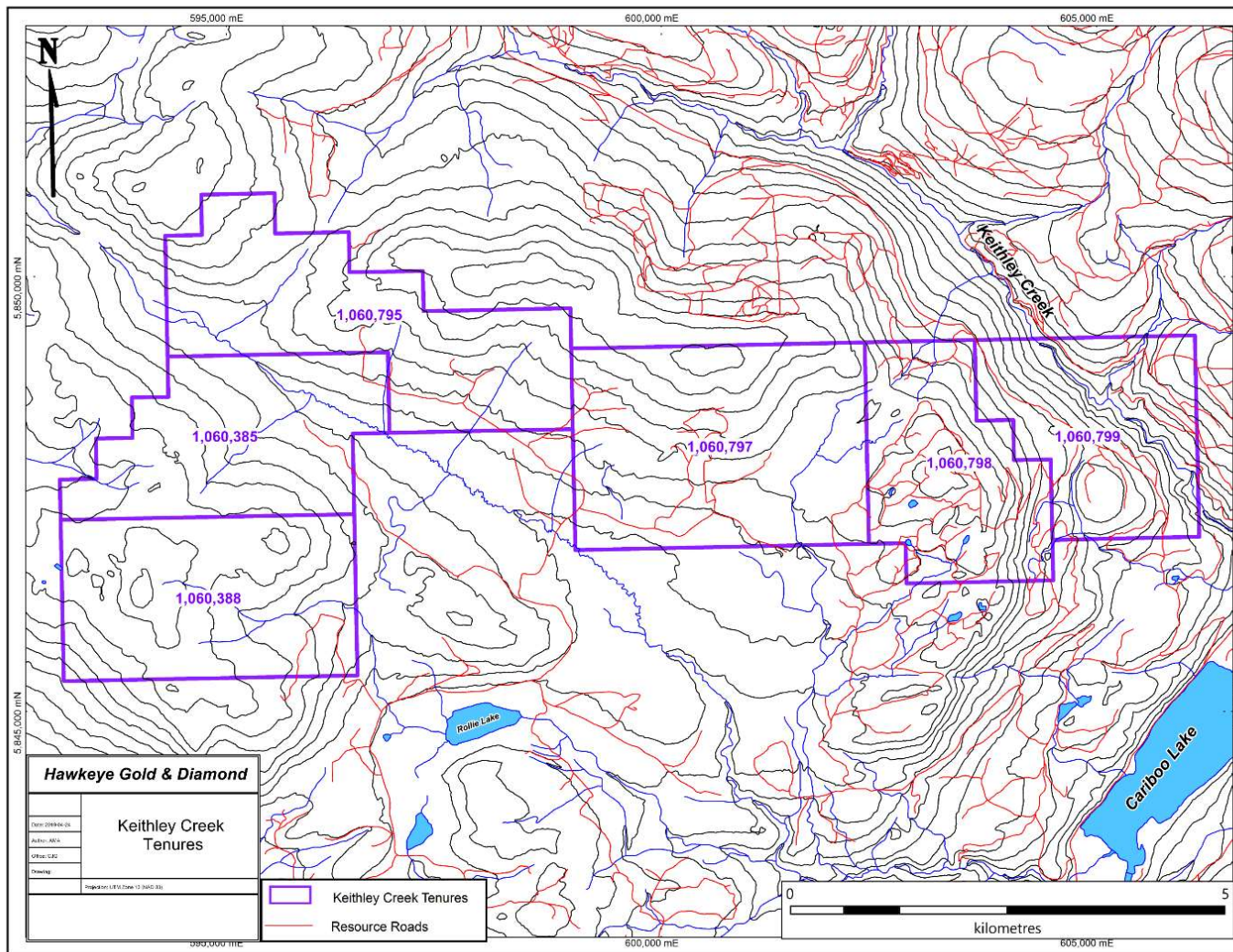


Figure 3. Keithley Creek property claim location map with resource roads

Table 1. List of mineral tenures

Claim Name	Tenure Number	Issue Date	Good to Date	Area (ha)
SURRUCA70	1060385	2018/May/02	2021/APR/01	547.6304
SURRUCA71	1060388	2018/May/02	2021/APR/01	626.0919
SURRUCA74	1060795	2018/May/27	2021/APR/01	684.3528
SURRUCA75	1060797	2018/May/27	2021/APR/01	782.3339
SURRUCA76	1060798	2018/May/27	2021/APR/01	469.4207
SURRUCA77	1060799	2018/May/27	2021/APR/01	488.9242

## 4.0 History

The Keithley Creek property is located southwest and along trend of the of the Cariboo Gold Belt, host to the world-class Barkerville gold camp with a rich history of mining dating from the Cariboo gold rush in the 1860's. Recorded gold production from the Cariboo Gold Belt totals more than 4.5 million ounces from alluvial and lode deposits ([www.barkervillegold.com/wp-content/uploads/2018/09/CorporateUpdateSeptember11\\_2018-1.pdf](http://www.barkervillegold.com/wp-content/uploads/2018/09/CorporateUpdateSeptember11_2018-1.pdf)).

From 1874 to 1945, placer gold has been mined from a number of sites along Keithley Creek, which crosses the easternmost edge of the Keithley Creek property. A considerable amount of underground work was carried out on a bench situated over 30 m above the creek. For the period of 1984 to 1945 there is a recorded production of almost 40,000 ounces of gold (Minfile: 093A 004).

In the 1980s, the BC Geological Survey collected over 4000 stream sediment samples to cover NTS map sheets 93A, 93B, G and N and parts of NTS map sheet 93H. The pulps of these samples were reanalysed by Geoscience BC in 2008 by inductively-coupled plasma mass spectrometry (ICP-MS). One stream sediment sample collected from a drainage on the western part of the Keithley Creek property (Sample ID: STRM93A805067) returned 19,432 ppb Au and 1.4 ppm Ag (Jackaman and Balfour, 2007 – Figure 5).

In 2005, Barker Minerals collected 6 stream sediment and 6 rock samples on the eastern part of the property. No analytical results were reported, however, Doyle (2005) recommended a second phase consisting of geological mapping along with geochemical and geophysical surveys (Assessment Report: 27954).

## 5.0 Regional and Property Geology

The Keithley Creek property is situated near the western margin of the Barkerville Subterrane, a subset of the Kootenay Terrane, with which it shares many similarities (Struik, 1986 and 1988 – Figure 4). The Barkerville Subterrane consists of a late Proterozoic and/or Paleozoic sequence of continental shelf and slope deposits developed adjacent to the craton of Ancestral North America, and includes clastic sedimentary rocks along with lesser amounts of volcanic rocks and carbonates. Rocks of the Keithley Creek property area have been metamorphosed from upper greenschist to lower amphibolite facies (Ferri and O'Brien, 2001).

Rocks of the Barkerville Subterrane were subjected to an early period of ductile deformation that resulted in a westward directed, asymmetrical folds that plunge shallowly to the northwest. Post metamorphic open folds with upright cleavage are superimposed on earlier structures. During Late Cretaceous to Early Tertiary time, the terrane was disrupted by northwest trending dextral strike-slip faults (Struik, 1988). Northwest- and north-trending faults, with an important normal component and generally apparent right lateral displacements, record extension, probably associated with transcurrent movement. The north striking cross faults are an important control for the gold-bearing vein systems within the Cariboo Gold Belt.

Immediately west of the property lies the Quesnel Terrane, which comprises an early Mesozoic island arc assemblage consisting of basaltic, andesitic, pyroclastic, volcanoclastic and greywacke rocks. The Quesnel Terrane has been thrust west to east onto the Barkerville Subterrane, along the Eureka Thrust Fault (Figure 5). To the east, the Cassiar Terrane, a late Proterozoic to Paleozoic sequence of continental shelf clastic and carbonate rocks have been thrust from east to west onto the Barkerville Subterrane along the Pleasant Valley Thrust Fault.

The Keithley Creek property is almost entirely underlain by Snowshoe Group rocks comprising the Keithley, Harveys Ridge and Goose Peak Successions, with lesser Devonian to Carboniferous orthogneiss and Upper Carboniferous to Permian serpentinite ultramafic rocks underlying the westernmost parts of the property (Figure 5). The Keithley Succession consists of thin to medium bedded and interlayered light green to grey micaceous quartz, the Harveys Ridge Succession is characterized by grey to dark grey or black phyllite, schist, siltstone, sandstone to impure quartzite and mafic volcanic rocks and the Goose Peak quartzite is characterized by thick to massive beds of greenish-grey to grey micaceous and feldspathic sandstone to quartzite and contains minor horizons of grey to dark grey phyllite or schist, siltstone wacke and chlorite schist (metavolcanics) (Ferri and O'Brien, 2001).

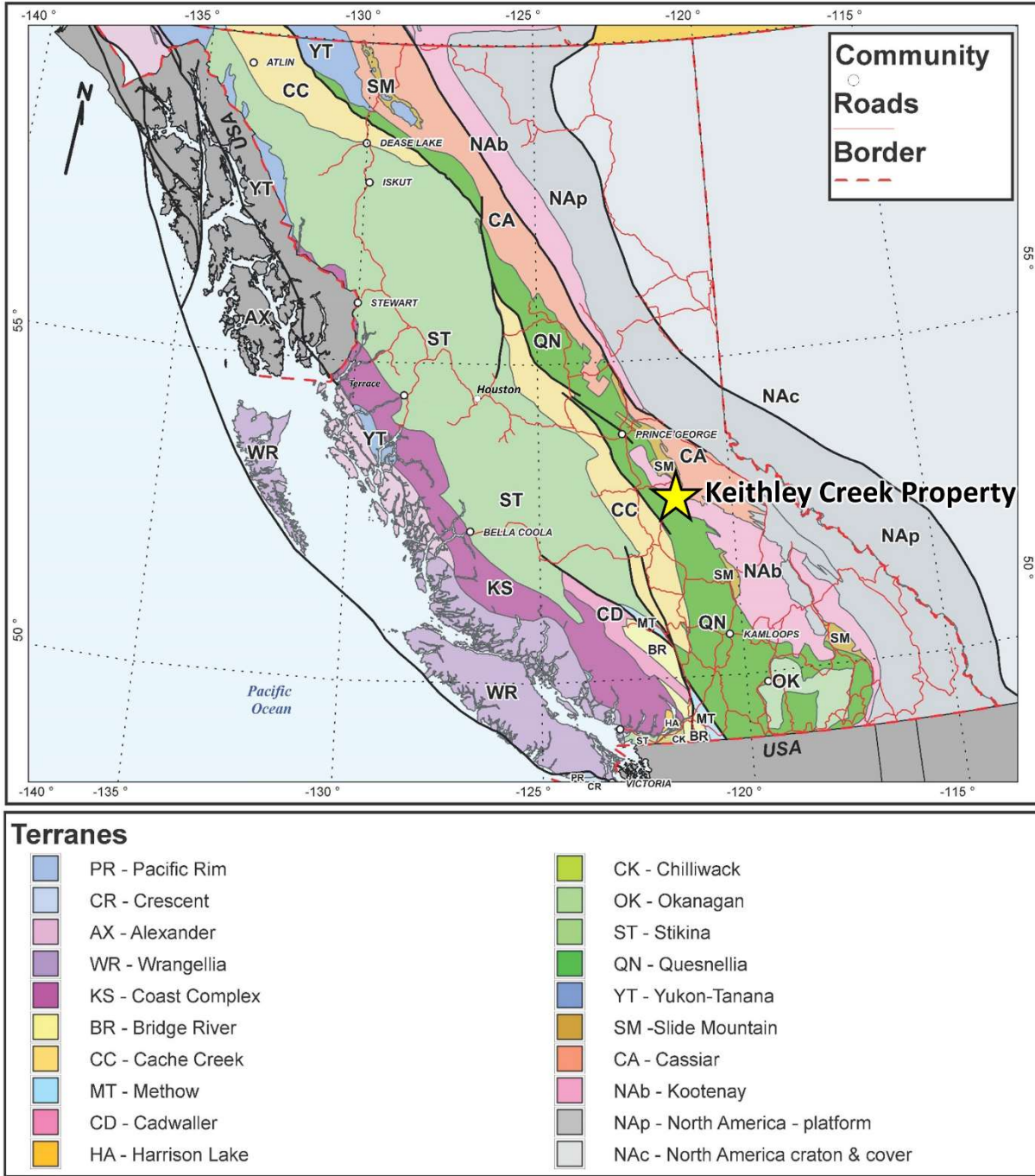


Figure 4. Cordilleran Terrane map with Keithley Creek property location after Colpron et al., 2007

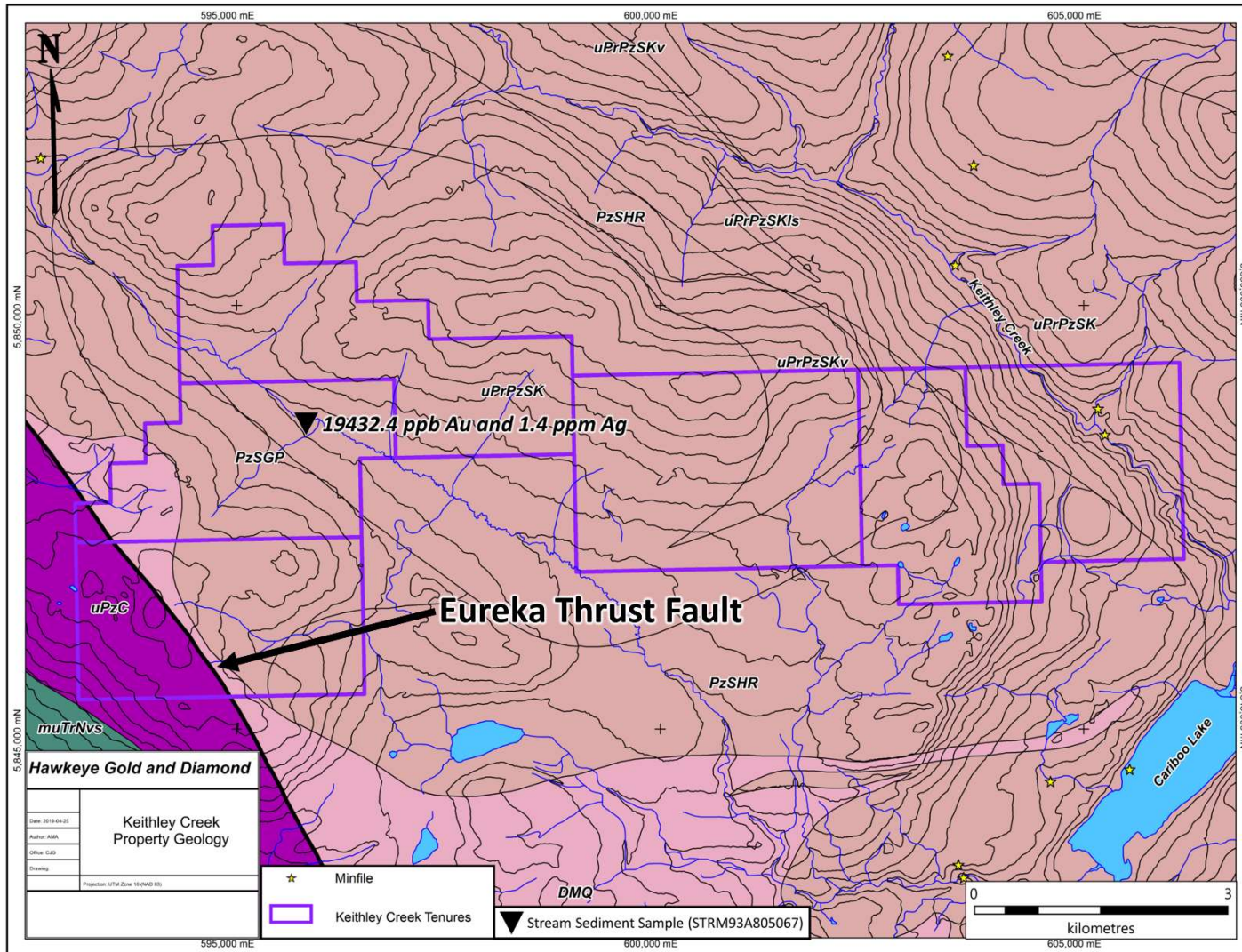
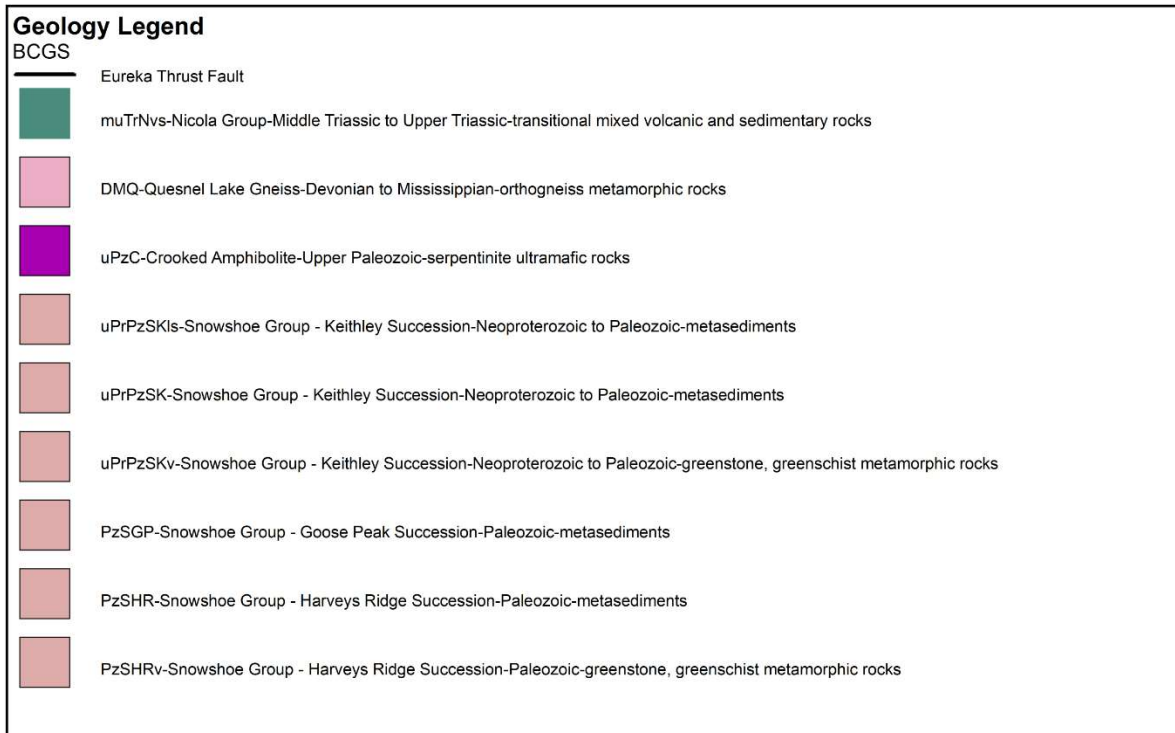


Figure 5. Keithley Creek property geology map after the BC Geological Survey, including regional stream sediment sample STRM93A805067 (Key below)



## 6.0 Mineralization

Hawkeye’s Keithley Creek property is situated within the Cariboo Gold Belt, an area that has produced over 4.5 million ounces of gold from alluvial and lode deposits. Barkerville Gold Mines published a resource of 1.60 million ounces of gold in the measured and indicated categories (8.1 million tonnes grading 6.1 g/t Au) and 2.16 million ounces of gold in the inferred category (12.7 million tonnes grading 5.2 g/t Au) from their Cariboo Gold projects, which are located approximately 35 km to the north-northeast of Keithley Creek property ([www.barkervillegold.com/wp-content/uploads/2018/09/CorporateUpdateSeptember11\\_2018-1.pdf](http://www.barkervillegold.com/wp-content/uploads/2018/09/CorporateUpdateSeptember11_2018-1.pdf)).

The Keithley Creek property area is known to host auriferous quartz vein and replacement styles of mineralization, with lesser volcanogenic massive sulphide (VMS) mineral occurrences. There is currently no recorded bedrock mineralization (only placer gold production from Keithley Creek – Minfile: 093A 004, 230) on the Keithley Creek property, however, brief descriptions summarizing the different types of mineralization in the area (primarily the Cariboo Gold Belt and associated deposits) are as follows:

### Gold-Bearing Quartz Veins

Four types of quartz veins have been recognized in the Cariboo Gold Belt (Johnston and Uglow, 1926; Hanson, 1935; Richards, 1948; Sutherland Brown, 1957; Robert and Taylor, 1989; Hall, 1999a). The quartz veins and their orientations are summarized below:

- 1) **Transverse (orthogonal) veins:** Typically strike northeast at 30-40° with sub-vertical to steep southeast dips. The Transverse veins are the most abundant type in the region and are generally small quartz extension veins with strike lengths of 0.5-5 m. Larger transverse veins are present within ore zones at the former Cariboo Gold Quartz mine (Minfile: 093H 019), and other locations in the district. At the Cariboo Gold Quartz mine the Transverse veins contained 60-70 % of the gold ore.
- 2) **Diagonal (oblique) veins:** Typically strike 70-90°, with vertical or north dipping in orientation at the Cariboo Gold Quartz mine, and steep south-dipping at the Island Mountain mine. Veins of this type are sinistral shear veins that generally have longer strike lengths than transverse veins. These veins are few in number but larger than the transverse veins and were the only veins mineable at the Island Mountain mine (Minfile: 093H 006).
- 3) **Strike veins:** The earliest vein set and strikes parallel to northwest trending bedding, parallel/subparallel to S2 foliation, and dip 45-70° to the northeast, generally more steeply than bedding. Although not abundant, these are the most prominent veins with the longest strike lengths in the district, forming resistant outcrops which were the focus of early lode gold prospecting and mining in the area. Veins of this type, including the BC Vein (093H 139), are generally erratically gold-bearing and only limited production has been obtained from them.

### **Pyrite Replacement**

Two types of pyrite replacement ore exist within the Cariboo Gold Belt. One type of replacement mineralization occurs within limestones, and the other type within clastic rocks.

- 1) **Pyrite Replacement in Limestone:** Ores of this type were historically mined from Mosquito Creek and Island Mountain Gold mines and occur within limestones. The ore bodies occur in the form of pipes or pencil-like ore shoots which plunge 45° to the northwest at an angle of 22°. Ore comprises fine-grained massive pyrite.
- 2) **Pyrite Replacement in Clastic Rocks:** Mineralization comprising auriferous fine-grained massive pyrite within clastic sedimentary rocks located at the Bonanza Ledge deposit (093H 140).

### **VMS Style Mineralization**

**Ace Showing (Minfile: 093A 142):** The Ace showing is located approximately 20 km east-northeast of the Keithley Creek property (Figure 6). The Ace showing was discovered in 1994 by Louis Doyle, who discovered mineralized boulders by following up flakes of gold found in a culvert along the “F” spur, a branch of Weldwood’s “8400” logging road in 1993 (Assessment Report No. 24989A). The Ace showing possibly represents a sheared, Besshi-style system with meta-sediments and volcanics of the Downey succession (Höy and Ferri, 1998a; Payne, 1999 – Assessment Report: 25904). Also, at the Ace showing, are boulders containing gold-rich quartz-sulphide veins. Grab samples of massive sulphide boulders from the Ace showing have returned up to 9.9% Zn and 7.7% Pb, while grab samples from the quartz-sulphide veins have returned up to 29 g/t Au.

**Frank Creek Showing (Minfile: 093A 152):** The Frank Creek showing is located approximately 6 km southeast of the Keithley Creek property (Figure 6). The Frank Creek showing likely represents Besshi or SEDEX-style mineralization. Significant assay results include up to 21.2% Cu, 0.73% Pb, 8.44% Zn and 165 g/t Ag within disseminations, blebs, stringers and semi-massive to massive sulphide lenses in a heavily altered sedimentary host rock. In 2011, Barker Minerals drilled 22.45 m grading 3.8 g/t Au in diamond drill hole FC11-03. In 2016 a rock sample (Sample 286) contained 501.2 g/t Au, while another sample (Sample 289) assayed 14.63 g/t Au, 0.025 % Cu and 0.058 % Zn (Assessment Report: 36449).

## **7.0 Geophysics**

### **7.1 Regional Airborne Magnetics**

In 2016, Barkerville Gold Mines identified a 60 km long gold-bearing structural trend (Cariboo Break) from a high resolution airborne magnetic survey (Barkerville Gold Mines Press Release, Dated October 4, 2016 - Figure 6). The Cariboo Break is interpreted as a major deep-seated shear zone which appears to have acted as a fluid pathway to focus gold mineralization along its length. It is characterized as a linear magnetic low coincident with auriferous soil samples that can be traced for more than 60 km. The Cariboo Break is situated approximately 12 km northeast of the Keithley Creek property.

### **7.2 2018 Airborne Magnetic Survey**

In 2018, an airborne magnetic survey was flown over the entire Keithley Creek property. Hawkeye contracted GEOTECH to fly a total of 282 line-km along east-west oriented lines spaced at 100 m apart. The detailed report is located in Appendix C of this report.

### **7.3 Interpretations of 2018 Airborne Magnetic Survey**

The survey identified a several features of interest on the Keithley Creek property (Figure 7). A northwest to southeast-trending linear magnetic low occurs on the western part of the property which likely represents the Eureka Thrust Fault. Directly west of the Eureka Thrust, is a strong magnetic high, which likely represents serpentinite ultramafic rocks of the Slide Mountain Group – the Crooked Amphibolite. A magnetic linear high approximately 6 km long by 0.4 km wide, striking northeast, transects the central part of the property and may represent magnetite-bearing dyke(s), sill(s) or orthogneiss.

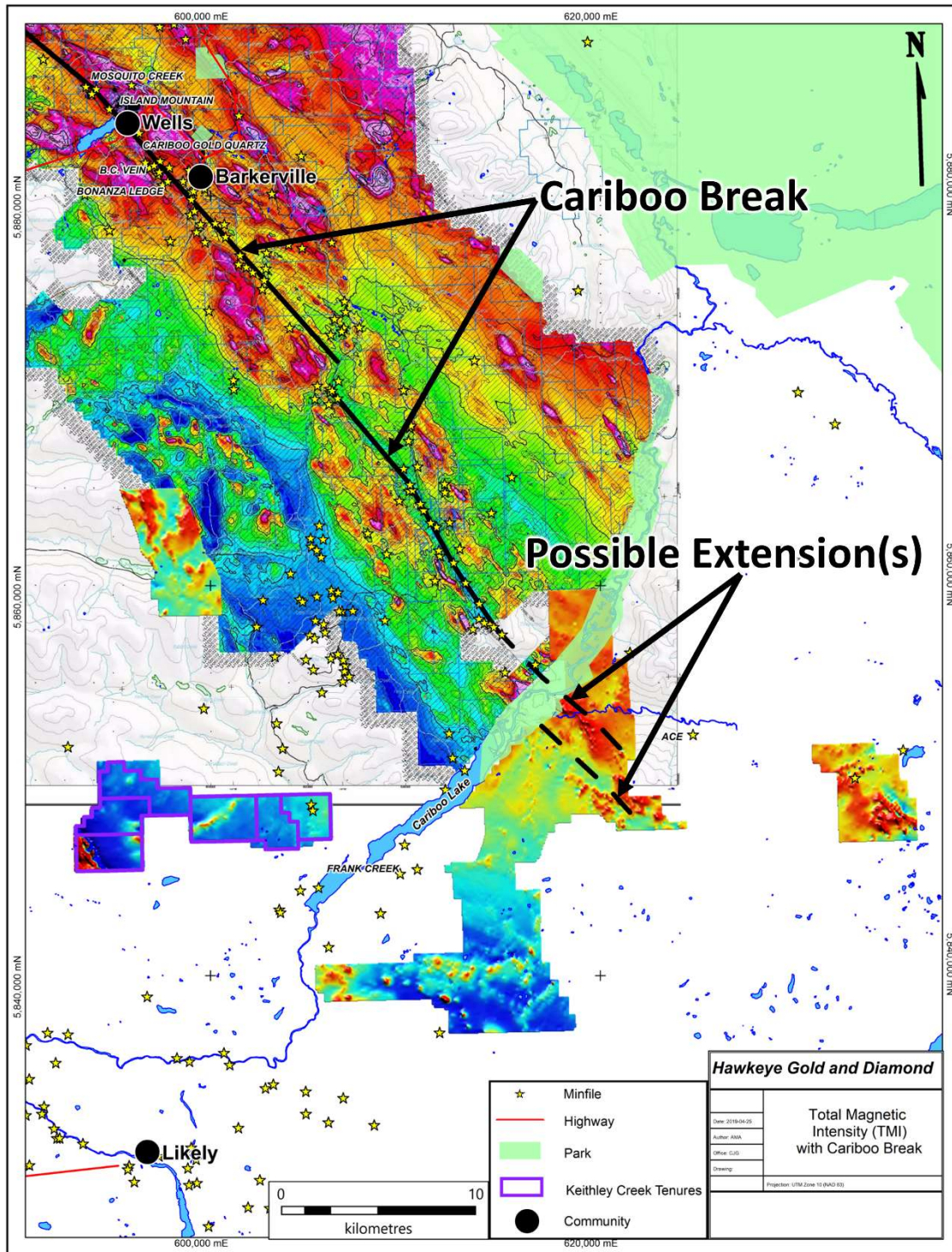


Figure 6. Cariboo Break identified by Barkerville Gold Mines from regional soil geochemistry and airborne magnetic surveys and regional mineral occurrences (<http://barkervillegold.com/wp-content/uploads/2017/06/j.pdf>)

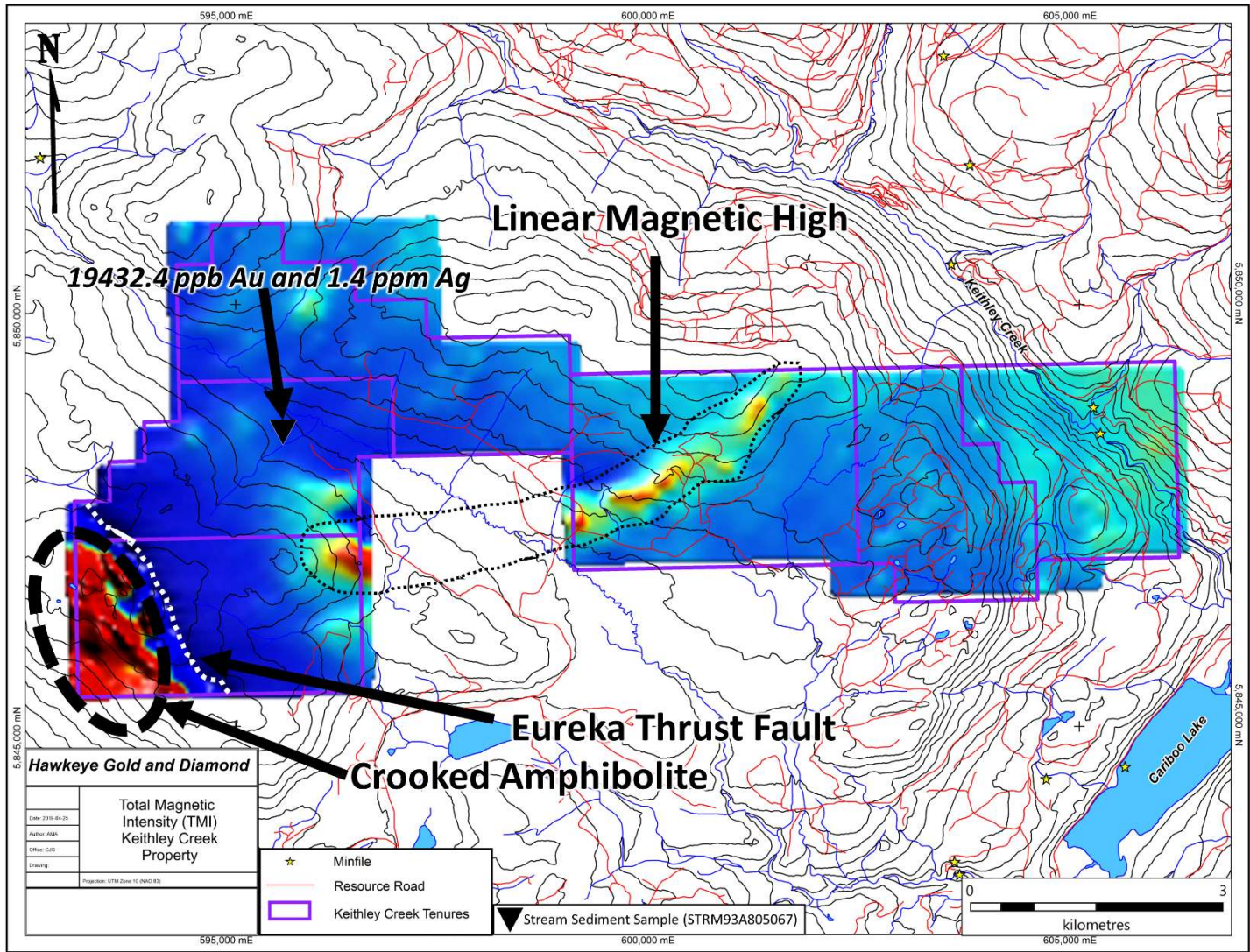


Figure 7. Airborne Total Magnetic Intensity survey data over the Keithley Creek property with interpreted geophysical anomalies

## 8.0 Conclusions

The Keithley Creek property is situated southwest of the of the Cariboo Gold Belt, an area that has produced over 4.5 million ounces of gold from alluvial and lode deposits. The region has a strong history of mining dating back to the 1860's during the Cariboo gold rush. Barkerville Gold Mines is currently conducting definition drilling at Cariboo Gold projects, located about 35 km to the north-northeast.

The detailed magnetic survey has outlined several areas of interest for ground-based exploration on the Keithley Creek property. The first phase of work should include prospecting, and stream sediment and contour soil geochemical sampling over geophysical anomalies and in the vicinity of stream sediment sample STRM93A805067, which returned 19,432.4 ppb Au and 1.4 ppm Ag. If results are favourable from the phase one program, detailed geological mapping and ground-based IP surveys should be implemented, and if areas of coincident geophysical and geochemical anomalies are outlined, they should be tested by diamond drilling.

## 9.0 References

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- Johnston, W. A. and Uglow, W. L. (1926). Placer and Vein Deposits of Barkerville, Cariboo District, British Columbia; Canada Department of Mines, No. 130, Memoir 149.
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Sutherland Brown, A. (1957). Geology of the Antler Creek Area, Cariboo Gold District, British Columbia, Department of Mines and Petroleum Resources, Bulletin 38.

\* All Assessment Reports are available on-line at <http://aris.empr.gov.bc.ca/>

\* BC Ministry of Energy, Mines and Petroleum Resources Exploration Assistant available online at [http://webmap.em.gov.bc.ca/mapplace/minpot/ex\\_assist.cfm](http://webmap.em.gov.bc.ca/mapplace/minpot/ex_assist.cfm)

\* Minfile descriptions are available on-line at <http://minfile.gov.bc.ca/searchbasic.aspx>

\* All BC GSB publications are available on-line at

<http://www.empr.gov.bc.ca/MINING/GEOSCIENCE/PUBLICATIONSCATALOGUE/Pages/default.aspx>

# Appendix A: Statements of Qualifications

I, Arron M. Albano, of 950 Tillar Road, Naramata, British Columbia, Canada, hereby certify that:

1. I am a graduate of the University of British Columbia with a B.Sc. (Geological Sciences, 2017) and have practiced my profession continuously from 2014 to present.
2. I have been employed in the geoscience industry for 5 years and have explored for gold and base metals in British Columbia, Canada, for junior exploration companies as well as one mid-tier mining company.
3. I am a Geoscientist in Training from the Association of Professional Engineers and Geoscientists of British Columbia (license #202310).
4. I am not aware of any material fact or material change with respect to the subject matter of the technical report that is not reflected in the technical report, the omission to disclose which makes the technical report misleading.
5. I have no direct or indirect interest in the property described herein, nor do I expect to receive any.
6. I am an author of the report entitled; “Airborne Magnetic Surveying at the Keithley Creek Property” dated May 14, 2019.

Dated at Penticton, British Columbia, this 14th day of May, 2019

*“A M Albano”*

Arron M. Albano, B.Sc., G.I.T.

I, Andrew Mitchell of 1090 Lacombe Road, Kelowna, British Columbia, Canada, hereby certify that:

- 1) I graduated from the University of British Columbia in 2010 with a B.Sc. in Earth and Environmental Sciences
- 2) From 2010 to present, I have been actively engaged in mineral exploration in Yukon Territory and British Columbia.
- 3) I am a member in good standing of the Association of Professional Engineers and Geoscientists of British Columbia (license #46211)
- 4) I have interpreted all data resulting from this work.
- 5) I am a co-author of the report entitled: “Airborne Magnetic Surveying at the Keithley Creek Property,” dated May 14, 2019.

Dated at Penticton, British Columbia, this 14th day of May, 2019.

Respectfully submitted,

*“Andrew James Mitchell”*

Andrew J. Mitchell, B.Sc., P.Geo.

# **Appendix B: Statement of Costs**

***Keithley Creek Property Statement of Work***

	<b>line-kilometers</b>	<b>Subtotal</b>
Airborne Magnetic Survey	282	\$32,628.81
Report writing	1.538 days @ \$650/day	\$ 1,000.00
	<b>Total</b>	<b>\$33,628.81</b>

# **Appendix C: Heliborne High Resolution Aeromagnetic Survey**



# HELISTINGER

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REPORT ON A HELICOPTER-BORNE AEROMAGNETIC  
GEOPHYSICAL SURVEY

PROJECT: KEITHLEY CREEK  
LOCATION: LIKELY, BRITISH COLUMBIA  
FOR: HAWKEYE GOLD & DIAMONDS INC.  
SURVEY FLOWN: NOVEMBER – DECEMBER 2018  
PROJECT: GL180345

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## EXECUTIVE SUMMARY

### KEITHLEY CREEK BLOCK LIKELY, BRITISH COLUMBIA

From November 16<sup>th</sup> to December 7<sup>th</sup>, 2018 Geotech Ltd. carried out a helicopter-borne geophysical survey over the Keithley Creek Block situated near Likely, British Columbia.

The principal geophysical sensor was a caesium magnetometer. Ancillary equipment included a GPS navigation system, radar altimeter and laser altimeter. A total of 289 line-kilometres of geophysical data were acquired during the survey.

In-field data quality assurance and preliminary processing were carried out on a daily basis during the acquisition phase. Preliminary and final data processing, including generation of final digital data and map products were undertaken from the office of Geotech Ltd. in Aurora, Ontario.

The processed survey results are presented as the following maps:

- Total Magnetic Intensity (TMI),
- Calculated Vertical Gradient (CVG)
- Digital Terrain Model (DEM)

The survey report describes the procedures for data acquisition, description of equipment processing, final image presentation and the specifications for the digital data set.

# 1. INTRODUCTION

## 1.1 GENERAL CONSIDERATIONS

Geotech Ltd. performed a helicopter-borne geophysical survey over the Keithley Creek Block situated near Likely, British Columbia ( Figure 1 & Figure 2).

Greg Neeld represented Hawkeye Gold & Diamonds Inc. during the data acquisition and data processing phases of this project.

The geophysical survey consisted of helicopter-borne aeromagnetics using a caesium magnetometer system. A total of 289 line-km of geophysical data were acquired during the survey.

The crew was based out of Likely, within the project area, for the acquisition phase of the survey. Survey flying started on November 16<sup>th</sup>, 2018 and was completed on December 7<sup>th</sup>, 2018.

Data quality control and quality assurance, and preliminary data processing were carried out on a daily basis during the acquisition phase of the project. Final data processing followed immediately after the end of the survey. Final reporting, data presentation and archiving were completed from the Aurora office of Geotech Ltd. in January, 2017.



Figure 1: Survey location.

## 1.2 SURVEY AND SYSTEM SPECIFICATIONS

The survey area was located approximately 15 kilometres north of Likely, British Columbia (Figure 2).

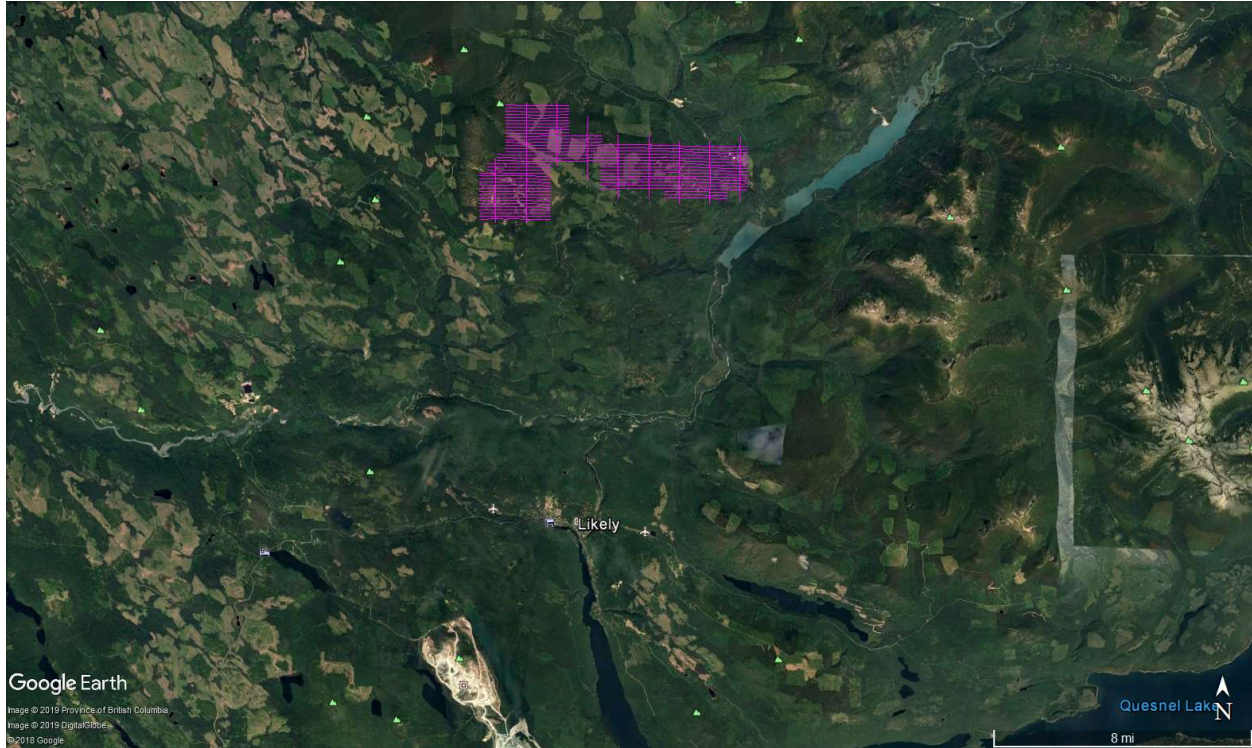


Figure 2: Survey area locations on Google Earth.

The survey was flown in an east to west (N 90° E azimuth) direction, with traverse line spacing of 150 as depicted in Figure 3. Tie lines were flown perpendicular to the traverse lines. For more detailed information on the flight spacing and direction see Table 1.

### 1.3 TOPOGRAPHIC RELIEF AND CULTURAL FEATURES

Topographically, the survey area exhibits a moderate relief with an elevation ranging from 897 to 1622 metres above mean sea level over an area of 38 square kilometres.

There are various rivers and streams running through the survey area which connect various lakes and wetlands. There are no visible signs of culture such as roads and buildings located in the survey area. (Figure 3)

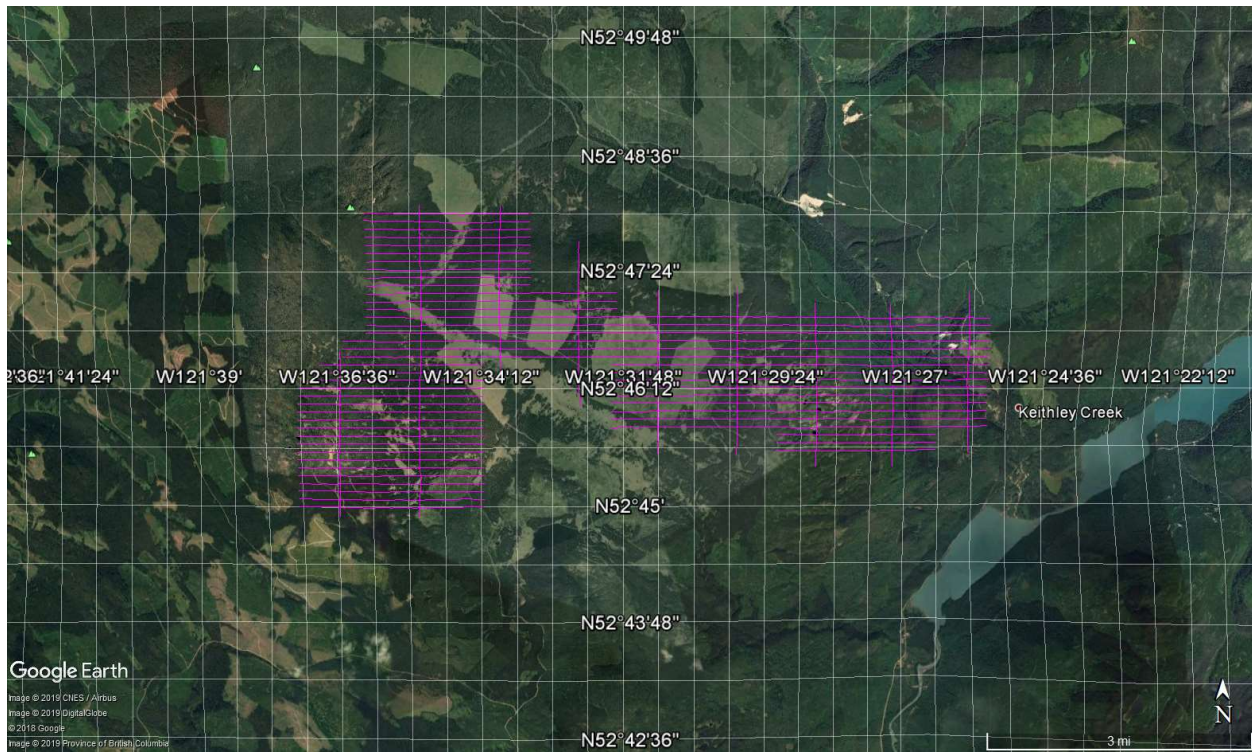


Figure 3: Flight path over a Google Earth Image.

## 2. DATA ACQUISITION

### 2.1 SURVEY AREA

The survey area (see Figure 3 and Appendix A) and general flight specifications are as follows:

**Table 1: Survey Specifications**

Survey block	Line spacing (m)	Area (Km <sup>2</sup> )	Planned <sup>1</sup> Line-km	Actual Line-km	Flight direction	Line numbers
Keithley Creek	Traverse: 150	20	282	289	N 90° E / N 270° E	L1000 – L1370
	Tie: 1500				N 0° E / N 180° E	T2000 – T2080
TOTAL		20	282	289		

Survey area boundaries co-ordinates are provided in Appendix B.

### 2.2 SURVEY OPERATIONS

Survey operations were based out of Likely, British Columbia from November 16<sup>th</sup> until December 7<sup>th</sup> 2018. The following table shows the timing of the flying.

**Table 2: Survey schedule**

Date	Comments
2018-11-16	Crew arrived in Okotoks, AB. Completed local logistics.
2018-11-17	Commenced system assembly.
2018-11-18	Completed system assembly.
2018-11-19	Commenced system testing, mag issue observed during testing. Commenced troubleshooting and located source, requested part from the office.
2018-11-20	Crew received shipment from the office.
2018-11-21	Replaced part, completed test line. Unable to complete high altitude test flights due to extreme high winds at altitude, will complete once onsite. Ground crew commenced mobilization towards Likely, BC.
2018-11-22	Ground crew arrived onsite, Heli arrival delayed due to weather.
2018-11-23	Heli arrival delayed due to weather, tested base stations.
2018-11-24	Heli arrived on site in the afternoon, completed recon flight, will re-adjust flying height due to 120-130ft trees in the survey area. Unable to complete test flights due to low ceilings.
2018-11-25	No test flights completed due to weather, low ceilings.
2018-11-26	No test flights completed due to weather, rain throughout the day.
2018-11-27	No test flights completed due to weather, rain and low ceilings throughout the day.
2018-11-28	Late start due to weather, crew was able to complete high altitude test flights, system cleared for production.
2018-11-29	1 short production flight completed in the morning, aborted due to low ceilings, once weather improved 2nd production flight completed in the afternoon, 267km flown.
2018-11-30	Late start due to weather, 2 production flights completed, 249km flown.
2018-12-01	Late start due to weather, 2 production flights completed, 222km flown.
2018-12-02	Late start due to weather, 1 production flight completed, 138km flown.
2018-12-03	2 short production flights completed, 53km flown. Some troubleshooting required.
2018-12-04	Completed troubleshooting, test flight completed, 9km flown.

<sup>1</sup> Note: Actual Line kilometres represent the total line kilometres in the final database. These line-km normally exceed the Planned Line-km, as indicated in the survey NAV files.

2018-12-05	Attempted production flight but aborted due to weather, low ceilings throughout the day.
2018-12-06	3 production flights completed, 355km flown.
2018-12-07	3 production flights completed, 169km flown. Flight Path Completed.

## 2.3 FLIGHT SPECIFICATIONS

During the survey the helicopter was maintained at a mean altitude of 70 metres above the ground with a nominal survey speed of 140 km/hour.

The on-board operator was responsible for monitoring the system integrity. The operator also maintained detailed flight logs during the survey, tracking the times of the flight as well as any unusual geophysical or topographic features.

On return of the aircrew to the base camp the survey data was transferred from a compact flash card (PCMCIA) to the data processing computer. The data were then uploaded via ftp to the Geotech office in Aurora for daily quality assurance and quality control by qualified personnel.

## 2.4 AIRCRAFT AND EQUIPMENT

### 2.4.1 SURVEY AIRCRAFT

The survey was flown using an Aerospatiale A-Star 350 B2, registration C-GXAH. The helicopter is owned and operated by Yellowhead Helicopters. Installation of the geophysical and ancillary equipment was carried out by a Geotech Ltd crew.

### 2.4.2 AIRBORNE MAGNETOMETER

The magnetic sensor utilized for the survey was Geometrics optically pumped cesium vapour magnetic field sensor was installed inside the stinger. The sensitivity of the magnetic sensor is 0.01 nanoTesla (nT) at a sampling interval of 0.025 seconds or at sampling frequency of 40Hz.

### 2.4.3 MAGNETIC COMPENSATION SYSTEM

The magnetic data were compensated in real-time using an RMS Instruments AARC510 Compensator, utilizing a three-axis (XYZ) Fluxgate magnetometer to measure roll, pitch and yaw movements of the survey aircraft. A 26-term model of the aircraft magnetic noise was determined during a pre-survey test flight, removing permanent, induced, and eddy current fields from the airborne magnetic measurements. The efficacy of this compensation was tested with a Figure of Merit (FOM) test; the total FOM was determined to be 1.071 nT (Appendix D).

### 2.4.4 ALTIMETER

A Terra TRA 3000/TRI 40 radar altimeter was used to record terrain clearance.

### 2.4.5 VIDEO CAMERA

A colour 550 High-Resolution camera with auto gain control, 550 line resolution was used with a standard 3.6mm lens. Digital files provided with resolution of 768 by 494 at selectable 1-30 frames per second.

### 2.4.1 LASER ALTIMETER

A Schmitt Industries AR300 laser altimeter was used. Altitude range 0.5 to 300m and accuracy  $\pm 5$ cm.



Figure 4: System Configuration.

#### 2.4.2 GPS NAVIGATION SYSTEM

The navigation system used was a Geotech PC104 based navigation system utilizing a NovAtel's WAAS (Wide Area Augmentation System) enabled GPS receiver, Geotech navigation software, a full screen display with controls in front of the pilot to direct the flight and a NovAtel GPS antenna mounted on the helicopter tail (Figure 4). As many as 11 GPS and two WAAS satellites may be monitored at any one time. The positional accuracy or circular error probability (CEP) is 1.8 m; with WAAS active, it is 1.0 m. The co-ordinates of the block were set-up prior to the survey and the information was fed into the airborne navigation system.

### 2.4.3 DIGITAL ACQUISITION SYSTEM

A Geotech data acquisition system recorded the digital survey data on an internal compact flash card. Data is displayed on an LCD screen as traces to allow the operator to monitor the integrity of the system. The data type and sampling interval as provided in Table 3.

**Table 3:** Acquisition Sampling Rates

Data Type	Sampling
Magnetometer	0.025 sec
GPS Position	0.2 sec
Pressure and Temperature	1 sec
Radar Altimeter	0.2 sec

### 2.5 BASE STATION MAGNETOMETER

A dedicated computer including a high sensitivity base station cesium magnetometer and a GPS system to record the GPS time together with the magnetic data was employed to record diurnal magnetic activity. A Geometrics G822B high-sensitivity caesium vapour magnetometer and integrated GPS unit for accurate time synchronization was used with 10Hz data output. Digital recordings of the ground magnetometer were recorded at all times during the survey. The digital data include the date, an absolute value of the magnetic field, and GPS time with accurate synchronization to the aircraft data acquisition system.

The base station magnetometer sensor was installed near the landing site, away from electric transmission lines and moving ferrous objects such as motor vehicles. The base station data were backed-up to the data processing computer at the end of each survey day.

### 2.6 GPS GROUND BASE STATION

A dedicated Novatel PROPAK-V3\_TR20 GPS receiver and a dedicated ground based GPS antenna was used with a 10Hz Raw GPS data recording. Post-flight differential GPS data processing utilizing Novatel GrafNav 8.3 software was used to produce sub-meter accuracy of the airborne system location at 10Hz sampling interval.

### 3. PERSONNEL

The following Geotech Ltd. personnel were involved in the project.

#### FIELD:

Project Manager:	Shauna-Lee Hewitt (Office)
Data QC:	Dmitriy Danchenko (Office)
Crew chief:	Juan Carlos Florez Osorio
Operator:	n/a

The survey pilot and the mechanical engineer were employed directly by the helicopter operator – Yellowhead Helicopters.

Pilot:	Jason Cyr
Mechanical Engineer:	n/a

#### OFFICE:

Preliminary Data Processing:	Dmitriy Danchenko
Final Data Processing:	TaiChyi Shei
Data QA/QC:	Zihao Han Kanita Khaled
Reporting/Mapping:	Joseli Soares

Processing and Interpretation phases were carried out under the supervision of Alexander Prikhodko, P.Geo, PhD, and Director of Geophysics. The customer relations were looked after by Jean M. Legault.

## 4. DATA PROCESSING AND PRESENTATION

Data compilation and processing were carried out by the application of Geosoft Oasis Montaj and programs proprietary to Geotech Ltd.

### 4.1 FLIGHT PATH

The flight path, recorded by the acquisition program as WGS 84 latitude/longitude, was converted into the WGS84 Datum, UTM Zone 10 North coordinate system in Oasis Montaj.

The flight path was drawn using linear interpolation between x, y positions from the navigation system. Positions are updated every second and expressed as UTM easting's (x) and UTM northing's (y).

### 4.2 MAGNETIC DATA

The processing of the magnetic data involved a correction for diurnal variations by using the digitally recorded ground base station magnetic values. The base station magnetometer data was edited and merged into the Geosoft GDB database on a daily basis. The aeromagnetic data was corrected for diurnal variations by subtracting the observed magnetic base station deviations.

Tie line levelling was carried out by adjusting intersection points along traverse lines. A micro-levelling procedure was applied to remove persistent low-amplitude components of flight-line noise remaining in the data.

The corrected magnetic data was interpolated between survey lines using a random point gridding method to yield x-y grid values for a standard grid cell size of 37.5 metres at the mapping scale. The Minimum Curvature algorithm was used to interpolate values onto a rectangular regular spaced grid.

## 5. DELIVERABLES

### 5.1 SURVEY REPORT

The survey report describes the data acquisition, processing, and final presentation of the survey results. The survey report is provided in two paper copies and digitally in PDF format.

### 5.2 MAPS

Final maps were produced at scale of 1:15,000 for best representation of the survey size and line spacing. The coordinate/projection system used was WGS84 Datum, UTM Zone 10 North. All maps show the flight path trace and topographic data; latitude and longitude are also noted on maps.

The preliminary and final results of the survey are presented as a colour TMI contour map and vertical derivative colour maps.

- Maps at 1:15,000 in Geosoft MAP format, as follows:

GL180345_15K_TMI_KeithleyCreek:	Total Magnetic Intensity (TMI)
GL180345_15k_CVG_KeithleyCreek:	Calculated Vertical Gradient (CVG)
GL180345_15k_DEM_KeithleyCreek:	Digital Elevation Model (DEM)

- Maps are also presented in PDF format.
- The topographic data base was derived from 1:50,000 Natural Resources Canada NTDB data [www.geogratis.ca](http://www.geogratis.ca)
- A Google Earth file *GL180345\_Hawkeye\_KeithleyCreek.kml* showing the flight path of the block is included. Free versions of Google Earth software from: <http://earth.google.com/download-earth.html>

### 5.3 DIGITAL DATA

Two copies of the data on DVD were prepared to accompany the report. Each DVD contains a digital file of the line data in GDB Geosoft Montaj format as well as the maps in Geosoft Montaj Map and PDF format.

- DVD structure.

Data contains databases, grids and maps, as described below.  
 Report contains a copy of the report and appendices in PDF format.

Databases in Geosoft GDB format, containing the channels listed in Table 4.

**Table 4:** Geosoft GDB Data Format

Channel Name	Description
X	X Easting Positional data (meters) – WGS84 UTM 10N
Y	Y Northing Positional data (meters) – WGS84 UTM 10N
Z	GPS antenna elevation (meters – ASL)
Longitude	WGS84 GPS longitude (decimal degrees) from x
Latitude	WGS84 GPS latitude (decimal degrees) from y
Date	Flight Date (YYYY/MM/DD)
gtime	UTC time, second of the day
Fiducial	Sample Number
Flight	Survey Flight Number
Radar	Aircraft Terrain Clearance from Radar altimeter (metres)
DEM	Digital elevation model derived from Radar altimeter (metres)
Flux_X	Vector Magnetometer X Component (nT)
Flux_Y	Vector Magnetometer Y Component (nT)
Flux_Z	Vector Magnetometer Z Component (nT)
TFCMP1	Raw Total Compensated Magnetic field (nT)
Mag1	De-spiked and compensated Total Magnetic field (nT)
Basemag	Magnetic diurnal variation (nT)
Mag2	Diurnal corrected Total Magnetic field (nT)
Mag3	Final Levelled Total Magnetic field (nT)
CVG	First Vertical Derivative of Total Magnetic field (nT/m)

- Grids in Geosoft GRD and GeoTIFF format, as follows:

GL180345\_TMI\_KeithleyCreek: Total magnetic intensity (nT)  
 GL180345\_CVG\_KeithleyCreek: Calculated Vertical Derivative of TMI (nT/m)  
 GL180345\_DEM\_KeithleyCreek: Digital Elevation Model (metres)

A Geosoft .GRD file has a .GI metadata file associated with it, containing grid projection information. A grid cell size of 37.5 metres was used.

## 6. CONCLUSIONS AND RECOMMENDATIONS

A helicopter-borne geophysical survey has been completed over the Keithley Creek Block situated near Likely, British Columbia.

The total area coverage is 38 km<sup>2</sup>. Total survey line coverage 289 line kilometres. The principal sensor was a high-sensitivity caesium magnetometer. Results have been presented as contour colour images at a scale of 1:15,000. A formal Interpretation has not been included or requested.

Based on the geophysical results obtained a formal magnetic interpretation is recommended and can be completed by Geotech. This includes the structural interpretation and 3D magnetic inversion and geological integration.

Respectfully submitted<sup>2</sup>,



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Dmitriy Danchenko  
**Geotech Ltd.**



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Tai-chyi Shei  
**Geotech Ltd.**



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Kanita Khaled, P.Geo  
**Geotech Ltd.**



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Joseli Soares  
**Geotech Ltd.**



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Alexander Prikhodko, P.Geo, PhD  
**Geotech Ltd.**  
January, 2019.



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Zihao Han  
**Geotech Ltd.**

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<sup>2</sup> Final data processing of the EM and magnetic data were carried out by Tai-chyi Shei, from the office of Geotech Ltd. in Aurora, Ontario, under the supervision of Alexander Prikhodko, P.Geo.

## APPENDIX A

### SURVEY AREA LOCATION MAP



Overview of the Survey Area

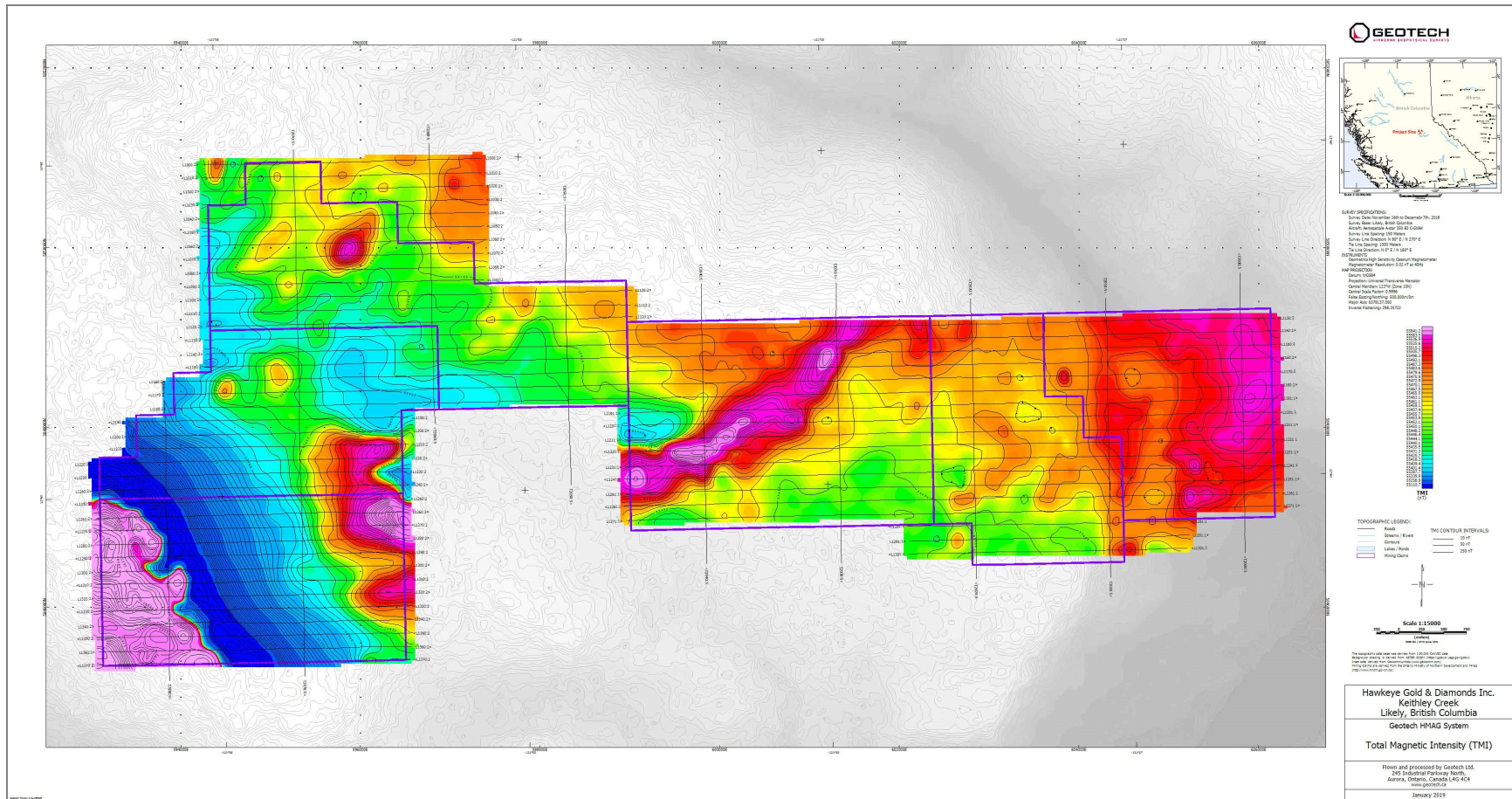
## APPENDIX B

### SURVEY AREA COORDINATES

(WGS 84, UTM Zone 10 North)

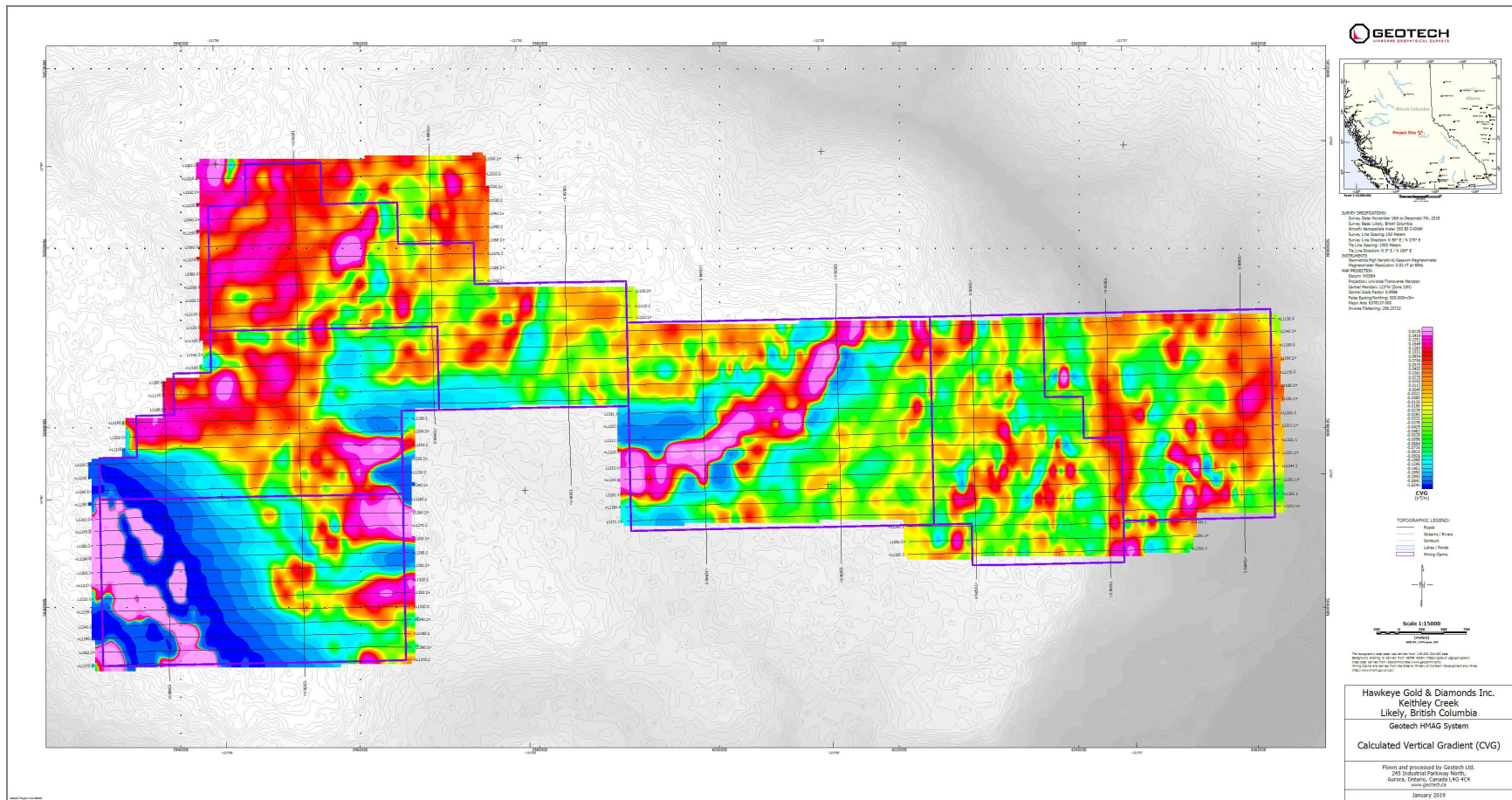
Keithley Creek	
X	Y
606130	5849323
598965	5849172
598955	5849636
597324	5849603
597317	5850529
597286	5850988
594287	5850925
594300	5850470
594337	5848616
593916	5848608
593925	5848144
593503	5848136
593512	5847673
593090	5847665
593135	5845347
596509	5845413
596454	5848193
598984	5848245
599012	5846855
602161	5846915
602165	5846462
605164	5846526
605160	5846979
606181	5847007

# APPENDIX C - GEOPHYSICAL MAPS<sup>1</sup>

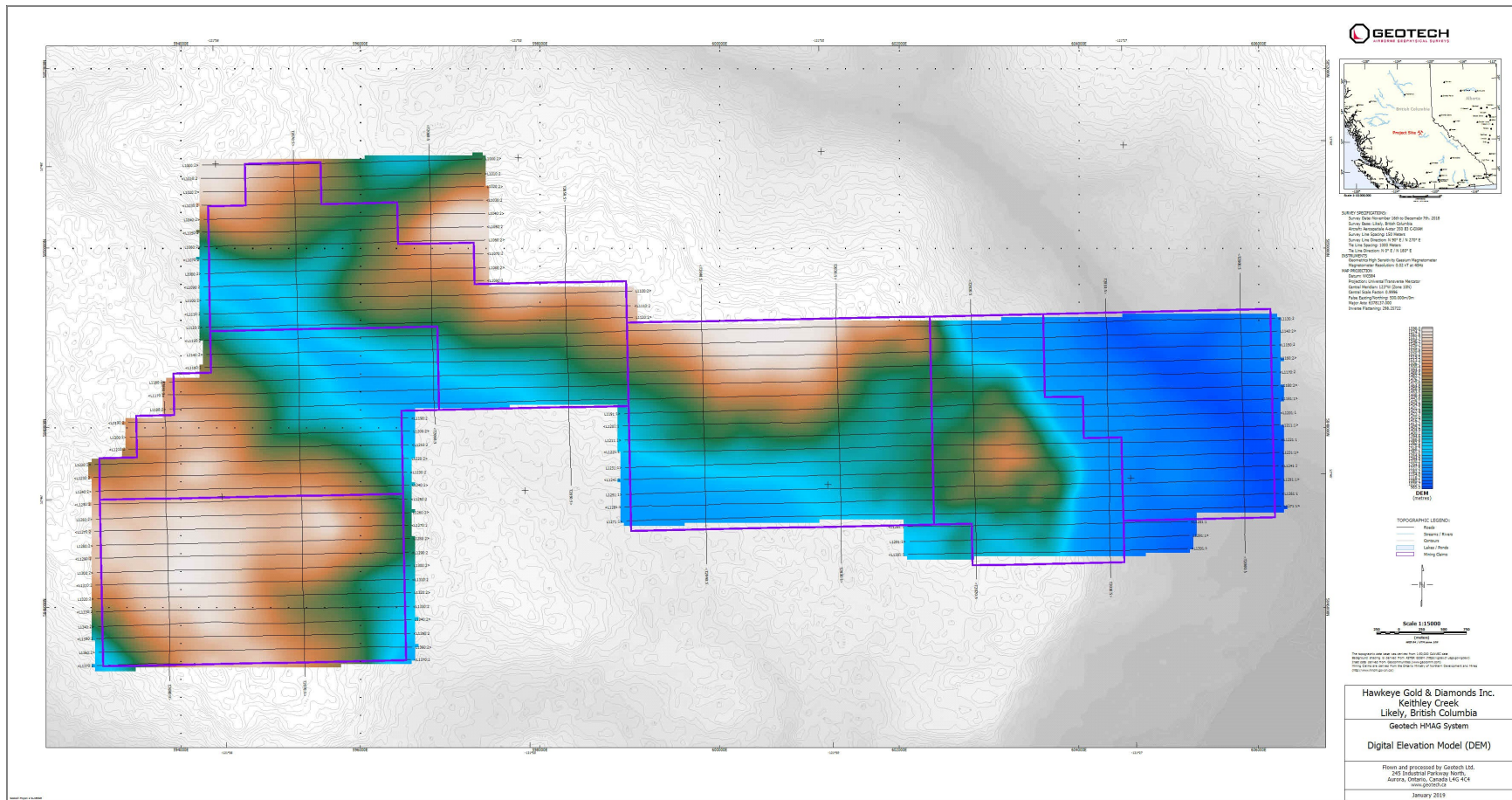


Total Magnetic Intensity (TMI)

<sup>1</sup> Full size geophysical maps are also available in PDF format on the final DVD



Calculated Vertical Gradient (CVG)



Digital Elevation Model (DEM)

## APPENDIX D

### FIGURE OF MERIT TEST

The Figure of Merit test was performed immediately after the compensation solution was acquired during a high-altitude test near Dragon, BC, on November 28, 2018.

During the test, the aircraft duplicates the roll, pitch and yaw maneuvers performed during the compensation test in all four survey directions. The absolute errors from each of the 12 manoeuvres are summed, and should be less than 2.0nT to confirm adequate compensation.

Figure of Merit result:

#### Total Field 1 (Stinger Sensor)

Direction	Roll	Pitch	Yaw	Total
0	0.118	0.125	0.088	<b>0.331</b>
90	0.088	0.079	0.098	<b>0.265</b>
180	0.109	0.068	0.086	<b>0.263</b>
270	0.063	0.075	0.074	<b>0.212</b>
<b>Total</b>	<b>0.378</b>	<b>0.347</b>	<b>0.346</b>	<b>1.071</b>

FOM = 1.071 nT