



**BC Geological Survey
Assessment Report
41824**



ASSESSMENT REPORT TITLE PAGE AND SUMMARY

TITLE OF REPORT: Technical Report OPL and HALO Properties

TOTAL COST:\$48,585.98

**AUTHOR(S):D Manley Fredlund
SIGNATURE(S):**

**NOTICE OF WORK PERMIT NUMBER(S)/DATE(S):
STATEMENT OF WORK EVENT NUMBER(S)/DATE(S):OPL-5998811. Oct3/23
HALO- 6017420. Feb28/24**

YEAR OF WORK:2023

PROPERTY NAME:OPL Group, HALO Group

CLAIM NAME(S) (on which work was done): all

COMMODITIES SOUGHT: base and precious metals

MINERAL INVENTORY MINFILE NUMBER(S),IF KNOWN:

MINING DIVISION: Cranbrook

NTS / BCGS:

LATITUDE: 49 ° 38 ' 42 "

LONGITUDE: 116 ° 18 ' 47 " (at centre of work)

UTM Zone: EASTING: NORTHING:

OWNER(S):David Manley Fredlund

MAILING ADDRESS:1801 3rd Ave SE Salmon Arm BC V1E-1V1

OPERATOR(S) [who paid for the work]: As above and New Gold

MAILING ADDRESS: as above

REPORT KEYWORDS (lithology, age, stratigraphy, structure, alteration, mineralization, size and attitude. Do not use abbreviations or codes) mineralization, size, structure

REFERENCES TO PREVIOUS ASSESSMENT WORK AND ASSESSMENT REPORT NUMBERS:

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 263 line-kilometers		OPL and Halo groups	\$40,000.00
GEOCHEMICAL (number of samples analysed for ...)			
Soil			
Silt			
Rock			
Other			
DRILLING (total metres, number of holes, size, storage location)			
Core			
Non-core			
RELATED TECHNICAL			
Sampling / Assaying			
Petrographic			
Mineralographic			
Metallurgic			
PROSPECTING (scale/area)	Area wide looking for outcrops	all	\$8,000.00
PREPATORY / PHYSICAL			
Line/grid (km)			
Topo/Photogrammetric (scale, area)			
Legal Surveys (scale, area)			
Road, local access (km)/trail			
Trench (number/metres)			
Underground development (metres)			
Other			
TOTAL			\$48,585.98

TECHNICAL PROSPECTING REPORT

FOR THE MINERAL PROPERTYS
KNOWN AS OLD PEN LOCK (OPL) GROUP
Tenure Numbers 1082668, 1082719, 1082720
Event Number 5998811

and THE HALO GROUP
Tenure Numbers 1102855, 1102856
Event Number 6017420

Cranbrook Mining Division, B.C.

(49°36'28" N, 115°29'12" W)

Report by
registered claim owner

David Manley Fredlund
1801 3rd Ave S.E. Salmon Arm
(250) 804-0781

March, 25-2024

TABLE OF CONTENTS

	Page
SUMMARY	3
INTRODUCTION	3
Location	3
Access.....	3
Tenure Details	3
GEOLOGY	3
Property	4
Mineralization	4
Exploration	4
Magnetometer	4
CONCLUSIONS	4
APPENDICES:	
A. Statement of Expenditures	4
B Writer's Certificate	5

Figures

Figure:

Regional Location Map	
Access road.....	
Claim map.....	

SUMMARY

During the summer of 2023 from May 6 to 12, prospector Kris Fredlund, and myself made a trip to the OPL Group mineral property and the Halo Group which surround the OPL Group. The decision was made to investigate the properties using Pioneer Exploration Consultants with follow up analysis by Geophysicist Todd Ballantine P Geo. Magnetometer readings were taken utilizing mag drones which explored the OPL and Halo groups of claims by flying a 263 lineal Km survey at 50 meter intervals. Due to the nature of the findings and the results of the geological investigation, further work is warranted as will be detailed in in this report and a drill permit application is in progress.

INTRODUCTION

Location: The property lies to the west of Kimberly within the St Mary's River valley. The mineral tenure is located approximately 25 km west of Kimberly. B C

The geographical coordinates for the center of the tenure are (49°38'42" N, 116°18'47" W) . The terrain consists of wooded slopes rising from St Mary's River to about 6,500 feet ASL where the terrain steepens considerably. The property is located on the North side of St Mary's valley on a South facing slope. The elevations vary from 3,500 feet ASL along the center of the property to 7,000 feet ASL to give a relief of 3500 feet.

The main water source is the easterly flowing St Mary's River which traverses the property. The forest cover is timber and tag alder, tag cedar, tag hemlock and devils club in all clear cut areas.

Access: Access is provided by the St Mary's Forest service road which crosses the property and logging access roads providing random access.

History and previous work: This general area has been the subject of attention for over a hundred years, although because of the soil cover and lack of outcrop, old workings are very hard to locate or non-existent. No successful drilling has been done and no geophysical work because of a powerline which crossed the property until decommissioning a few years ago.

Property geology: Determining property geology was very difficult as it stretches across a wide deep overburden covered valley. Outcrops have been found on the east side of the tenure as terrain rises which expose an andulitic mudstone impregnated with minerals. As this could indicate a SEDEX style of deposit, we have commissioned a drone magnetometer survey from Pioneer Geophysics, and we explored the claims to try to find bedrock exposures.

GEOLOGY Property: Located in the Purcell range in Southeast BC.

Rocks of the Mesoproterozoic Purcell Supergroup form a conformable sequence that dominates this part of southeastern BC. Lowest rocks of the Purcell Supergroup belong to the Fort Steele Formation, originally deposited as sands, silts and muds that display characteristics of having been accumulated at or above sea level. Aldridge strata rest on the Fort Steele Formation. For the most part the Aldridge Formation accumulated as muds, silts and sands at substantial depths below sea level in a basin that developed during a period of crustal rifting. Next in the succession is the Creston Formation, initially muds, silts and sands that accumulated in a shallow aqueous to emergent environment, parts of which have been interpreted as lacustrine and other parts as alluvial fans. Kitchener Formation strata succeed the Creston Formation. Kitchener sediments were carbonate-rich silts and muds deposited in a shallow aqueous environment.

Mineralization: Based on geological reports on the area, it is this writers opinion that the Mag readings could be consistent with base and precious metals carried by quartz veins, SEDEX and/or porphyritic structures.

Magnetometer: Exploration foreman Manley Fredlund and prospector Kris Fredlund traveled to the OPL claim area during May 06-12/23 to conduct an initial exploration survey and to familiarise the Pioneer Drone Mag crew with the area to be scanned. A base line was established on The St Mary's River Forest Service Road on the tenure and established by GPS navigation utilizing the Iridium satellite system. The decision was made to scan the Halo claims as we were in negotiation to acquire them.

Exploration: This project was undertaken because of previous geological reports in the area and surmising that the Sullivan fault traveling west was interrupted by the Hall Lake fault providing geological settings that could be applicable to mineral deposition.

Conclusion: The extremely large anomalie has been followed to its boundaries and an area permit is being applied for, covering exploration, drilling, and trenching. The entire anomaly will need to be examined in detail with a magnetometer to provide more information for geological mapping. A drone mag survey was commissioned to examine the area in detail. With a follow up VLF airborne survey follow up. Extreme hot spots will need to be uncovered or drilled in order to accurately determine controls for mineralization and potential orebodies. Attached is the mag report by Pioneer Geophysics. This exploration was undertaken and paid for by New Gold and D Manley Fredlund.

APPENDICES:

A. Statement of Expenditures for the trip to project including MAG crew (May 06-17/23)

Field:

Foreman	M Fredlund	5 days at \$400.00 per day = \$2,000.00
Prospector	Kris Fredlund	5 days at \$300.00 per day = \$1,500.00
	Total	= <u>\$3,500.00</u>

Transportation:

Kelowna to Cranbrook rtn. 4 trips OPL to Cranbrook rtn.
Milage; 4x4 truck 1,500 kilometers at .55/k = \$825.00

Equipment rental and Contract for Drone Mag: May 06/23 to Sept 30/23

Pioneer Exploration Consultants May 6/23 to 17/23= \$40,285.98

Devin Wade, Chief P Geo. = \$750.00/day x 2 = \$1,500.00

Tod Ballantine, P Geo, Consulting Geophysicist, 15 hrs at \$100.00/hr =. \$1,500.00

Food and Lodging:

5 days food allowance @ \$75.00/day/man for crew = \$375.00.

5 days hotel costs @ \$120.00.00/day/man for crew. =\$600.00.

Total claimed for assessment work on OPL and HALO claim groups. **\$48,585.98**

APPENDICES:

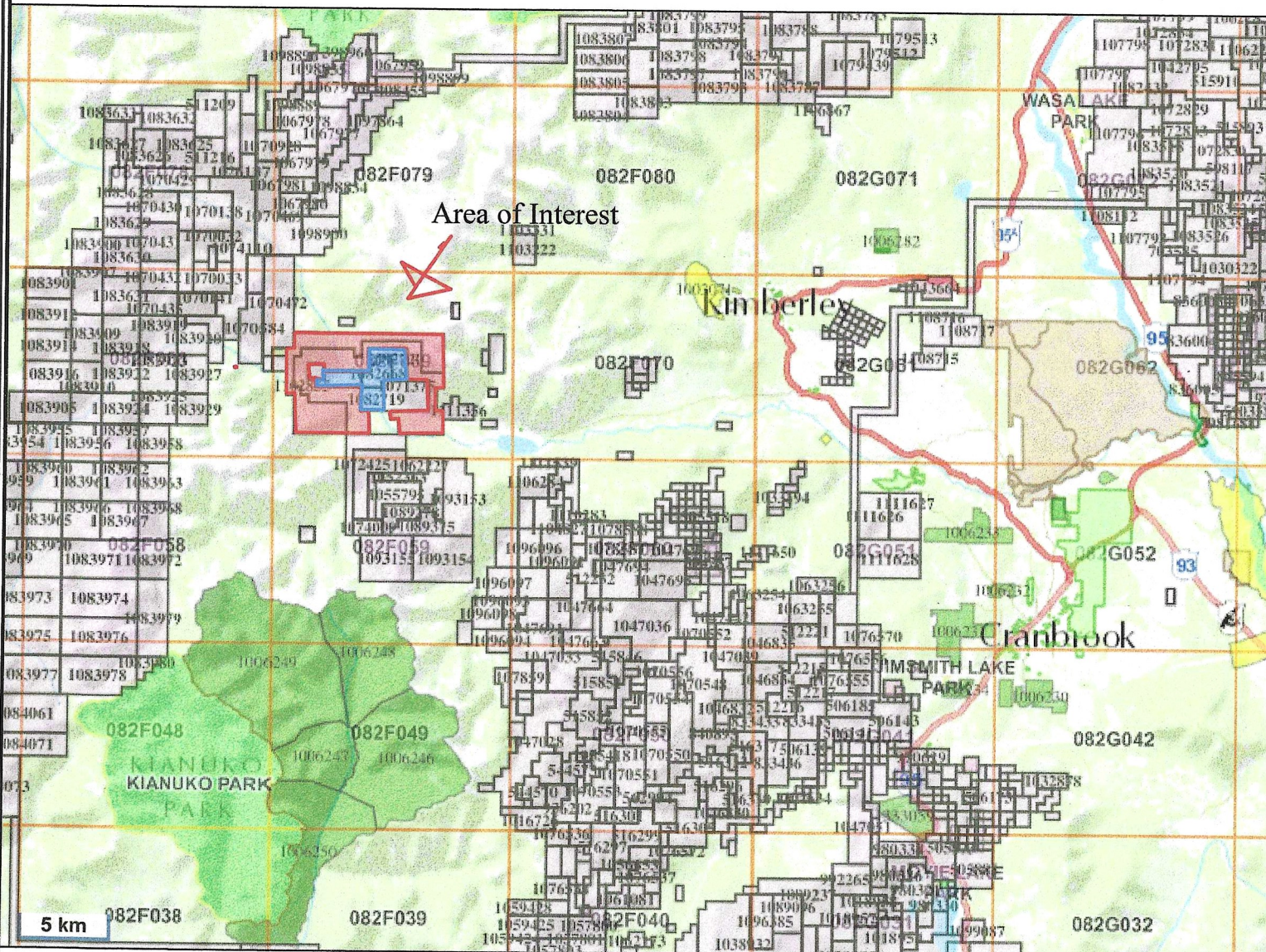
B. Statement of Writer's Qualifications

I, David Manley Fredlund am holder of valid free miners license number 108862 which I have held since 1965 and hereby certify that:

1. I started my mining career at age four as the camp water boy and cooks helper in a placer mining operation (my fathers).
2. I have been involved professionally in mineral exploration in different places for over forty two years including ;
 - Kootenays – gold, silver, lead, magnesite
 - Cariboo – gold
 - Revelstoke areas – silver, zinc, lead, dolomite, feldspar
 - Baker Lake N.W.T. – uranium, gold
 - Ominica – zinc
 - Stikine – gold, silver
 - Turnagain – gold, copper, jade
 - James Bay – diamonds
 - Pickle Lake – gold, platinum
3. I have worked with exploration crews for Boulder Creek Mines, Magnum Resources, Noranda, ESSO Resources, Texasgulf, Baker Mines, Powder Ridge Resources, Hammond Exploration and De Beers Canada Exploration (Monopros).
4. I am experienced in evaluating mineral prospects by Deteck magnetometer as I was the Canadian distributor for Deteck for 3 years and was able to practice on known mineralization, also in geology, soil sampling, rock sampling and pan sampling.
5. I maintain an extensive library of geological books, reports and articles.
6. I am the author of this report, which is primarily based on my personal observations made while in the field.

Dated at Salmon Arm, B. C. this 25 day of March 2024

OPL & HALO Groups Area



Legend

- Mineral Titles (MTO)**
- MTO Grid
- Title (current)
- LEASE
- CLAIM
- Reserves
- No Registration
- Conditional
- Heritage/Historic Site
- Crown Land Layers (Tantalis)**
- Land Act Survey Parcels - Tantalis - Legal Descriptions
- Label Text
- Land Act Survey Parcels - Tantalis - Outlined
- Administrative Boundaries**
- FADM - Designated Areas
- Designated Areas
- Designated Areas
- Local Regional Greenspaces - Outline
- Local and Regional Greenspaces - Colour Filled
- Local Regional Greenspaces - Colour Filled
- Federal Transfer Lands - Outlined
- Federal Transfer Lands - Colour Filled
- National Parks - Outlined
- National Parks - Colour Filled

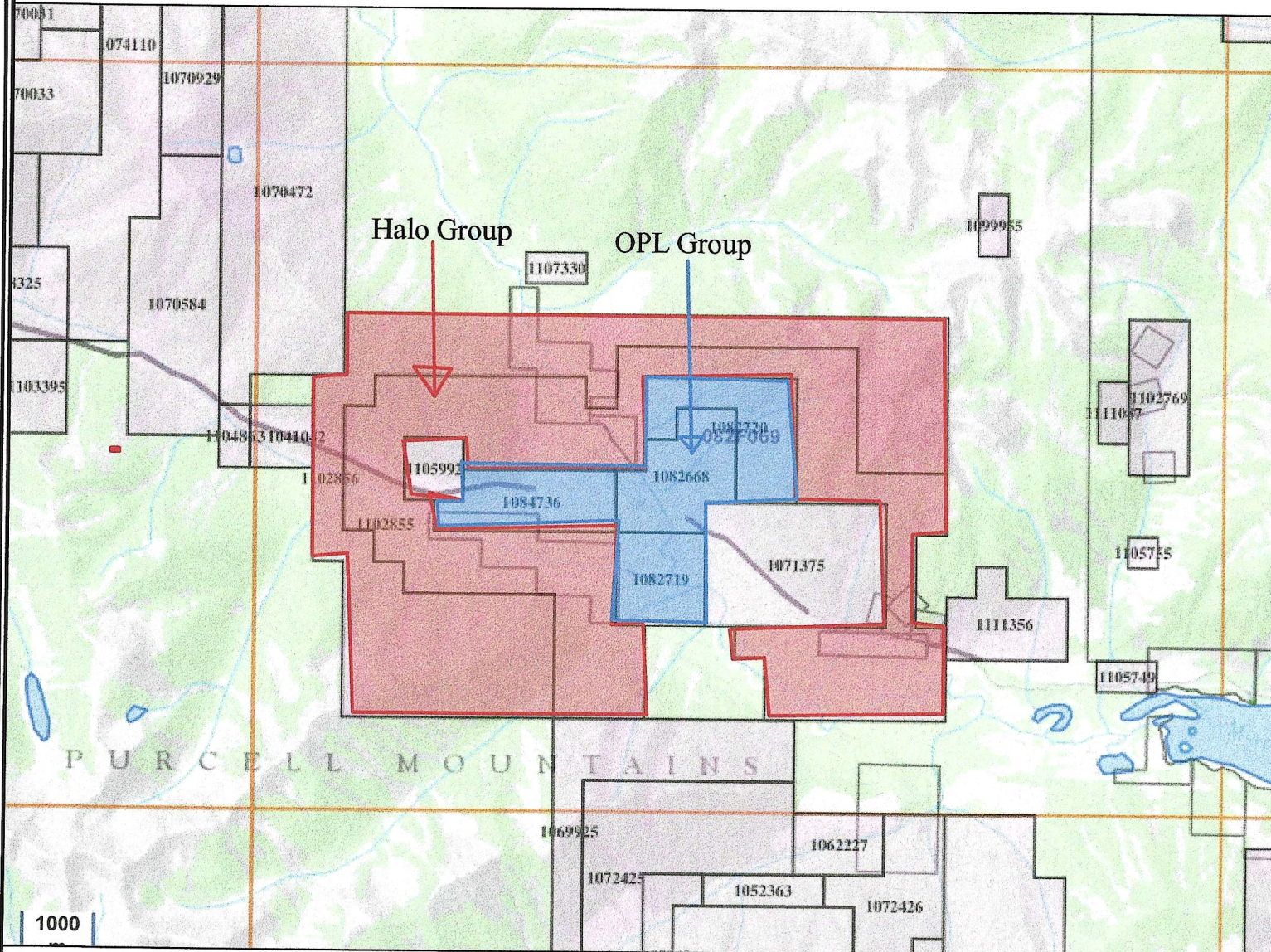
This map is a user generated static output from an Internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.
THIS MAP IS NOT TO BE USED FOR NAVIGATION.

Printed using the Mineral Titles Online (MTO) application.

Center: 49°35'17", -116°5'33"
Scale: 1 : 541679
SRS: EPSG:3857
UTM Zone: 11



OPL & HALO Groups



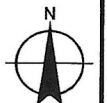
Legend

- Mineral Titles (MTO)**
- MTO Grid
- Title (current)
 - LEASE
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- Reserves
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- Crown Land Layers (Tantalis)**
- Land Act Survey Parcels - Tantalis - Legal Descriptions
- Label Text
- Land Act Survey Parcels - Tantalis - Outlined
-
- Administrative Boundaries**
- FADM - Designated Areas
- Designated Areas
 - Designated Areas
- Local Regional Greenspaces - Outline
- Local and Regional Greenspaces
- Local Regional Greenspaces - Colour Filled
-
- Federal Transfer Lands - Outlined
-
- Federal Transfer Lands - Colour Filled
-
- National Parks - Outlined
-

*This map is a user generated static output from an Internet mapping site and is for general 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.*

Printed using the Mineral Titles Online (MTO) application.

Center: 49°38'40", -116°19'10"
 Scale: 1 : 135420
 SRS: EPSG:3857
 UTM Zone: 11



Prospecting Work - 2023

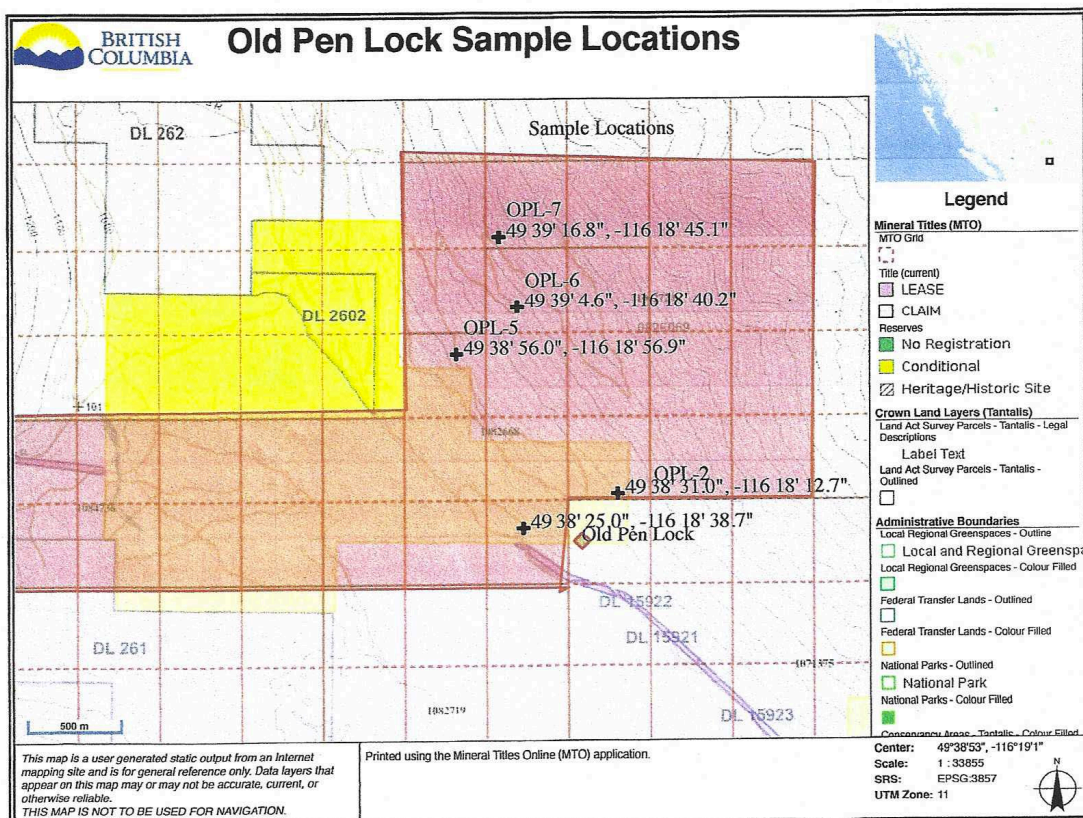
The OPL property lies across a wide overburden covered valley, so it was possible to lay out prospecting grids to attempt to discover bedrock outcrops. Many grids were attempted across the entire property but with limited success. However, with low vegetation covering most of the terrain, it was necessary to attempt to visit all quadrants. Potential areas were observed with binoculars from across the valley and then prospectors were dispatched by the many logging roads to as close as possible and then traverses were originated.

No new outcrops were discovered during our explorations, however for clarity purposes, previous reported bedrock outcrops discovered, and assays will be listed here.

The magnetic drone survey and all prospecting included the OPL, halo and Kobi claims.

OPL Mineral Claims			
Tenure No.	Area (ha)	Date Issued	Good to date
1082268	251 ha	2021/05/19	2027/10/22
1082719	188 ha	2021/05/22	2027/10/22
1082720	251 ha	2021/05/22	2027/10/22
1084736	230 ha	2021/10/13	2027/10/13
1105992	83.6 ha	2023/07/13	2025/07/13
1102855	2092 ha	2023/03/03	2025/03/03
1113122	565 ha	2024/05/26	2025/05/26
1102856	1634.4 ha	2023/03/03	2025/03/03
TOTAL AREA:	5295 ha		

BEDROCK SAMPLES, mudstone with quartz and metal particles, classic sedex



Sample ID	Ag	Pb	Zn	Cu	Cr	Ni	V	Fe
Old Pen Lock	.03 ppm	10.6 ppm	43 ppm	17.8 ppm	17 ppm	4.6ppm	13 ppm	2.67 %
OPL-2	.06 ppm	2.7 ppm	42 ppm	132 ppm	50 ppm	35.5 ppm	65 ppm	3.39 %
OPL-5	.1 ppm	14.9 ppm	36 ppm	25.8 ppm	16 ppm	4.7 ppm	15 ppm	3.1 %
OPL-6	.09 ppm	17 ppm	39ppm	20.8 ppm	14 ppm	5.6 ppm	15 ppm	2.93 %
OPL-7	.01 ppm	1.6 ppm	20 ppm	2.0 ppm	7 pp	2.3 ppm	3 ppm	.99 %



PIONEER EXPLORATION



International
Airborne Geophysics
Safety Association

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Table of Contents

Introduction	1
Location.....	1
Survey Specifications and Procedures	2
Instrumentation and Software.....	3
Magnetic Base Station	3
UAV Aeromagnetic Configuration.....	3
UAV VLF Configuration.....	3
Data Deliverables and Channel Descriptions.....	4
Magnetic Maps and Derived Data Products	6
Total Magnetic Intensity	6
First Vertical Derivative.....	6
3D Analytic Signal.....	6
VLF Inversion Algorithm (By EMTOMO™).....	7
Data Processing.....	8
Data Comments	10
GSM-90AVU VLF Sensor.....	13

List of Figures

Figure 1: The magnetic survey flight lines are shown in red in contrast to the VLF in Black . Inset, the project location can be observed 25 km west of Kimberley, BC.	1
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List of Tables

Table 1: Personnel involved with the project.	1
Table 2: Survey details.	2
Table 3: Database channel descriptions for the magnetic data.	4
Table 4. Database channel descriptions for the VLF data.....	5
Table 5. Database channel descriptions for the VLF inverted data.	6

List of Appendices

<u>Appendix 1: Instrument Specification.....</u>	<u>11</u>
<u>Appendix 2: Final Maps.....</u>	<u>17</u>

Introduction

From May 9th to May 16th, 2023, Pioneer Exploration Consultants Ltd. (Pioneer) completed an airborne magnetic and Very Low Frequency (VLF) survey using an Unmanned Aerial Vehicle (UAV) over an area near Kimberley, BC. The survey was flown.

This report covers data acquisition, instrument descriptions, data processing and presentations. The digital data delivery is described later in this report. This report does not include any geological interpretations of the geophysical dataset. Key survey personnel are listed in [Table 1](#).

Table 1: Personnel involved with the project.

<i>Pilot in Command</i>	Mackenzie Evenden
<i>Ground Crew</i>	Kiyavash Parvar, Liam Connor
<i>Data Processing and QA/QC</i>	Kiyavash Parvar (M.A.Sc. Geophysics)

Location

The project area is located approximately 25 km west of Kimberley, BC, Canada. The staging locations were accessed by a 4x4 truck. The completed survey lines are illustrated in [Figure 1](#).

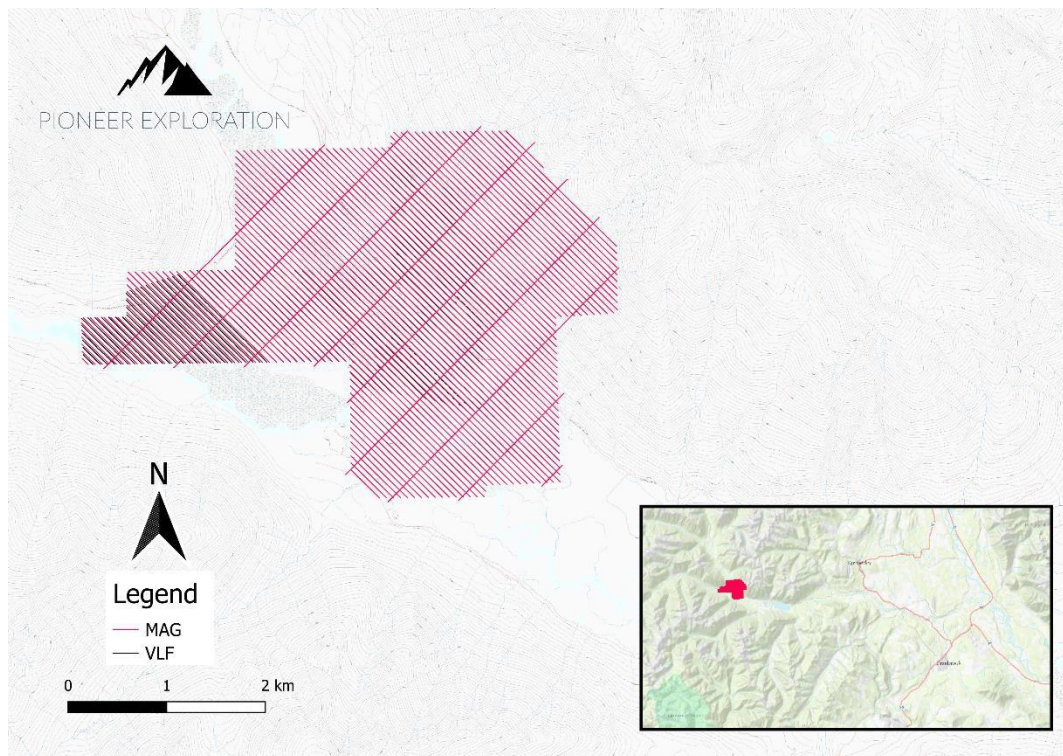


Figure 1: The magnetic survey flight lines are shown in red in contrast to the VLF in Black . Inset, the project location can be observed 25 km west of Kimberley, BC.

Survey Specifications and Procedures

Data collection for this survey area was conducted at 50 m spacing with 500 m spaced tie lines. The central area of the survey area was flown at 50 m spacing in both orientations. The nominal magnetic sensor altitude above ground level (AGL) was set to 45 m. The VLF sensor was set to be about 55 m above the ground level. Elevation from the terrain may vary depending on the treeline and obstacles on the flight route. Satellite imagery was used to create a high resolution DSM to assist the UAV terrain following procedure and to minimize the possible topographic effects on the magnetic data. The nominal production groundspeed for the magnetic survey is 9 m/s for flat topography with no wind. This speed was set to 12 m/s for the VLF to ensure the proper sensor orientation during the data collection. The surveys speed may vary depending on the terrain and environmental conditions.

The ground crews performed daily safety meetings and pre-flight checks prior to the start of drone flight operations. The Pilot in Command (PIC) is responsible for the safety of the crew and equipment during the survey operations. Each survey flight is pre-planned using ground control software, then the flight plans are uploaded to the UAV prior to takeoff. The UAV system flies the pre-defined waypoint-based flight plans while the ground crew maintains visual line of sight with the craft and the flight telemetry information. Flights are terminated and the UAV returns for landing when the battery voltage reaches a certain limit, or when the flight plan is complete. The survey flights can be manually terminated and taken over with full manual pilot control at anytime. Upon landing, the flight batteries are exchanged and the sensor is downloaded for data QAQC. The average distance covered by each flight is approximately 6-10-line kms of data acquisition.

Addition details on the completed survey can be found in [Table 2](#).

Table 2: Survey details.

Project	Line Spacing (m)	Line Direction (deg)	Tie Line Spacing (m)	Total Line Kilometres (km)
Mag	50	135	500	263.308
Kootenays VLF	50	135	NA	98.809

Instrumentation and Software

The principal airborne sensors used were a Gem Systems Canada GSMP-35U potassium vapor sensor mounted on a UAV platform for the magnetic survey and a GEM Systems Canada GSM-90AVU UAV VLF system for the VLF survey.

Ancillary equipment included a laser altimeter with range of 130m, Global Positioning Satellite (GPS) system antenna and Inertial Measurement Unit (IMU).

A stationary GSM-19 Overhauser magnetometer was used as a base station for correction of the mag data. Raw aerial magnetometer data was collected at a rate of 20 Hz while base station data was collected at a rate of 0.16 Hz. Total field and GPS UTC time were recorded with each data point, enabling diurnal correction to be applied during final data processing.

Magnetic Base Station

A GSM-19 Overhauser Magnetometer base station was placed in a location of low magnetic gradient, away from electrical transmission lines and moving metallic objects, such as motor vehicles and aircrafts. The data collected from this base station was used to diurnally correct the aeromagnetic data. The GSM-19 Overhauser Magnetometer is supplied by GEM systems of Markham, Ontario. General specifications of the magnetometer are included in [Appendix 1: Instrument Specification](#).

UAV Aeromagnetic Configuration

GEM System's UAV GSMP-35U is a potassium magnetometer providing unmatched sensitivity in addition to a low heading error effect. The GSMP-35U operates similarly to other alkali vapor magnetometers while benefiting from the unique spectral properties of potassium. Each GSMP-35U system has 0.0002 nT sensitivity combined with +/- 0.1 nT absolute accuracy over its full operating range. More details on the instrument can be found in [Appendix 1: Instrument Specification](#). The UAV aeromagnetic setup consists of a towed bird configuration with a sensor-aircraft separation distance of either 3 or 5m. The sensor is flown along the survey lines with a fixed heading to maximize the signal amplitude and provide the best sensor orientation for the local conditions. This action minimizes heading errors. The data is both stored on board during acquisition and transmitted in real-time back to the ground control station to monitor the collection during flight and ground clearance of the sensor from the laser altimeter data.

UAV VLF Configuration

GEM Systems GSM-90AVU UAV VLF system provides true measurements of the Vertical inphase & Out of-phase components as % of total field within the VLF frequency range of 15.0 - 30.0kHz. Many older systems only measure the total field and quadrature components of the field. This VLF system features two separate sensors with three light weight orthogonal air coils in each to provide reduced noise and allow true in-phase and quadrature data to be gathered rapidly from two VLF transmitting stations simultaneously, regardless of sensor orientation. Data includes in-phase, out-of-phase, horizontal components in x and y and field strength in picoTesla (pT).

Data Deliverables and Channel Descriptions

All data is typically delivered in either Geosoft Database (GDB) or simple formats such as .txt or csv. The data deliverables are client specific to best suit their needs and software requirements. Regardless of software, a database is supplied to the client with channel descriptions as described in [Table 3](#).

Table 3: Database channel descriptions for the magnetic data.

Parameter	Explanation	Units/Format
Date	Flight date	yyyy/mm/dd
Time	GNSS time stamp	hhmmss.ss
lat	Latitude (WGS84)	Decimal degrees
lon	Longitude (WGS84)	Decimal degrees
alt	GPS altitude above the average sea level	metres
utmE	UTM easting (WGS84)	metres
utmN	UTM northing (WGS84)	metres
sat	Number of locked satellites	metres
zone	UTM zone	-
yaw	IMU yaw reading	Degrees
pitch	IMU pitch reading	Degrees
roll	IMU roll reading	Degrees
nT	Magnetic field readings (Raw)	nanotesla
nT2	Diurnal correction has been applied on the nT channel (Diurnal datum: 54600 nT)	nanotesla
Final	Final Total Magnetic Intensity	nanotesla
Levelled	Levelled data based on tie line intersections	nanotesla
VD1	1 st Vertical derivative	nT/m
AS	Analytic Signal	nT/m

Table 4. Database channel descriptions for the VLF data.

Parameter	Explanation	Units/Format
heading	Flight date	yyyy/mm/dd
hhmmss_ss	Flight time	hhmmss.sss
ralto	Relative altitude/laser reading	metres
VLF1_H1	Station 1 coil signal pickup in direction of flight	NA
VLF1_H2	Station 1 coil signal pickup perpendicular to direction of flight	NA
VLF1_INP	Station 1 In-phase (IP) as percentage of total field	%
VLF1_INP_FR	Fraser filter applied to VLF1_INP	%
VLF1_kHz	Station 1 frequency	KHz
VLF1_pitch	Pitch	Degrees
VLF1_pT1	Station 1 total field	nanotesla
VLF1_QUAD	Station 1 out-of-phase (OP) as percentage of total field	%
VLF1_roll	Roll	Degrees
VLF2_H1	Station 2 coil signal pickup in direction of flight	NA
VLF2_H2	Station 2 coil signal pickup perpendicular to direction of flight	NA
VLF2_INP	Station 2 In-phase (IP) as percentage of total field	%
VLF2_INP_FR	Fraser filter applied to VLF2_INP	%
VLF2_kHz	Station 2 frequency	KHz
VLF2_pitch	Pitch	Degrees
VLF2_pT1	Station 2 total field	nanotesla
VLF2_QUAD	Station 1 out-of-phase (OP) as percentage of total field	%
VLF2_roll	Roll	Degrees
xraw	Easting	metres
yraw	Northing	metres
zraw	Elevation (AMSL)	metres

Table 5. Database channel descriptions for the VLF inverted data.

Parameter	Explanation	Units/Format
x	Easting	metres
y	Northing	metres
Z_cell	Elevation(AMSL)	metres
Distance	Distance from the 1 st point	metres
Ohm_m	Changes in the apparent resistivity	Ω.m

Magnetic Maps and Derived Data Products

The final magnetic data has been presented in the form of several different magnetic maps ([Appendix 2: Final Maps](#)). Each of these different data presentations is a useful tool for identifying geological structures and other features.

Total Magnetic Intensity

Based on the flight lines covered by the drone, the total magnetic field map grid was created by interpolating the filtered magnetic data. The purpose of this data presentation is to highlight geological structures that may be visible in the survey area by their magnetic signature or their magnetic contrast to their surroundings.

First Vertical Derivative

The first order vertical derivative quantifies the rate of change of the magnetic field as a function of elevation. It is an approximation of the vertical magnetic gradient, which could be directly measured with separate magnetometers vertically spaced apart. The purpose of this type of filter is to eliminate the long wavelength signatures and make sharp features more detectable, such as the edges of magnetic bodies. This filter also increases the noise level, which limits the use of higher order derivatives (n=2 for example). The vertical derivative is used to delineate the contacts between large-scale magnetic domains because its value is zero over vertical contacts.

3D Analytic Signal

The analytic signal is the square root of the sum of the squares of the derivatives in the x, y, and z directions:

$$\text{Analytical Signal} = \sqrt{dx * dx + dy * dy + dz * dz}$$

The analytic signal is useful in locating the edges of magnetic source bodies, particularly where remanent magnetic signals and/or low magnetic latitude complicates interpretation.

VLF Inversion Algorithm (By EMTOMO™)

For the inversion process, the collected data was low-passed by using the Fast Fourier Transfer. A variety of low pass filter was applied to the data to ensure no noise from periodical variations are altering the readings. The results were fed to VLF2DAB software by EMTOMO.

The nonlinear, smoothness-constrained inversion algorithm described by Monteiro Santos (2004) was adopted. The optimization equations are represented as follows: (Sasaki, 1989)

$$[(J^T J + \lambda C^T C)] \delta p = J^T b$$

or (Sasaki, 2001)

$$[(J^T J + \lambda C^T C)] \delta p = J^T b - \lambda C^T C (p - p_0)$$

where δp is the vector containing the corrections applicable to the parameters (logarithm of block conductivities, p) of an initial model, p_0 is a reference model, b is the vector of the differences between the observed and calculated tipper components

$[b = (T^o) - (T^c)]$, J is the Jacobian matrix whose elements are given by $(\sigma_j)(\partial T_i^f / \partial \sigma_j)$, the superscript T denotes the transpose operation, and λ is a Lagrange multiplier (Damping factor) that controls the amplitude of the parameter corrections and whose best value is determined empirically. The value can be determined empirically by comparing the models calculated using different values with the available information. The elements of the matrix C are the coefficients of the values of the roughness in each parameter, which is defined in terms of the four neighbours' parameters. The elements of C are -4, 1, or 0. An iterative process allows the final model to be obtained, with its response fitting the data set in a least square sense.

The misfit between data and model response is calculated by:

$$rms = \sqrt{\frac{1}{N} \sum_{i=1}^N (d_i^o - d_i^f)^2}$$

where N is the number of data values, σ the error on the data and d the data (real and imaginary components).

Data Processing

All general magnetic QA/QC and data processing techniques have been applied to the data. All post-field data processing was carried out using Geosoft Oasis Montaj, Python and Microsoft Excel software/programming languages. Presentation of final maps used ESRI ArcMap and/or Geosoft Oasis Montaj. Results were gridded using minimum curvature method and a grid cell size of approximately 1/3 of flight line spacing.

The geophysical images accompanying this report are positioned using the WGS 1984 datum. The survey geodetic GPS positions have been map-projected using the Universal Transverse Mercator (UTM) projection. A summary of the map datum and projection specifications are as follows:

- Datum: WGS 1984 UTM Zone 11 N
- Scale Factor: 1:7500
- Linear Unit: Metre (1)

The magnetic data was first quality checked in the field and any points lacking sufficient georeferenced data or which were excessively noisy were removed. The resulting data was processed as mosaics throughout the survey area as data was collected daily. The final result is a combination of all collected data, including lines that were re-flown due to weak or insufficient magnetic signal.

The base station readings were initially processed and filtered to remove high frequency noise. The filtered base station dataset was then used to perform a diurnal correction on the magnetic survey data. The diurnally corrected profile data were interpolated into a grid using the minimum curvature technique with a grid size of approximately 1/3 of flight line spacing. All final maps have a normalized color interval.

After finishing interpolation, initial processing subjected the data to a non-linear filter with a wavelength limit of 3-4 fiducials and tolerance of 0.001. This filter removes high frequency noise which mostly occur because the sensor is in the dead zone due to sudden changes in sensor orientation, effect of ferrometallic objects, or the influence of weather conditions on the sensor. This filter smooths out noise and high frequency features.

After leveling the data using the tie lines, the data was micro-levelled. This step is performed to mitigate the corrugation effect associated with gaps between the data lines and is completed by applying a high-pass butterworth filter with the threshold of 400 metres (line spacing x 4) followed by a directional cosine filter perpendicular to the line direction. The resulted noise channel was then subtracted from the leveled values to microlevel the data. The final result of the leveling and micro-leveling processes was then put in "Final" Channel of the database.

The following corrections were applied to the airborne magnetic data:

- Correction for diurnal variation using the digitally recorded ground base station magnetic values as described above
- Lag was measured by a lag test prior to the operation. Only a minor lag correction is applied to final data (0.2s)
- Heading biases were applied based on clover leaf data collected
- Micro-leveling
- Analytic Signal calculation
- First Vertical Derivative calculation

The final maps are included in [Appendix 2: Final Maps](#).

Data Comments

Pioneer's UAV aeromagnetic surveys result in a high-quality, high-resolution data product. The increased flight line density and lower flight elevation possible with the use of a UAV platform results in superior resolution data products when compared to conventional airborne magnetic data. Using an auto-controlled UAV platform also allows for minimal deviation from pre-planned flight lines, and greatly reduces the impact of human errors during data acquisition.

Logistics remains a major challenge of UAV surveying. In order to operate legally within the guidelines set by Transport Canada, line of sight must be maintained to the UAV and surrounding airspace at all times. This often results in the necessity of several staging locations for covering the survey area, and sometimes requires the employment of additional equipment such as an aerial platform or scissor lift to achieve unobstructed line of sight beyond surrounding buildings or vegetation. The smaller flight sorties are typical in UAV-based surveys and require greater attention in post processing.

Pioneer makes every effort to identify potential sources of noise in order to mitigate their impact on our collected survey data. The magnetic noise envelope of our UAVs has been mapped in 3D prior to use. Our flight lines are planned with a minimum of 50 m overlap past the survey boundaries so that the magnetic sensor has time to stabilize itself after the UAV has completed its turns. Additionally, weather is carefully monitored and when excessive data inconsistency is noted due to weather conditions, flights are suspended until conditions improve.

Pioneer is very pleased with the results from this survey and confirms that the level of error and noise in the dataset falls below our threshold, which is set based on the Geological Survey of Canada guidelines for airborne magnetometer survey data.

Respectfully submitted,

Kiyavash Parvar, M.A.Sc. UAV Geophysics
Vice President of Geophysics
Pioneer Exploration Consultants Ltd.
Ottawa, Ontario



Appendix 1: Instrument Specification

GSM-19 Overhauser Magnetometer

Performance

Sensitivity: Standard

GSM-19 0.022 nT @ 1 Hz

GSM-19PRO 0.015 nT @ 1 Hz

Resolution: 0.01 nT

Absolute Accuracy: 0.1 nT

Dynamic Range: 20,000 to 120,000 nT

Gradient Tolerance: up to 10,000 nT/m

Samples at: 60+, 5, 3, 2, 1, 0.5, 0.2 sec

Operating Temperature: -40°C to +50°C

Operating Modes

Manual: Coordinates, time, date and reading stored automatically at up to 0.2 sec.

Base Station: Time, date and reading stored at 1 to 60 second intervals.

Remote Control: Optional remote control using RS-232 interface.

Input / Output: Input/Output: RS-232 using 6-pin weatherproof connector with USB adapter.

Memory - (# of Readings in millions)

Mobile: 1.4M,

Base Station: 5.3M,

Gradiometer: 1.2M,

Walking Mag: 2.6M

Dimensions

Console: 223mm x 69mm x 240 mm(8.7x2.7x9.5in)

Sensor: 175mm x 75mm diameter cylinder (6.8in long by 3 in diameter)

Weights

Console with Belt: 2.1 kg

Sensor and Staff Assembly: 1.0 kg

GSM-90AVU VLF Sensor

Components:

- Two (2) VLF UAV Sensor coils with cables
- GSM-90AVU v7.0 VLF Electronics
- UAV VLF shell with 10m tow line
- Laser altimeter
- GPS (1.5m L1, 0.6m SBAS resolution)
- Radio Link (base station and remote)
- Ground station computer and GEM Airborne logger software (GEMDAS Data acquisition)

VLF Frequency:

- Two (2) user selected stations in the frequency range of 15.0 - 30.0kHz (simultaneous measurements).

Parameters:

- Vertical in-phase and out-of-phase (quadrature) components as % of total field.
- 2 components of horizontal field amplitude and total field strength in pT.

Resolution:

- 0.1% of total field (VLF fields >5 pT)

Tilt Correction:

- +/- 10 degrees (off horizontal)

Performance:

- 10, 5, 2, 1 Hz (Sample Rate) • Operating Temperature : -40°C to +50°C

Dimensions:

Sensor : 14 x 15 x 11 cm. (5.5 x 6 x 5 inches)
Console: 22.3 x 6.9cm x 2.4 cm

Weights:

Sensors : 0.65 kg (1.43 lb.)
Electronics : 1.21 kg (2.66 lb.)
Towed Bird : 4.4 kg (9.68 lb.)

Power Source:

11.1V 1.3Ah Lithium Battery

Output:

UTC time, GPS Position (latitude, longitude), altitude, pitch, roll, yaw, EM field, frequency, in- and out-of-phase vertical, and both horizontal components for each selected station. Data export in standard XYZ (i.e. line-oriented) format for easy use in standard commercial software programs such as **VLF2DMF** by **EMTOMO** (Optional).

Blacksquare SAS Hercules X4 Quadcopter UAV

Motor to motor diameter	1068mm
Drone weight without batteries	8.3kg
Maximum takeoff mass	25kg
Protection against water and dust	Ip54
Number of rotors	8
Rotor configuration	Coaxial octocopter
Engine model	T-motor u8ii
Esc model	T-motor alpha 60a hv
Propeller model	T-motor fa 28.2 x 9.2
Battery chemistry	High voltage lipo
Number of cells	12
Rated voltage	45.6v
Maximum voltage	52.2v
Minimum voltage	43.5v
Autopilot model	Cube orange
Firmware model	Arducopter
Gps model	Here3+
Radio control model	Frsky horus x10s

GEM GSMP-35UA: Ultra Light-Weight Potassium Magnetometer

Magnetometer Specifications

Sensitivity	0.0002 nT @ 1 Hz
Resolution	0.0001 nT
Absolute Accuracy	+/- 0.1 nT
Heading Error	+/- 0.05 nT
Dynamic Range	15 000 to 120 000 nT
Gradient Tolerance	50 000 nT/m
Sampling Intervals	1, 2, 5, 10, 20 Hz
Operating Temperature	-40°C to +55°C

Orientation

Sensor Angle: optimum angle 35° between sensor head axis & field vector.

Proper Orientation: 10° to 80° & 100° to 170

Heading Error: +/- 0.05 nT between 10° to 80° and 360° full rotation about axis.

Environmental

Operating Temperature: -40°C to +55°C

Storage Temperature: -70°C to +55°C

Humidity: 0 to 100%, splashproof

Dimensions & Weight

Sensor	161 mm x 64 mm (external diameter) with 2m cabling; 0.43 kg
Electronics Box	236 mm x 56 mm x 39 mm; 0.46 kg
Option 1 cabling	0.125 kg
Option 3 light weight battery	0.250 kg

Power

Power Supply: 18 to 32 V DC

Power Requirements: approx. 50 W at start up, dropping to 12 W after warm-up

Power Consumption: 12 W typical at 20°C

Warm-up Time: <15 minutes at -40°C

Outputs

20 Hz RS-232 output with comprehensive Windows Personal Computer (PC) software for data acquisition and display.

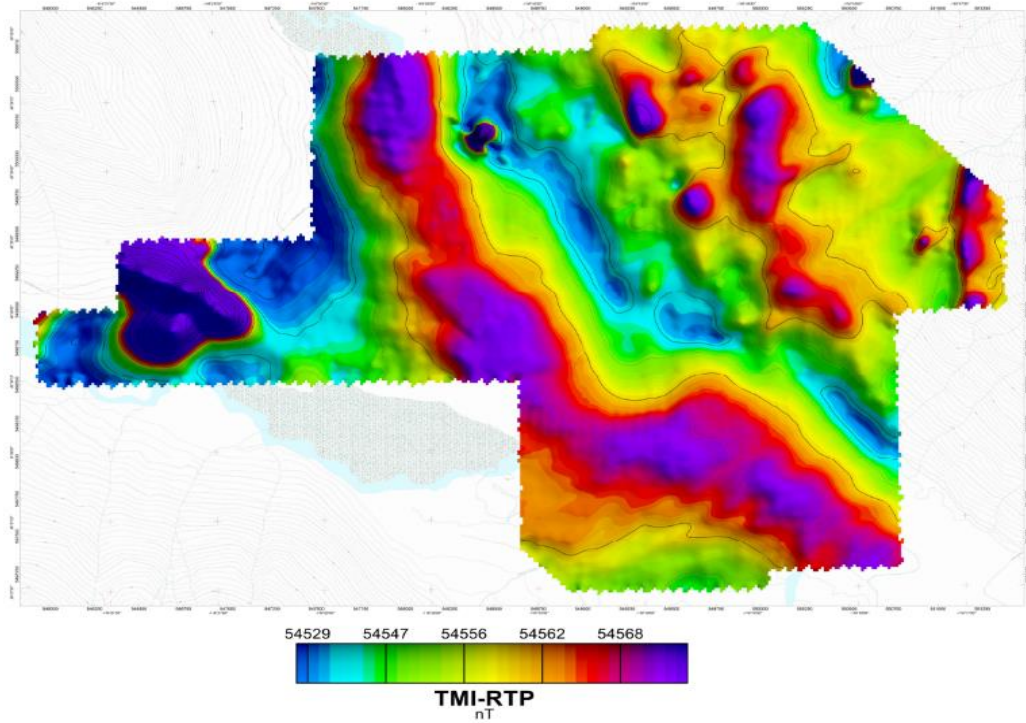


Outputs UTC time, magnetic field, lock indication, heater, field reversal, GPS position (latitude, longitude altitude, number of satellites)

Components

Sensor, pre-amplifier box, 2m sensor /pre-amplifier cable (optional cable 3-5m), manual & shipping case

Appendix 2: Final Maps



Flight Parameters:

Flight line spacing: 50 m
Flight line azimuth: 135-315°N
Tie-line spacing: 500 m
Tie-line direction: 045-225°N
Nominal sensor elevation above ground: 45m

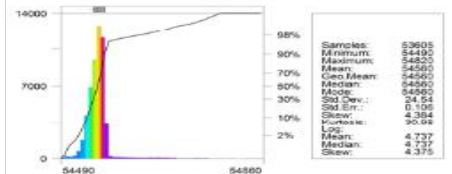
Instrumentation:

Unmanned aerial vehicle: BlackSquare Hercules X8
In-flight magnetometer: OEM Systems GSMP-35UA (Potassium vapor)
In-flight sampling time: 10 Hz (0.1 s)
Ground magnetometers (base station): OEM GSM-19 (Overhauser proton)
Base station sampling rate: 0.16 Hz (0.0 s)

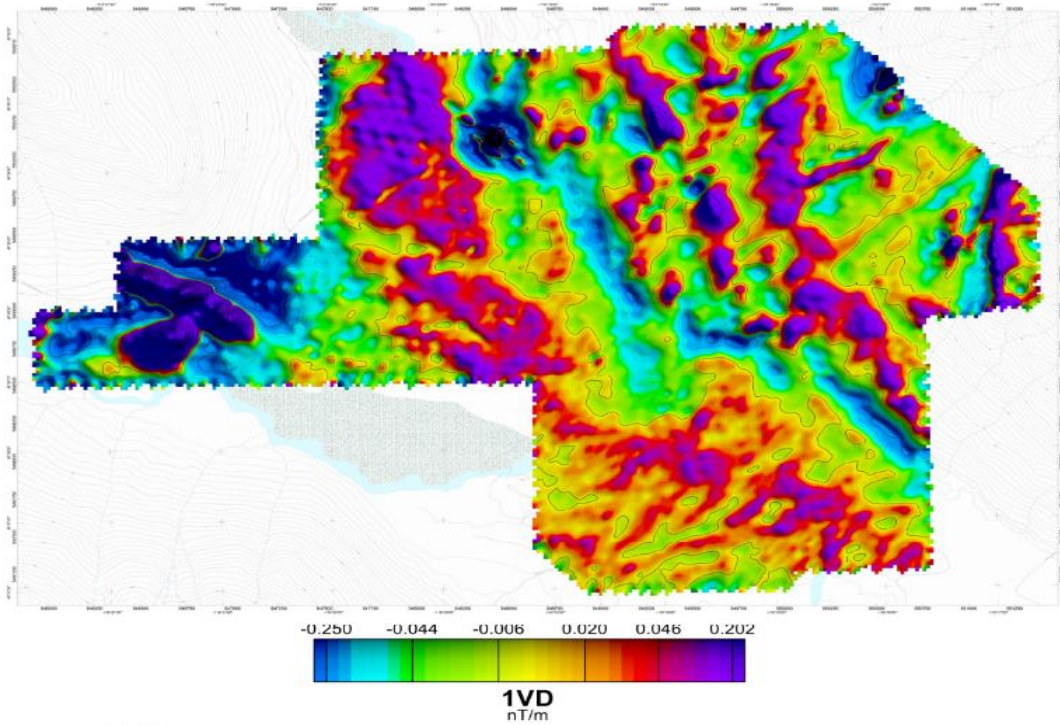
Coordinate system:

Datum: WGS84
Projection: Universal Transverse Mercator Central meridian: (Zone 11N)
Hill shade inclination: 045°N
Hill shade declination: 045°N (NE-SW)

Contour Legend:



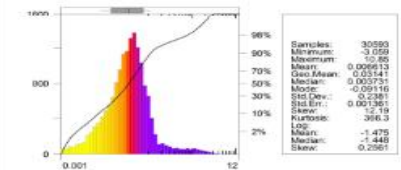
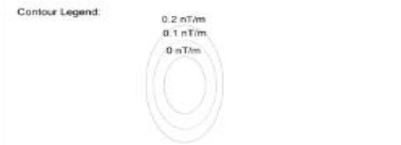
Pioneer Exploration Consultants Ltd.
Levelled and micro-Levelled Drone Mag Survey
Total Magnetic Intensity - Reduced to Pole (TMI-RTP)
Units: nT
Project: Kootenays
Survey Date: May 2023
Map Author: Kiyavash Parvar M.A.Sc. Geophysics



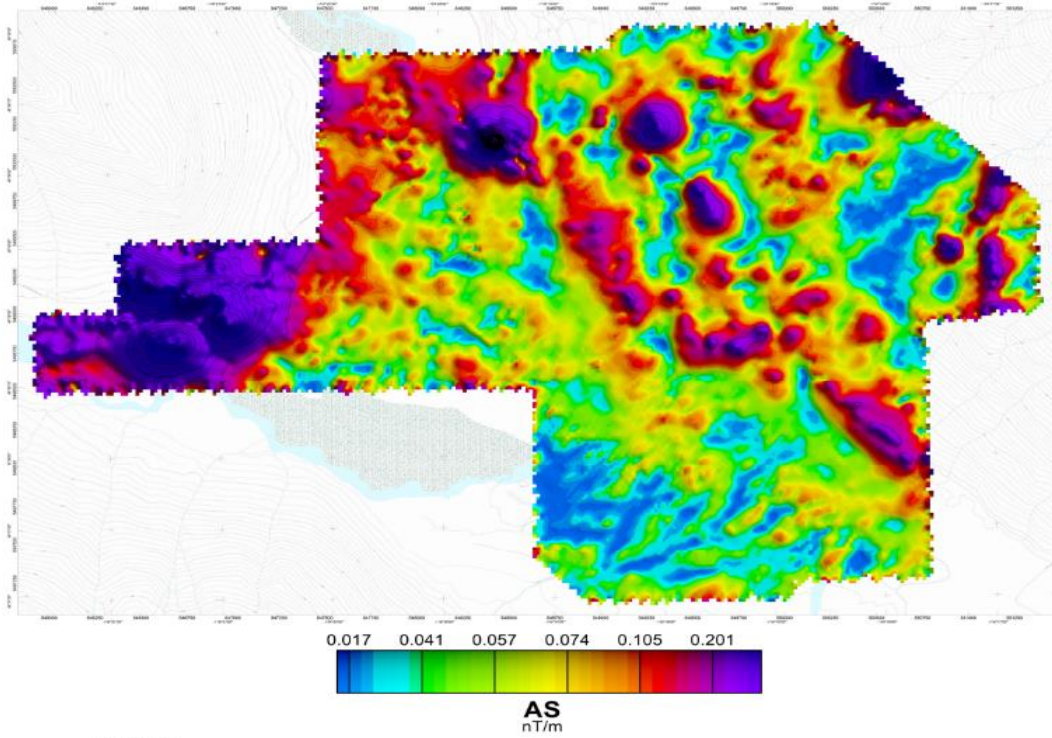
Flight Parameters:
 Flight line spacing: 50 m
 Flight line azimuth: 135-315°N
 Tie-line spacing: 500 m
 Tie-line direction: 045-225°N
 Nominal sensor elevation above ground: 45m

Instrumentation:
 Unmanned aerial vehicle: BlackSquare Hercules X8
 In-Flight magnetometer: GEM Systems GSMF-355JA (Potassium vapor)
 In-Flight sampling time: 10 Hz (0.1 s)
 Ground magnetometers (base station): GEM GSM-19 (Overhauser core)
 Base station sampling rate: 0.16 Hz (0.6 s)

Coordinate system:
 Datum: WGS84
 Projection: Universal Transverse Mercator Central meridian: (Zone 11N)
 Hill shade inclination: 045°N
 Hill shade declination: 045°N (NE-SW)



Pioneer Exploration Consultants Ltd.
 Levelled and micro-Levelled drone mag survey
 1st Vertical Derivative (1VD)
 Units: nT/m
 Project: Kootenays
 Survey Date: May 2023
 Map Author: Kiyavash Parvar MASC, Geophysics



Flight Parameters:

Flight line spacing: 50 m
Flight line azimuth: 135-315°N
Tie-line spacing: 500 m
Tie-line direction: 045-225°N
Nominal sensor elevation above ground: 45m

Instrumentation:

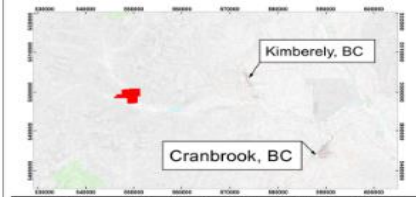
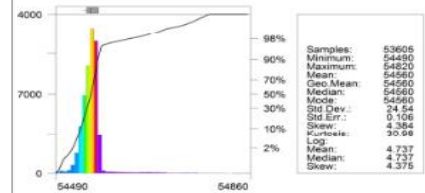
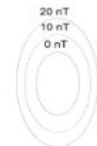
Unmanned aerial vehicle: BlackSquare Hercules X8
In-flight magnetometer: GEM Systems GSMP-35UA (Potassium vapor)
In-flight sampling time: 10 Hz (0.1 s)
Ground magnetometers (base station): GEM GSM-19 (Overhauser proton)
Base station sampling rate: 0.16 Hz (6.0 s)

Coordinate system:

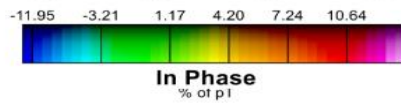
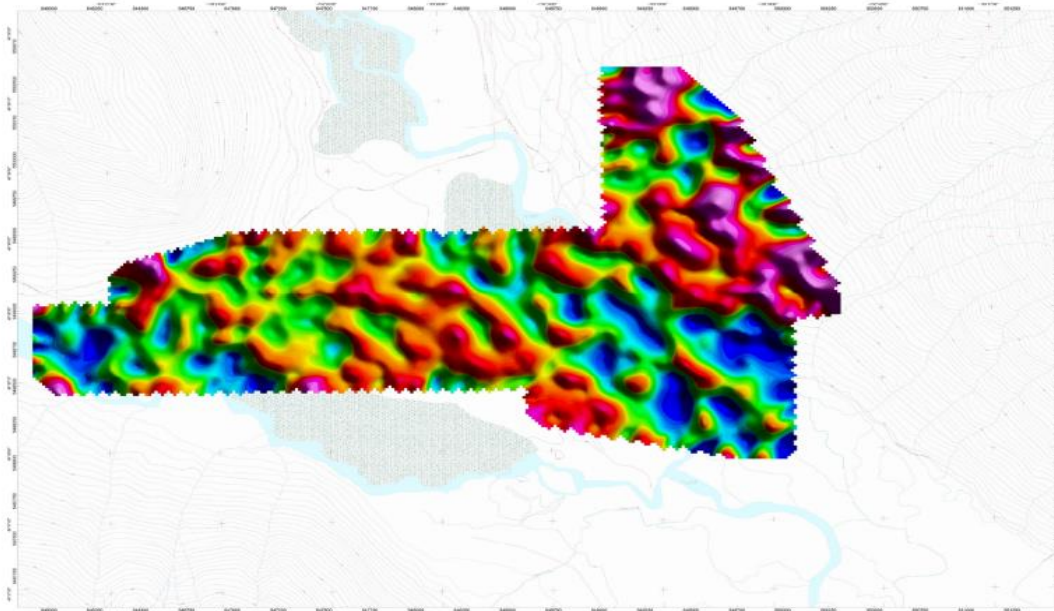
Datum: WGS84
Projection: Universal Transverse Mercator Central meridian: (Zone 11N)

Hill shade inclination: 045°N
Hill shade declination: 045°N (NE-SW)

Contour Legend:



Pioneer Exploration Consultants Ltd.
Levelled and Micro-Levelled Drone Mag Survey
Total Magnetic Intensity - Reduced to Pole (TMI-RTP)
Units: nT



Flight Parameters:

Flight line spacing: 50 m
Flight line azimuth: 135-315°N
Tie-line spacing: 500 m
Tie-line direction: 045-225°N
Nominal sensor elevation above ground: 45m

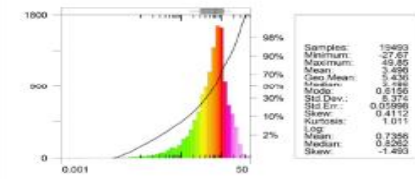
Instrumentation:

Unmanned aerial vehicle: BlackSquare Hercules XB
In-flight magnetometer: GEM Systems GSMP-35UA (Potassium vapor)
In-flight sampling rate: 10 Hz (0.1 s)
Ground magnetometers (base station): GEM GSM-19 (Overhauser proton)
Base station sampling rate: 0.16 Hz (6.0 s)

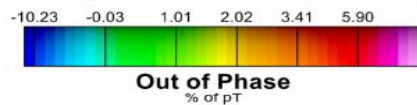
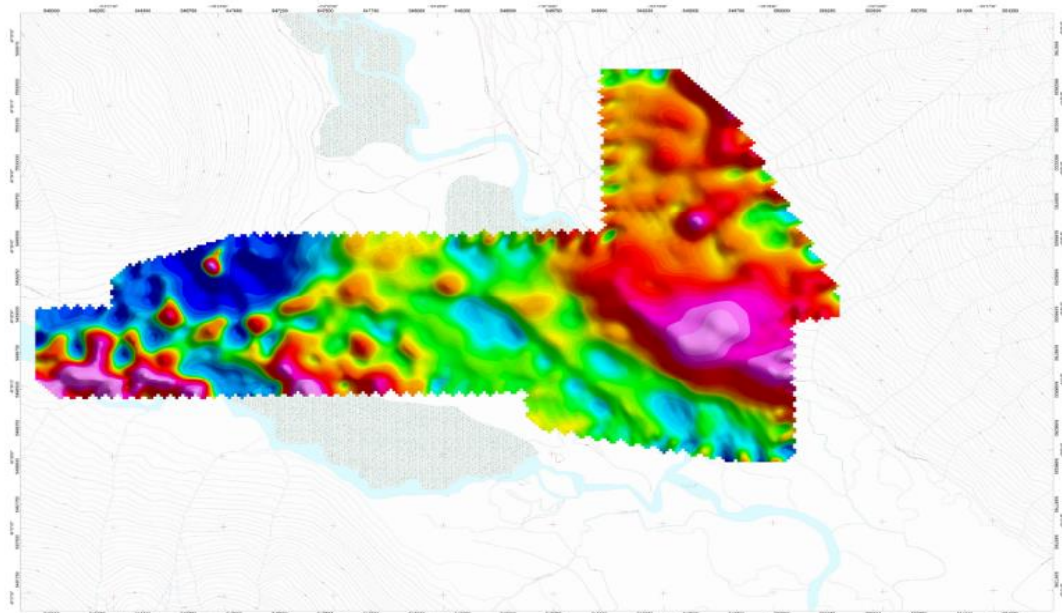
Coordinate system:

Datum: WGS84
Projection: Universal Transverse Mercator Central meridian: (Zone 11N)

Hill shade inclination: 045°N
Hill shade declination: 045°N (NE-SW)



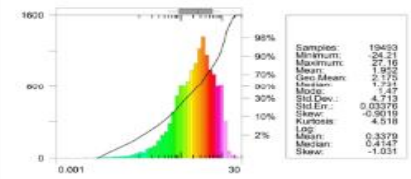
Pioneer Exploration Consultants Ltd.
very Low frequency (VLF) drone survey
In Phase Values
Units: % of Total field (pT)
Project: Kootenays
Survey Date: May 2023
Map Author: Kiyavash Parvar MASC. Geophysics



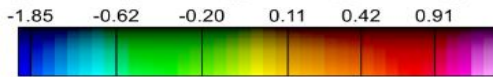
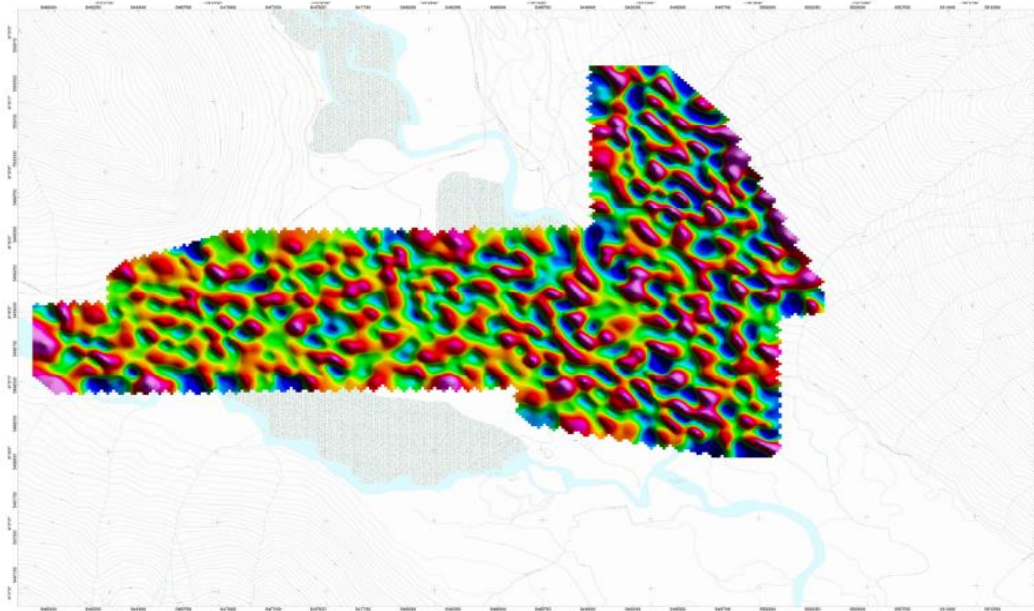
Flight Parameters:
 Flight line spacing: 50 m
 Flight line azimuth: 135-315°N
 Tie-line spacing: 500 m
 Tie-line direction: 045-225°N
 Nominal sensor elevation above ground: 45m

Instrumentation:
 Unmanned aerial vehicle: BlackSquare Hercules XB
 In-flight magnetometer: GEM Systems GSMP-35JA (Potassium vapor)
 In-flight sampling rate: 10 Hz (0.1 s)
 Ground magnetometers (base station): GEM GSM-19 (Cesium/auron)
 Base station sampling rate: 0.16 Hz (6.0 s)

Coordinate system:
 Datum: WGS84
 Projection: Universal Transverse Mercator Central meridian: (Zone 11N)
 Hill shade inclination: 045°N
 Hill shade declination: 045°N (NE-SW)



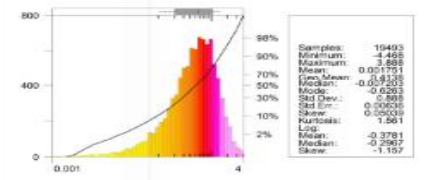
Pioneer Exploration Consultants Ltd.
 very Low frequency (VLF) Drone survey
 Out of Phase (Quadrature)
 Units: % of Total field (pT)
 Project: Kootenays
 Survey Date: May 2023
 Map Author: Kiyavash Parvar MASC. Geophysics



Flight Parameters:
 Flight line spacing: 50 m
 Flight line azimuth: 135-315°N
 Tie-line spacing: 500 m
 Tie-line direction: 045-225°N
 Nominal sensor elevation above ground: 45m

Instrumentation:
 Unmanned aerial vehicle: BlackSquare Hercules XB
 In-flight magnetometer: GEM Systems GEMP-35(A) (Potassium vapor)
 In-flight sampling time: 10 Hz (0.1 s)
 Ground magnetometers (base station): GEM GSM-19 (Overhauser proton)
 Base station sampling rate: 0.16 Hz (6.0 s)

Coordinate system:
 Datum: WGS84
 Projection: Universal Transverse Mercator Central meridian: (Zone 11N)
 Hill shade inclination: 045°N
 Hill shade declination: 045°N (NE-SW)



Pioneer Exploration Consultants Ltd.
 very Low Frequency (VLF) Drone survey
 Fraser Filter
 Units: Dimension-Less
 Project: Kootenays
 Survey Date: May 2023
 Map Author: Kiyavash Parvar M.A.Sc. Geophysics