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BC Geological Survey Assessment Report 39050

Ministry of Energy, Mines & Petroleum Resources
Mining & Minerals Division
BC Geological Survey

Assessment Report Title Page and Summary

TYPE OF REPORT [type of survey(s)]: Analyses of digitized airborne magnetic data and ground **TOTAL COST:** $7,931.60

AUTHOR(S): Frederick A. Cook **SIGNATURE(S):** Frederick A. Cook

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Date: 2020.04.22 14:43:18 -07'00'

NOTICE OF WORK PERMIT NUMBER(S)/DATE(S): **YEAR OF WORK:** 2019-20

STATEMENT OF WORK - CASH PAYMENTS EVENT NUMBER(S)/DATE(S): Event 5773861: Dates Aug 14 and 16, 2019; January 13-20, 20

PROPERTY NAME: Leaky Pipe

CLAIM NAME(S) (on which the work was done): Leaky Pipe 01-19 (Title No. 1066470), LP 02-19(Title No. 1068445)

COMMODITIES SOUGHT: massive sulphides

MINERAL INVENTORY MINFILE NUMBER(S), IF KNOWN:

MINING DIVISION: Ft. Steele **NTS/BCGS:** 082F

LATITUDE: 49 ° 08 '07.8 " **LONGITUDE:** 115 ° 9 '57.2 " **(at centre of work)**

OWNER(S):
1) D. E. LaVoie
2)

MAILING ADDRESS:
2290 DeWolfe Ave.
Kimberley, BC V1A1P5

OPERATOR(S) [who paid for the work]:
1)
2)

MAILING ADDRESS:

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

Metasedimentary rock; Proterozoic; Middle Aldridge Formation, sedex deposits

REFERENCES TO PREVIOUS ASSESSMENT WORK AND ASSESSMENT REPORT NUMBERS: Woodfill (24652); Pirie (17633)

Next Page

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	VLF-EM - 700m	1066470, 1068445	1450
Induced Polarization			
Radiometric			
Seismic			
Other	Data Processing	1066470, 1068445	800
Airborne	Digitization/Data Processing		2560
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	Report, travel		$3,121.60
		TOTAL COST:	$7,931.60

Assessment Report:

Analyses of Digitized Airborne Magnetic Data and VLF-EM Data on the Leaky Pipe Property, Southeastern British Columbia

MTO event 5773861

North 49° 08' 07.8"; West 115° 59' 57.2"

UTM Zone 11 573000E, 5443000N, WGS84

NTS map sheet 82G

Fort Steele Mining Division

by

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Salt Spring Imaging, Ltd.
128 Trincomali Heights
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for

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March, 2020

Table of Contents

Tables

List of Figures

Appendices

1.0 Summary

Application of modern data processing techniques to existing geophysical data on the Leaky Pipe property in southeastern British Columbia has provided new insights into structures delineated on aeromagnetic data as well as on subsurface variations of electrical conductivity determined from new VLF-EM data. The results include identification and delineation of a prominent magnetic features as well as electrically conductive zones that spatially correlate with an exposed shear zone with elevated metals.

2.0 Introduction

The purpose of this report is to describe the advanced processing and analysis of airborne magnetic data that were recorded 25 years ago and that were digitized to allow applications of digital filtering techniques, as well as a reconnaissance ground-based VLF-EM profileacross an exposed shear zone. The objectives are to use these techniques to enhance our understanding of the geologic structure and distribution of metals in the near subsurface of the Leaky Pipe property in the Purcell anticlinorium of southeastern British Columbia (Figure 1). The approach here will be to outline the geological setting, and then to focus on the results from the geophysical data sets.

All units used in this report are metric.

3.0 Property Description and Location

The Leaky Pipe Property ('the property') is located approximately 20-25 kilometres west-southwest of Moyie in the Fort Steele Mining Division of southeastern British Columbia (Figure 1). The two tenures (1066470 and 1068445; Table 1) cover an area of 908.77 hectares and is centred at approximate UTM coordinates 573000E, 5443000N, zone 11N WGS84, or 49^{o} 8' 7.8" North Latitude; 115^{o} 59' 57.2" West Longitude within map sheet 082G. Access to the property is via Highway 3 southwest of Moyie and then via forest service roads to the east. The area as been logged recently such that road access is good, although much of the ground is disturbed. Mineral cell titles were acquired online and as such there are no posts or lines marking the location of the property on the ground.

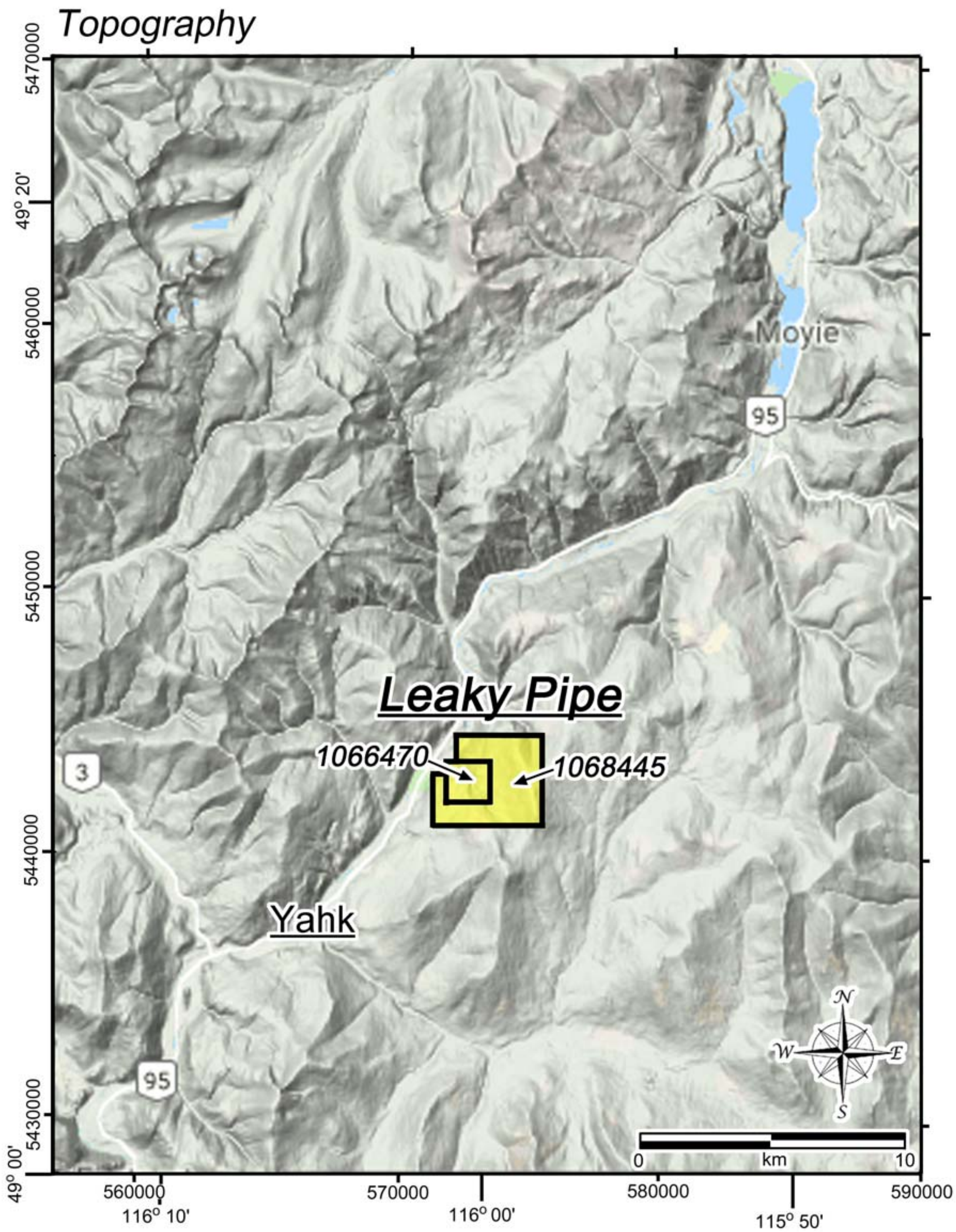

Figure 1. Shaded relief elevation map of the area near Moyie, British Columbia with the Leaky Pipe property indicated in yellow.

Title Number	Claim Name/Property	Issue Date	Good To Date	New Good To Date	# of Days For-ward	Area in Ha	Applied Work Value	Sub-mission Fee
1066470	LEAKY PIPE 01-19	2019/FEB/12	2020/FEB/12	2022/Jan/09	697	190.21	$ 1813.55	$ 0.00
1068445	LP 02-19	2019/MAY/09	2020/MAY/09	2022/Jan/09	610	718.56	$ 6004.41	$ 0.00

Table 1. Description of Leaky Pipe property mineral titles.

4.0 Geological Setting

The geology in the vicinity of the Leaky Pipe property (Figure 2) consists primarily of the Mesoproterozoic (ca. 1.47 Ga) Aldridge Formation metasedimentary rocks and associated mafic sills (Moyie sills). These rocks were deposited in an extensional basin (Belt-Purcell basin) that was subsequently uplifted and arched into the Purcell anticlinorium. The anticlinorium consists of thrust sheets that produced uplift and deformation of the strata into regional anticlines (e.g., Moyie anticline) that strike north-northeast and plunge northward in Canada. The location of the property with respect to the geologic structure is in the foot wall of the Moyie thrust fault, an east-northeast directed oblique thrust fault that was active into the late Cretaceous.

Uplift of the anticlinorium probably began in the Mesoproterozoic, but the latest movement on the Moyie thrust was at least as late as the Cretaceous (Yin, 1995) and that is likely when the final uplift of the Moyie anticline occurred as well. Uplift of the Moyie anticline as it is visible today was caused when the thick basinal sedimentary strata encroached upon and were thrust over a prominent west-facing ramp in the pre-Purcell basement. The Leaky Pipe property is situated in the vicinity of some of the stratigraphically deepest rocks of the Aldridge Formation that host the Sullivan deposit approximately 55 km to the north.

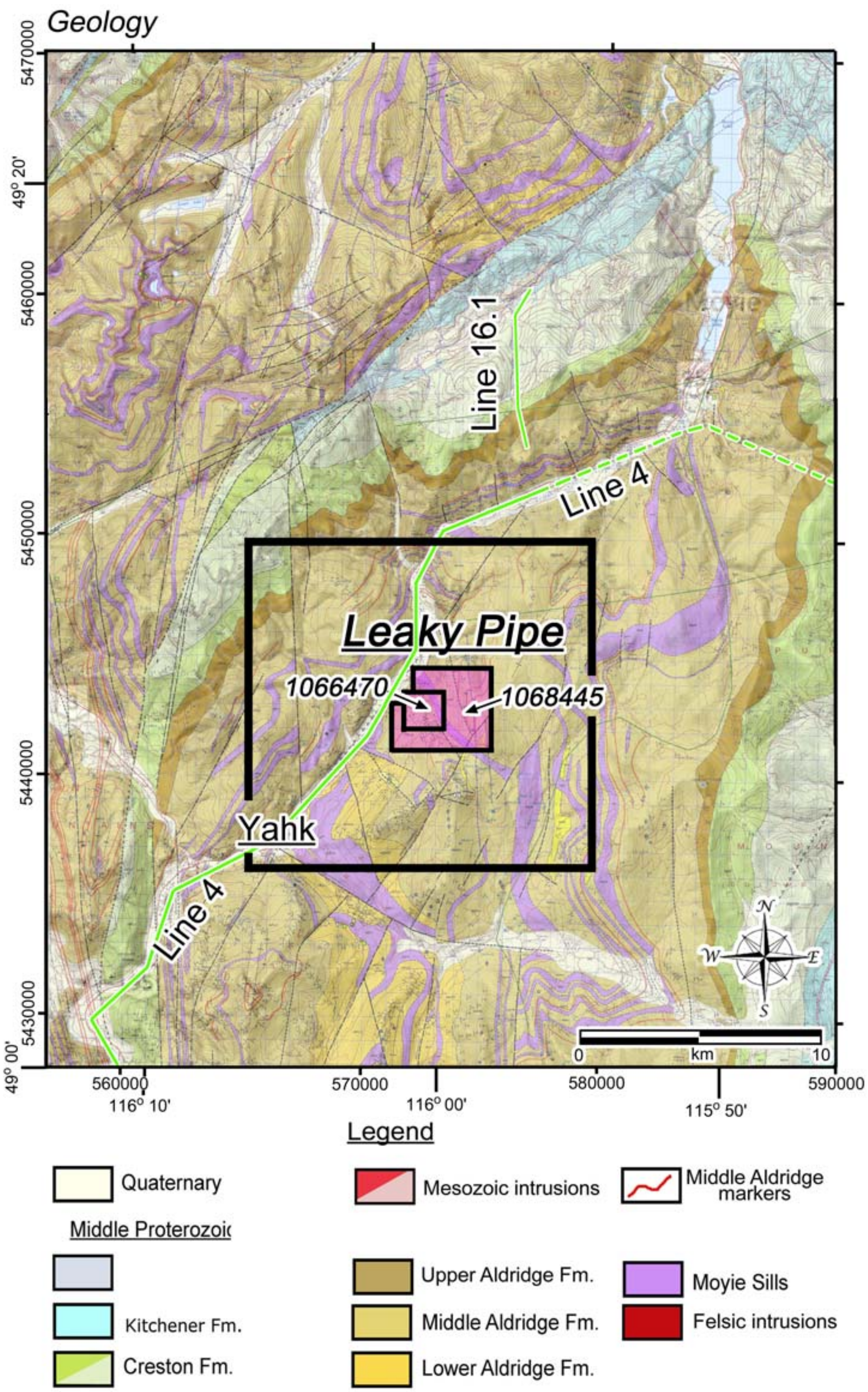

Figure 2. Geological map in the vicinity of the Leaky Pipe property (modified from Brown, 1998). The property area is outlined by the black rectangle surrounding the pink shading. The large black rectangle is the area enlarged in Figure 5.

5.0 Historical Development

Although the area of the Leaky Pipe property has been part of large-scale claim blocks, there is no record of detailed geochemical or geophysical work done in the immediate area of the property. However, A number of studies focuses east and south of the property have provided a significant amount of data. For example in Assessment Report #17633, Pirie described a CSAMT program that had identified two near-surface resistivity anomalies. Later, Minova undertook gravity, soil sampling and drilling in the area east of the property. Chevron held claims southeast of the property on Mount Mahon and undertook mapping, soil sampling and several drill holes.

Woodfill (1996) described an airborne magnetic survey of a large area that included about 50% of the Leaky Pipe property. Analyses of these data provide a large part of the present study.

6.0 Work Done in 2019

Work completed on the Leaky Pipe property in 2019 consisted of the analysis of digitized airborne magnetic data and a reconnaissance VLF-EM line across an exposed shear zone. The magnetic data were acquired in 1996 and reported in Woodfill (1996) in the form of scaled maps. As a result, the Total Field Magnetics, also known as the TMI (Total Magnetic Intensity) map could be digitized and then processed with additional methods that help to delineate structure.

A single VLF-EM line (Figure 3) was run across an exposed shear zone to help delineate the near-surface electrical conductivity structure.

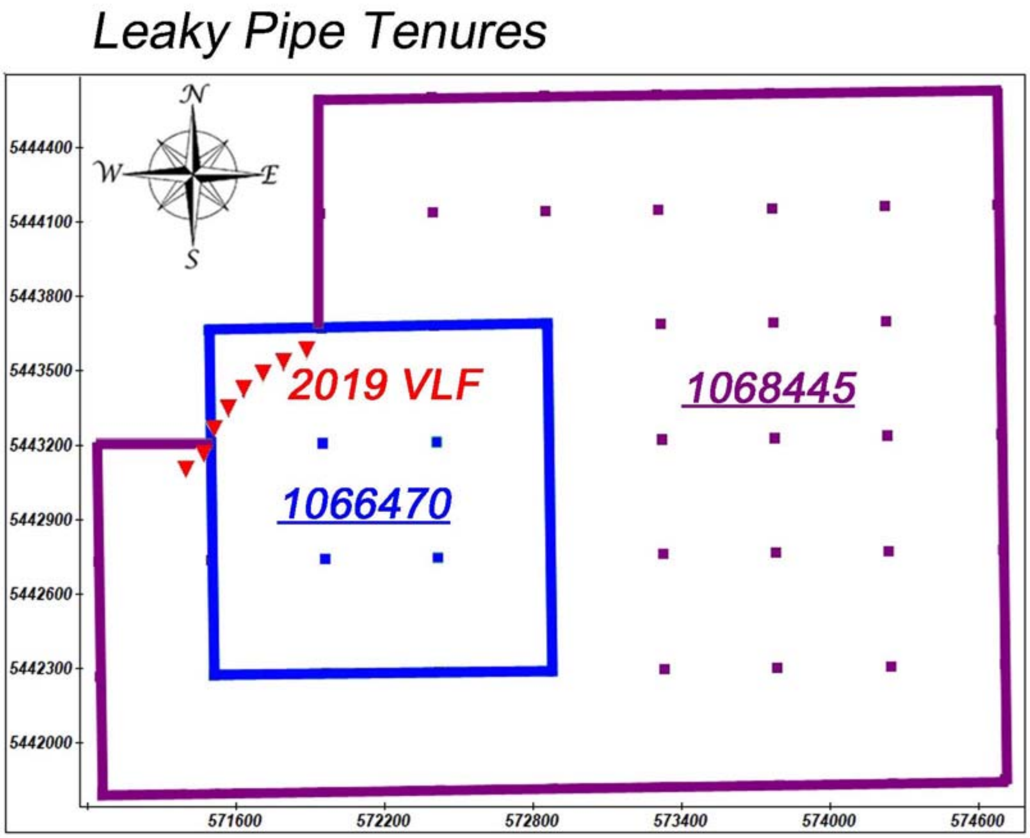

Figure 3. Map of the two Leaky Pipe tenures with the corners of each claim block indicated by dots. Red line with inverted triangles is the location of the new VLF line.

7.0 Data

7.1 General

Two data sets were used in this study: 1) a grid of aeromagnetic data that were acquired by High Sense Geophysics in 1996 (Woodfill, 1996), and, 2) a single reconnaissance VLF-EM line.

The magnetic data were presented as a large-scale map in Woodfill (1996) such that it could be digitized and regridded. The results of these efforts are the basis for further analyses of the data, including:

1. Removal of the IGRF (International Geomagnetic Reference Field);
2. Application of derivative – based analyses such as the tilt derivative and normalized standard deviation to delineate structure.

The VLF-EM data were acquired with a Geotronics EM-16 instrument set to receive signals from two distant transmitters (Seattle, WA and Lamoure, ND). The profile was oriented at high angle to an exposed shear zone in which anomalous metals have been found (As, Zn, Cu). Following are details of the data analyses.

7.2 Magnetic Data

The magnetic data utilized here were recorded by High Sense Geophysics with much higher resolution (50m grid spacing; Woodfill, 1996) than the regional magnetic data from Natural Resources Canada (200m grid spacing). The line spacing of 200m allowed for a grid spacing of 50m and contour maps are available in Woodfill (1996). In order to utilize these data for studies such as this one, and because the digital data were not available, the Total Field Magnetics (also known as the Total Magnetic Intensity, or TMI) map was hand digitized and re-gridded (50m grid spacing). Once the digitized data were obtained, the regional International Geomagnetic Reference Field (IGRF) was approximated and removed from the signal at each grid point.

Figure 4 shows the regional magnetic data from the area of the Leaky Pipe property. Figure 4a displays the regional magnetic data from Natural Resources Canada (http://gdr.agg.nrcan.gc.ca/gdrdap/dap/search-eng.php) with 250m grid spacing. After digitization of the map in Woodfill (1996), Figure 4b is the same map as in Figure 4a with the high-resolution data superimposed. The results of the high resolution data analysis shown in Figure 4b includes corrections for diurnal variations and the IGRF (International Geomagnetic Reference Field) and reduction to the North Pole (RTP). Corrections for the IGRF were made by taking the IGRF value for the central time of the survey (August 24 through September 1, 1996) at a number of points, contouring the values and then subtracting from the measured values. Although not as accurate as calculating for each point during data acquisition, this approach does allow a regionally trend if the IGRF to be removed.

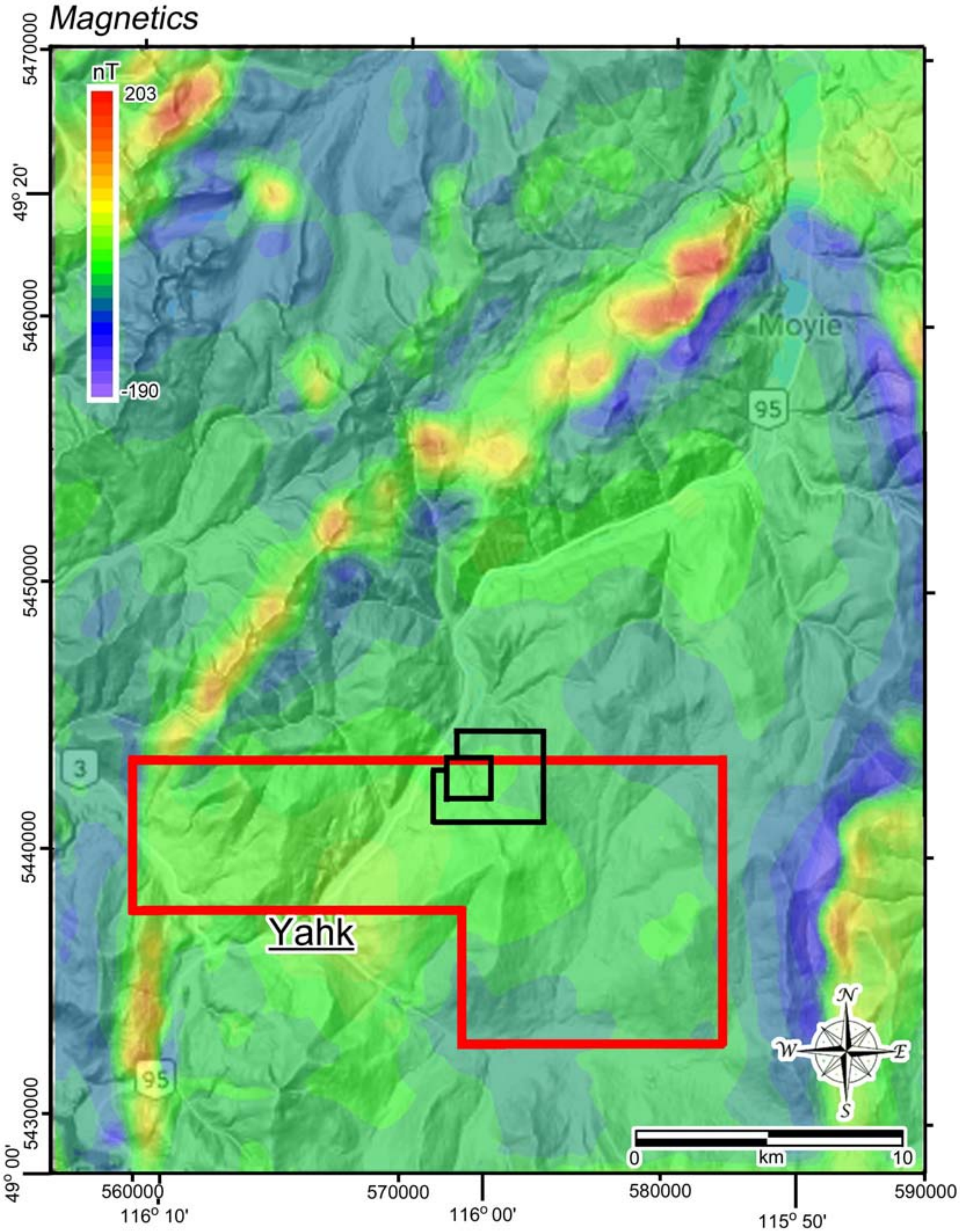

Figure 4a. Regional aeromagnetic map (200m grid spacing) from Natural Resources Canada (data available from http://gdr.agg.nrcan.gc.ca/gdrdap/dap/search-eng.php). The black rectangles outline the Leaky Pipe claim blocks and the red outlines the area of the digitized magnetic data from Woodfill (1996).

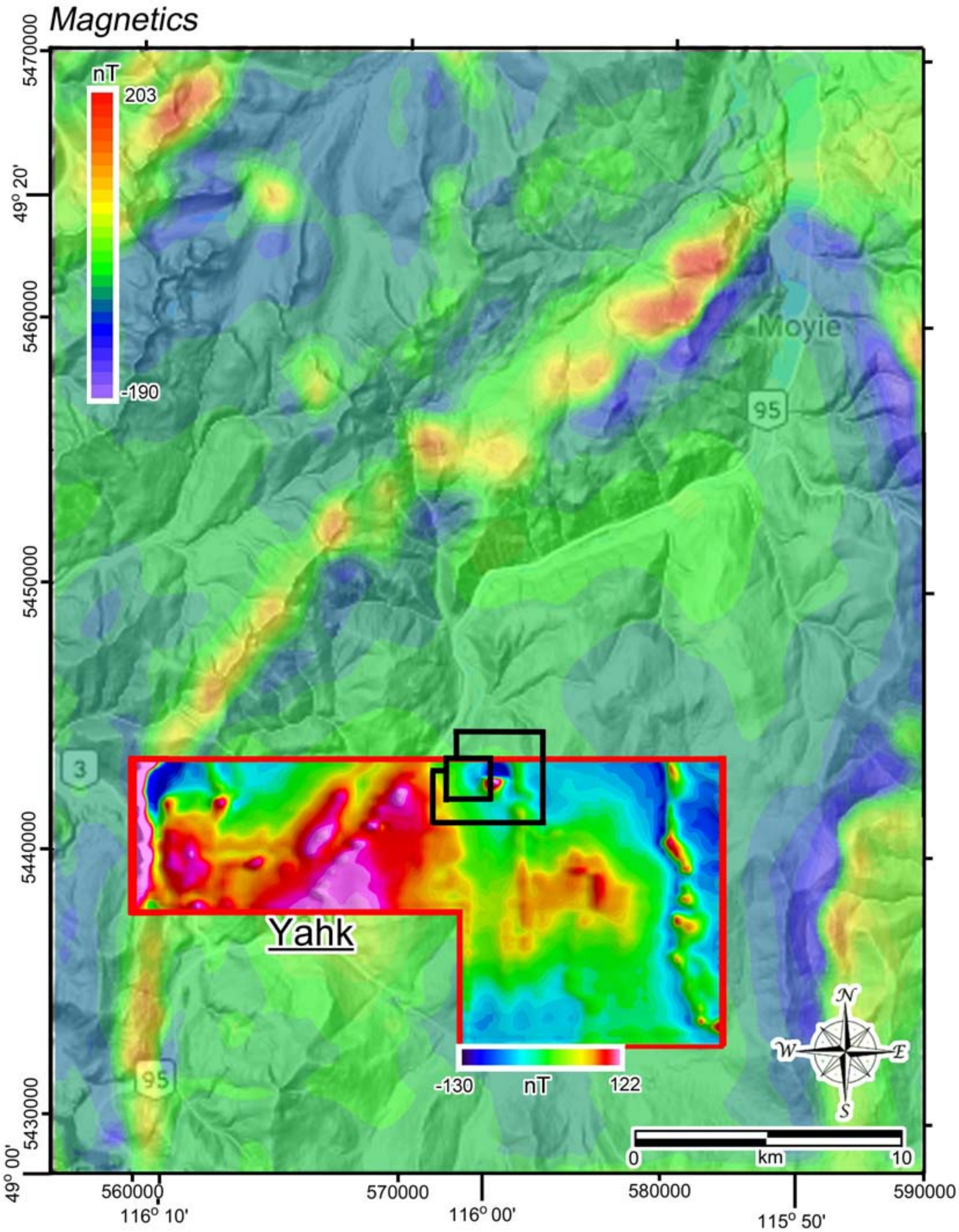

Figure 4b. Regional aeromagnetic map from Figure 4a with the newly digitized data within the red outline. Note that the colour scales are different between the regional and the local data sets.

7.3 VLF-EM Data

The VLF-EM data were acquired along a single line that is oriented southwest-northeast (Figures 3 and 5). Although the line is more-or-less parallel to the general strike of the Moyie anticline (north-northeast), it is oriented at high angle to many of the cross-cutting structures and thus has the potential for delineating conductive conduits associated with the shear zone and mineralization. The VLF data were recorded with 25m station spacing at 29 points for a total line length of 700m. GPS measurements (UTM values and elevation) were made at 100m intervals and interpolated to intervening stations.

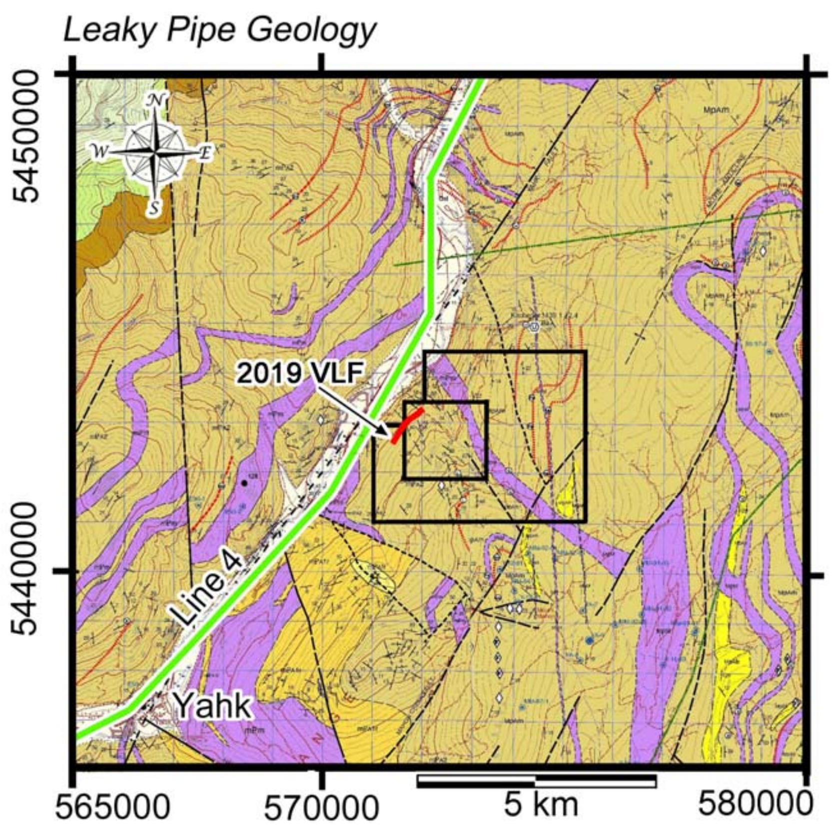

Figure 5. Map of geology in the vicinity of the Leaky Pipe property with the location of the VLF line shown in red.

8.0 Results: Magnetic Data

8.1 Magnetic Data: General

Analyses of the magnetic data were undertaken to delineate two types of characteristics in the magnetic data. First, the data were analysed for structural variations that could be related to the known geology in order to identify and map features that may not be visible in the geological mapping. Second, individual anomalies were analysed for depth and structural information. To accomplish these objectives, following reduction of the magnetic data by removing the IGRF signal and reduction to the North Pole, a series of gradient-based filters (e.g., tilt angle, Generalized Derivative Operator, etc.) were applied and the results were compared with the geological mapping. Some of the results from the filtering (e.g., tilt angle) were then used to assist in estimating depth for specific anomalies that may be significant for the Leaky Pipe property.

8.2 Magnetic Data: Regional Filter Results

Filtering is the process of modifying the data set to either enhance desirable signal, or to attenuate undesirable noise. For these data, several different approaches were taken in order to obtain as much information as possible. These include the tilt angle (Miller and Singh, 1994), the Generalized Derivative Operator (GDO; Cooper and Cowan, 2011) and the Normalized Standard Deviation (Cooper and Cowan, 2008).

Figure 6 shows the digitized data after gridding (50m), removal of the (approximate) IGRF, and reduction to the North Pole. This is the same result as displayed in Figure 4b and it is clear the digitized map provides significantly higher resolution results than the regional NRCan data set (~250m grid spacing). Application of the tilt angle (Figure 7) provides a first look at geometry. It tends to equalize amplitudes such that low-amplitude anomalies on the reduced-to-pole version appear amplitudes that are nearly equivalent to those of the prominent anomalies because calculation of the tilt angle depends on the gradients of the anomalies, rather than the amplitudes.

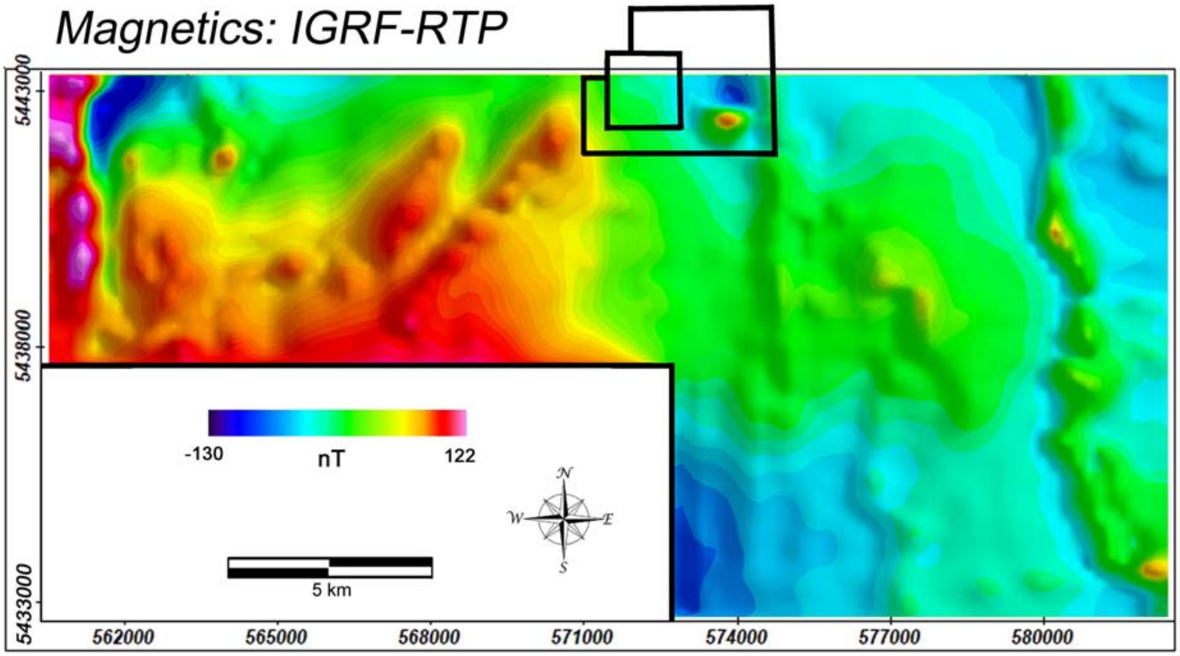

Figure 6. Map of digitized magnetic data after removal of the (approximated) IGRF and reduction to the pole. The locations of the Leaky Pipe tenures are shown by the outlines. This map forms the basis for the structural analyses as well as the anomaly-based analyses.

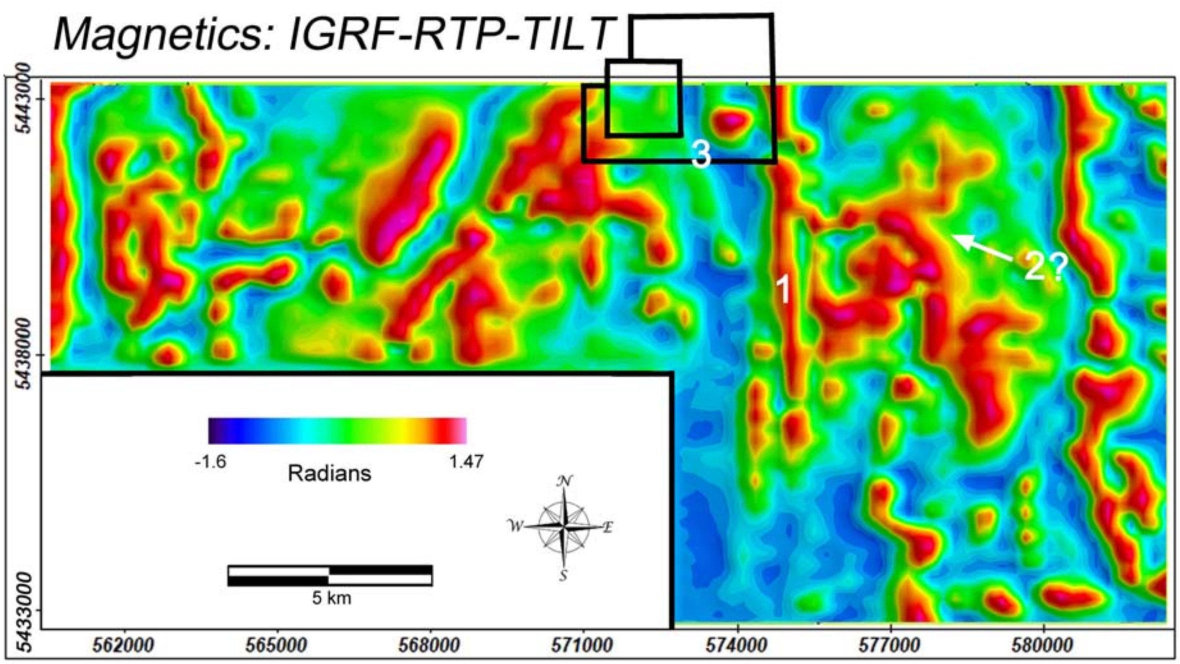

Figure 7. Same map as in Figure 6 after application of the tilt angle.

The effect of applying gradient-based filters is to minimize the significance of amplitude variations and to enhance the variations in geometry (structure). In Figure 7, for example, anomaly 1 is a long (7-8 km) north-south anomaly that is barely visible on the reduced-to-pole version (Figure 6). This anomaly corresponds to a north-south mafic dyke that may be associated with the ca. 1554 Ga Moyie intrusions. Perhaps significantly, there appears to be another, similar north-south linear anomaly about 1 km west of the southern part of anomaly 1. This may be another dyke that has not been seen in outcrop.

Elsewhere in the tilt angle image (Figure 7), location 2 may be the response of a northwest-southeast oriented structure (fault?) that appears to offset, or disrupt, anomaly 1 in the southeast corner of the Leaky Pipe property. Anomaly 3 is a local, prominent, moderately strong (about 50-75 nT above background). This feature will be discussed further with more detailed analysis later in this report.

An approach that is similar to the tilt gradient in a more generally applicable technique is the Generalized Derivative Operator (GDO; Cooper and Cowan, 2011). The GDO can be considered the tilt angle with an azimuthal component. Thus, to present the results of the GDO, maps of the GDO for a series of azimuths are shown in Figure 8. In a manner similar to directional filtering, the illumination is controlled by two parameters, the azimuth, or angle from horth, and the elevation, or inclination. For each of the azimuths shown in Figure 8 (0^o, 45^o, 90^o, 135^o, …, 315^o), the inclination of the illuminating source was taken to be 20^o. Thus, for the map in the top centre of Figure 8, the azimuth was 0^o (north) and the illumination inclination was 20^o from horizontal.

This approach will enhance features by both the gradient amplitudes as well as illumination inclination. For example, when the illumination is from the north with a low inclination angle, features that are oriented east-west will tend to be enhanced. Similarly, a feature that is oriented northwest-southeast will tend to be enhanced when the illumination direction is from the northeast. Indeed, the 45^o azimuth GDO (Figure 8) does appear to slightly enhance the northwest–southeast break along anomaly 2 (Figure 7).

When the illuminating azimuth is from the east (90^o) the prominent north-south dyke anomaly (anomaly 1 in Figure 7) is enhanced. Note that it is even more evident when illumination is from the west (270^o).

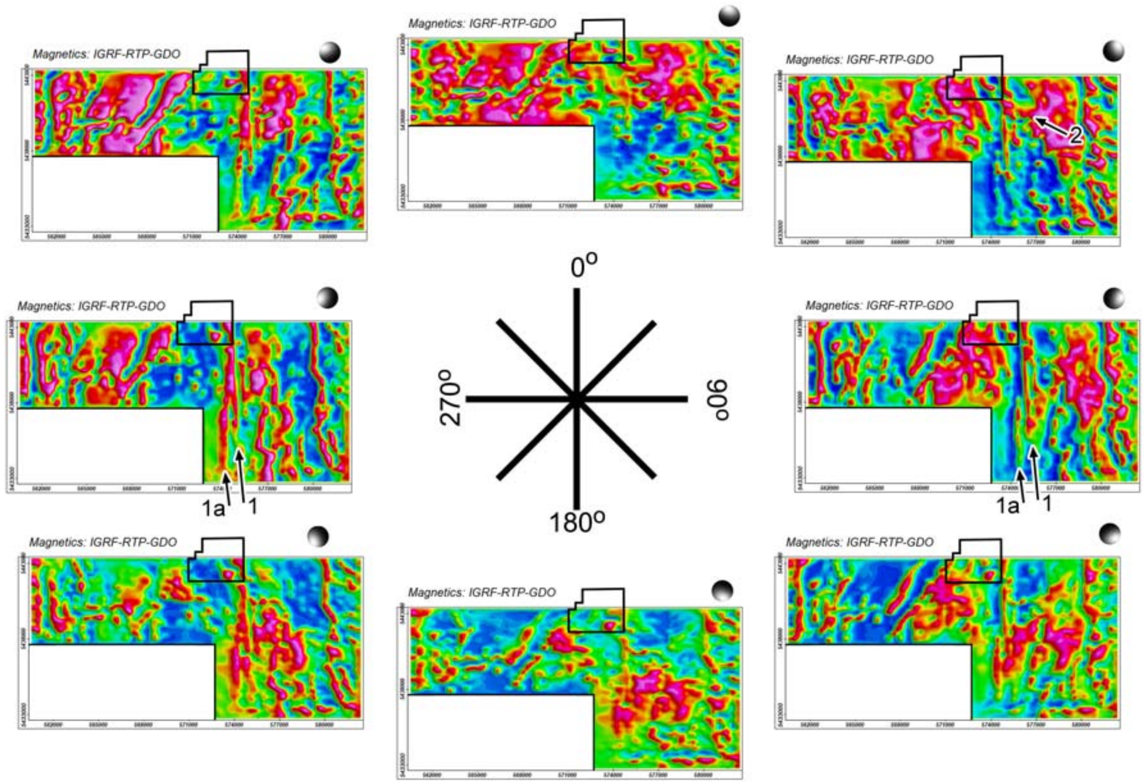

Figure 8. Eight Generalized Derivative Operator (GDO) maps for eight different azimuths. For each map the illumination inclination is 20^{o}.

A third filter that has been applied is the Normalized Standard Deviation, or NSTD (Cooper and Cowan, 2008). The NSTD has the advantage of highlighting the edges of anomalies in addition to equalizing the amplitudes. This, in turn, produces maps that can provide structural geometry. Figure 9 shows the same data as in Figure 6 after application of the NSTD with a window of 5x5 grid points after application of upward continuation of 300m. This was done to smooth the data and to minimize amplification of noise. Note that anomaly 3 appears as a doughnut-like feature because the NSTD outlines the edges of an anomaly. Elsewhere, anomaly 1 and 1a are apparent, but a possible linear structure at location 2 is not clear.

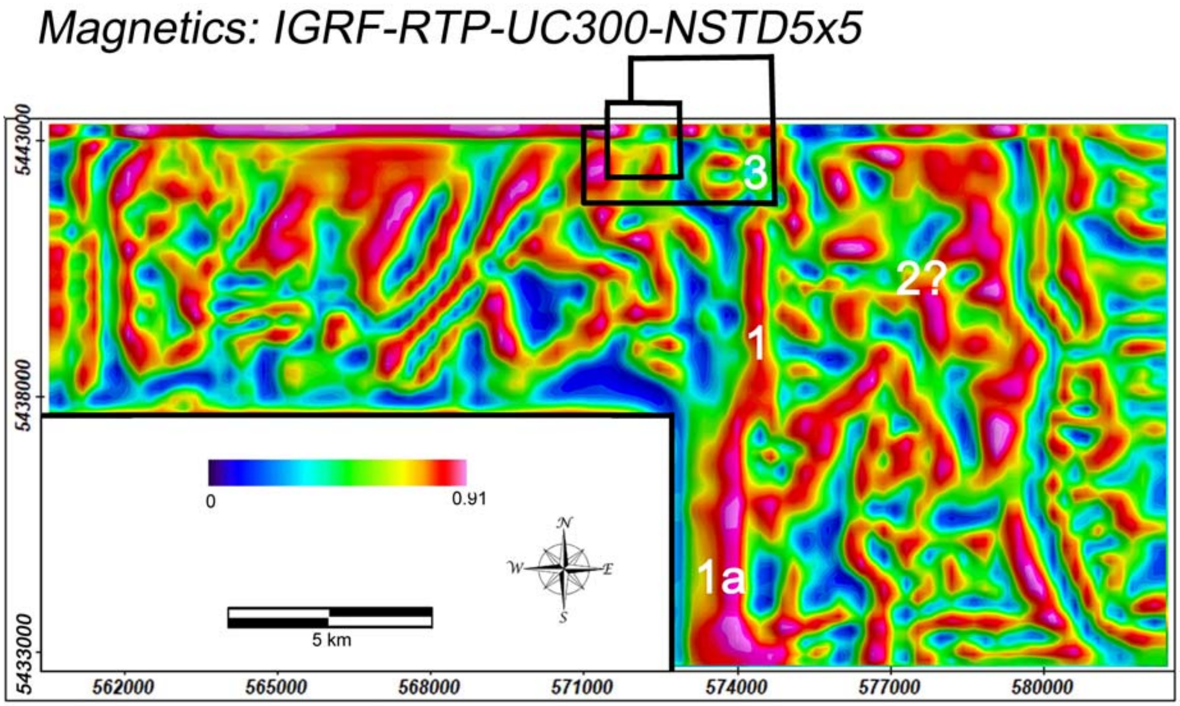

Figure 9. Same map as in Figure 6 after application of the NSTD. The data were upward continued by 300m prior to application of the NSTD filter.

8.3 Magnetic Anomaly Data: Regional Correlations with Geology

Figure 10 shows the geologic map in the vicinity of the Leaky Pipe property with the tilt angle version of the magnetic data overlain. Two features are significant on this map. First, the Moyie intrusions are generally not very magnetic. Exceptions, such as anomaly 1, are apparent, but as noted previously, it is not known if the dyke along anomaly 1 (and possibly 1a) is indeed associated with the Moyie intrusives.

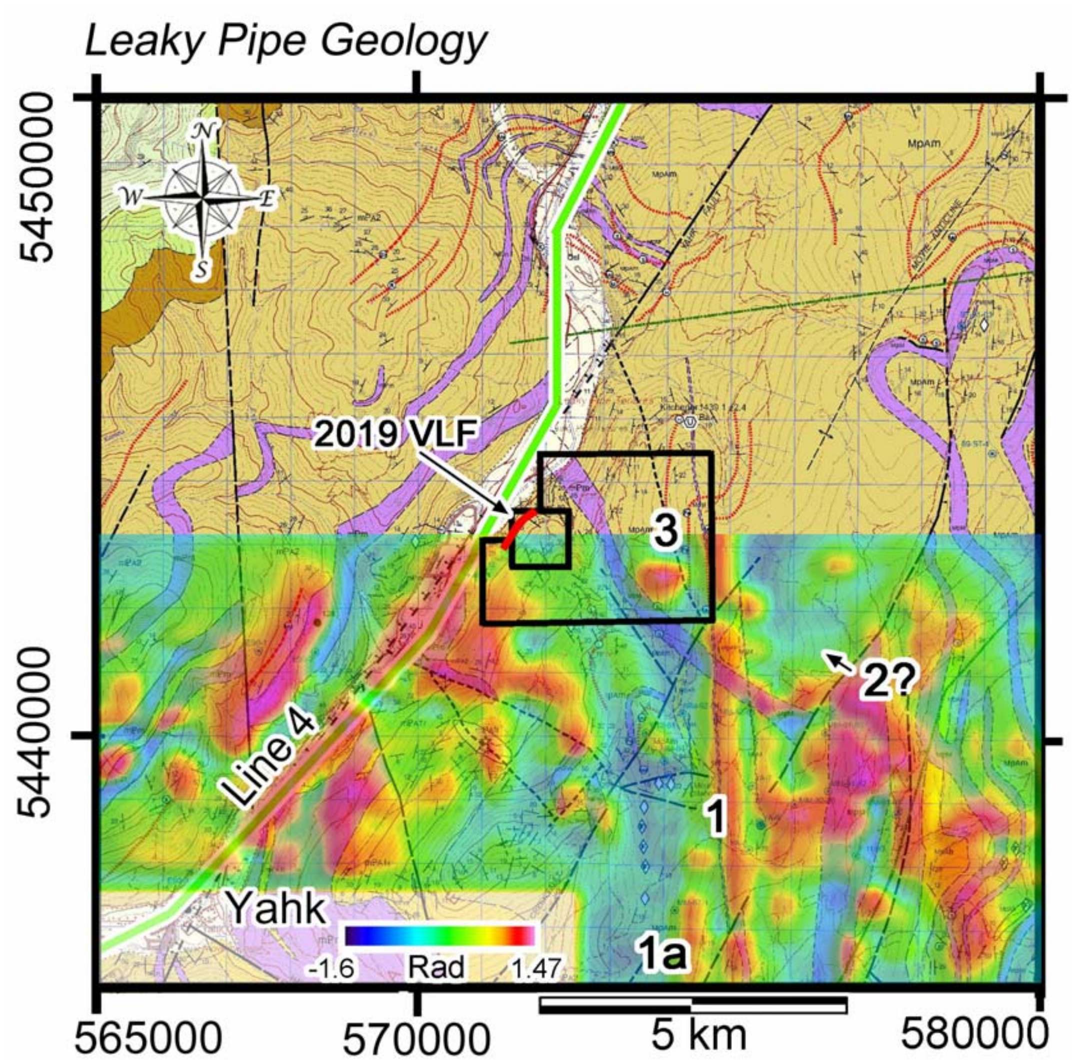

Figure 10. Geologic map from the vicinity of the Leaky Pipe property from Figure 5 with the tilt angle result overlain. Note the correlation of anomaly 1 with a north-south dyke.

8.4 Magnetic Anomaly Data: Property Scale Results

Application of the filtering techniques at the property-scale produced two significant results. First, anomaly 3 is clearly visible as a nearly circular anomaly in the southeast quadrant of the property (Figure 11). This is addressed further below. Second, the area northwest of anomaly 2 appears to correlate with a distinctive separation (discontinuity) in anomaly 1 (Figure 11). It is indeed possible that such a separation could have been caused by variations in magnetic susceptibility rather than a structure, so to determine the most likely interpretation it will probably be necessary to search for the causes of these features in the field.

Anomaly 3 is a new finding in that there is no evidence for it in the regional magnetic data (Figure 4a), nor is there any indication of it in the geological mapping from the area (e.g., Brown et al. 2011). Thus, the source of this anomaly is unknown; however, applications of some tilt angle-based techniques can provide some basic characteristics of depth and geometry.

When the data are reduced to the pole, the primary purpose is to transform the magnetic data into date in which anomalies associated with vertically dipping features are symmetric. Hence, in the case of anomaly 3, and assuming the IGRF calculations and pole reduction are reasonable, a vertical feature should be symmetric. However, anomaly 3 is not symmetric. Rather, it appears to be deeper on the north than the south, a geometry that suggests a south dip.

A relatively new approach makes use of the tilt angle to estimate depth (Salem et al. 2007). In this approach, sometimes called the tilt-depth method, the depth can be estimated by the width of the anomalies between +45 and -45 degrees. Thus, Figure 12 shows the tilt angle of the data in Figure 11, and Figure 13 shows the same data with the values greater than $+45^{o}$ in red and values less than -45^{o} in blue. As Salem et al (2007) describe, separation of the contours can be related to twice the depth. Two examples are shown in Figure 12. On the north side of anomaly 3, the contour width is about 200m. Thus, an estimate of depth would be: $Z = \frac{1}{2}(200)$ – height of instrument above the surface. The elevation of the instrument above the surface was approximately 45m, so the depth estimate here is about 55m (Figure 13). A similar calculation for the south side of anomaly 3 is Z = ½ (330) – 45m = 120m (Figure 13). Thus, the source for anomaly 3 appears to have a southward dip and is relatively shallow (~55 to120m). As there is no indication in the geology map (Figure 10) of a magnetic source at the location of anomaly 3, additional field work will be necessary to identify the cause of the anomaly.

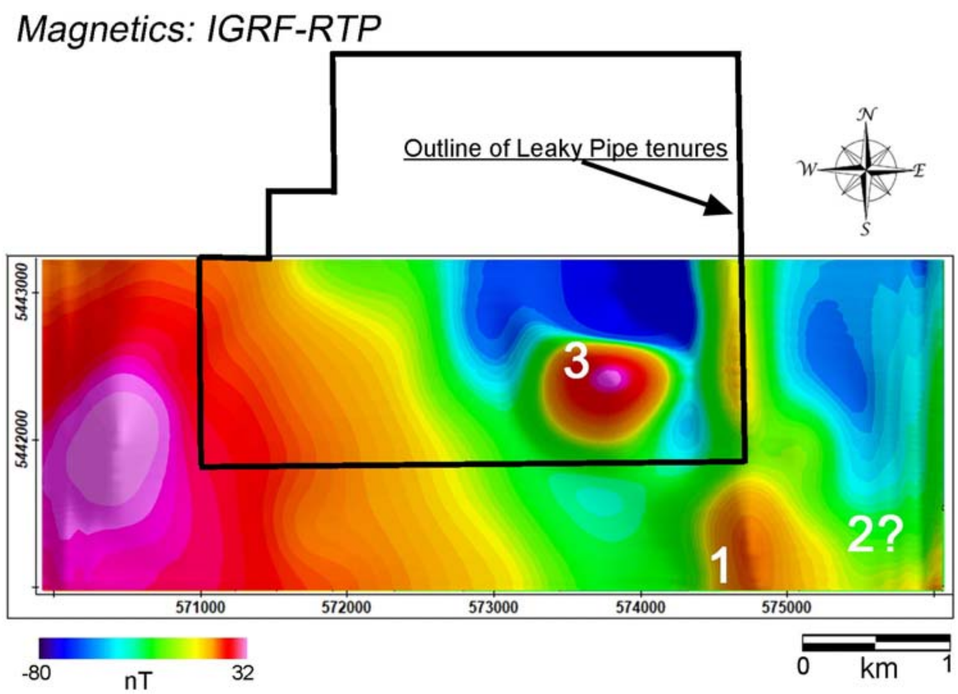

Figure 11. Enlargement of magnetic data near the Leaky Pipe property after removal of the (approximate) IGRF and reduction to the North Pole (RTP). Note the 'bulls-eye' geometry of anomaly 3 and the possible northwest-southeast break near location 2.

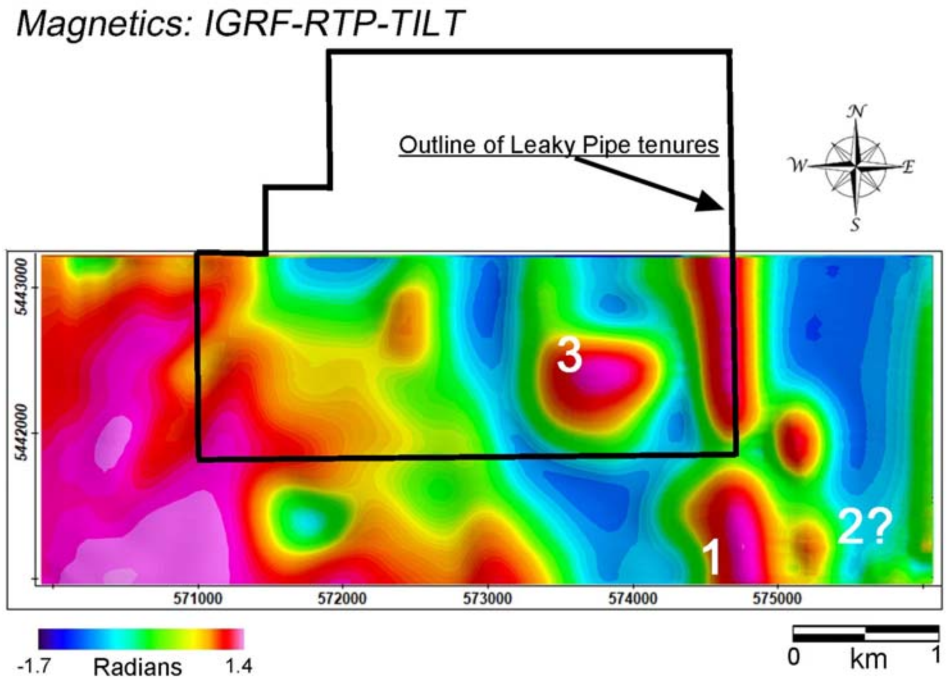

Figure 12. Map of the tilt angle applied to the data in Figure 11.

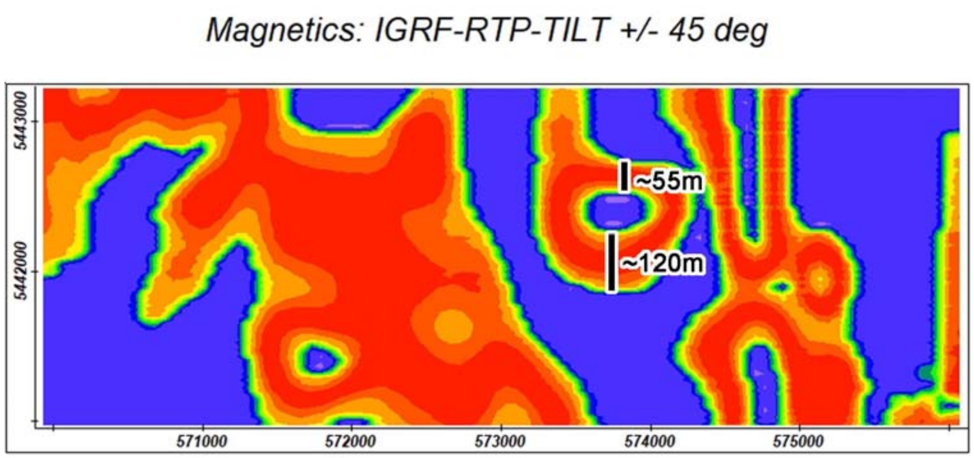

Figure 13. Estimation of depth based on the Tilt-Depth method (Salem et al. 2007) for anomaly 3. Note that the contour width on the north side of the anomaly is about half of the width on the south, thus indicating a southward dip.

Application of the NSTD technique with a window size of 3x3 grid points is shown in Figure 14. A smaller window size (3x3) was used for these data than for the larger area in Figure 9 because the area is smaller and the windowing procedure produces edge effects that are larger for larger window sizes.

Anomaly 3 is demarcated by a ring-like (or doughnut-like) shape. This is expected as the NSTD enhances the edges of anomalies. Similarly, anomaly 1 has two linears outlining the east and west edges of anomaly 1. Finally, there appears to be a northwest-southeast discontinuity in the vicinity of location 2, but it is neither distinct nor prominent. Hence, it is not clear if a structural feature (fault, shear, etc.) is associated with the breaks along the trend at location 2.

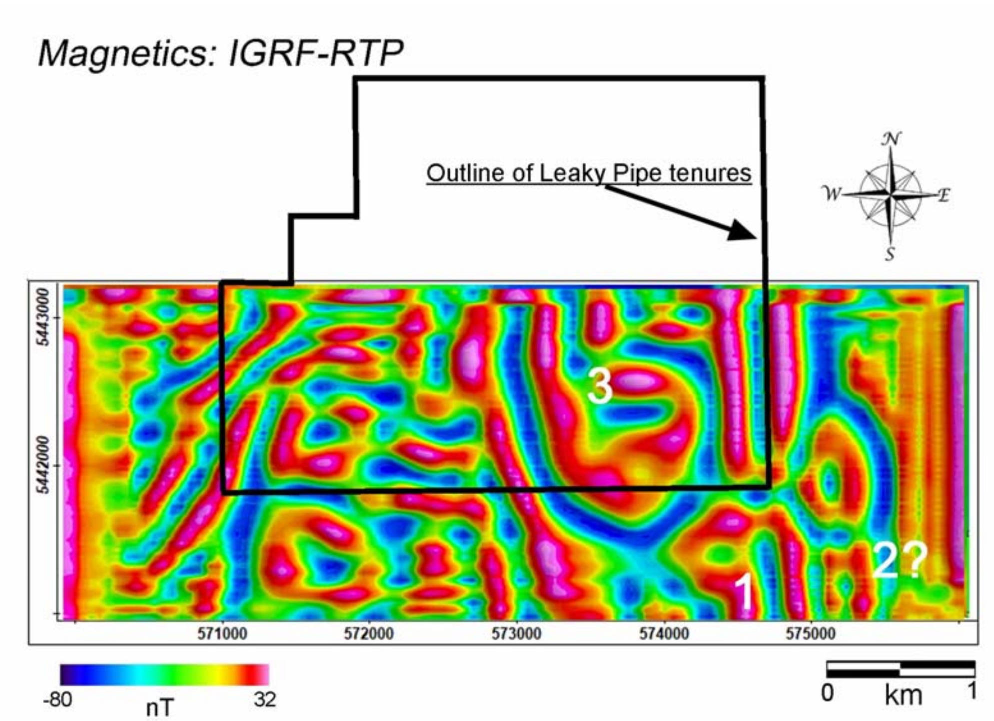

Figure 14. Map of the NSTD filter applied to the data in Figure 11 with a window of 3x3 grid points.

9.0 Results: VLF-EM Data

9.1 VLF-EM Data: General

A reconnaissance VLF-EM line was recorded along a road that is approximately parallel to the strike of the axis of the Moyie anticline (Figure 5). The data were recorded with a 25m station interval and GPS locations at 100m station locations for two distant transmitters: Seattle, WA (NLK, 24800 Hz) and La Moure, ND (NML, 25200 Hz). The field data (Figure 15a) were then filtered (running average; Figure 15b) and inverted (Monteiro-Santos et al. 2006) to approximate the variations of electrical conductivity in cross section (Figures 15c and 16).

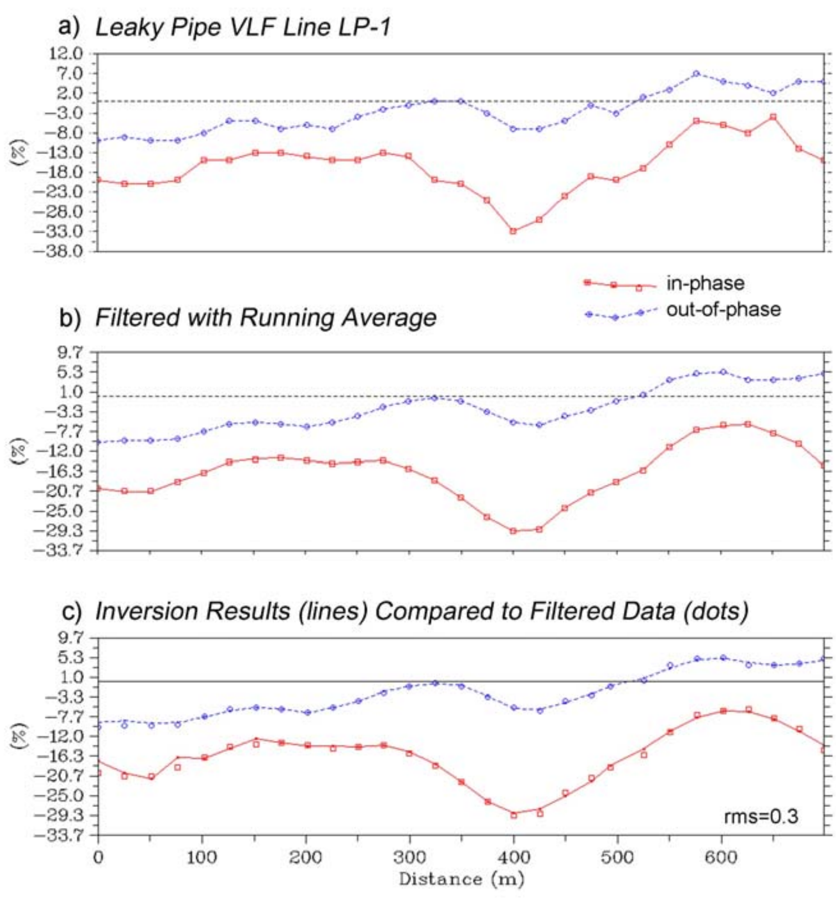

Figure 15. Filter and inversion tests for line 1, Seattle (NLK) transmitter. a) Recorded data, b) Application of running average filter; c) calculated curves (lines) compared with filtered data (dots). The rms error was 0.3%.

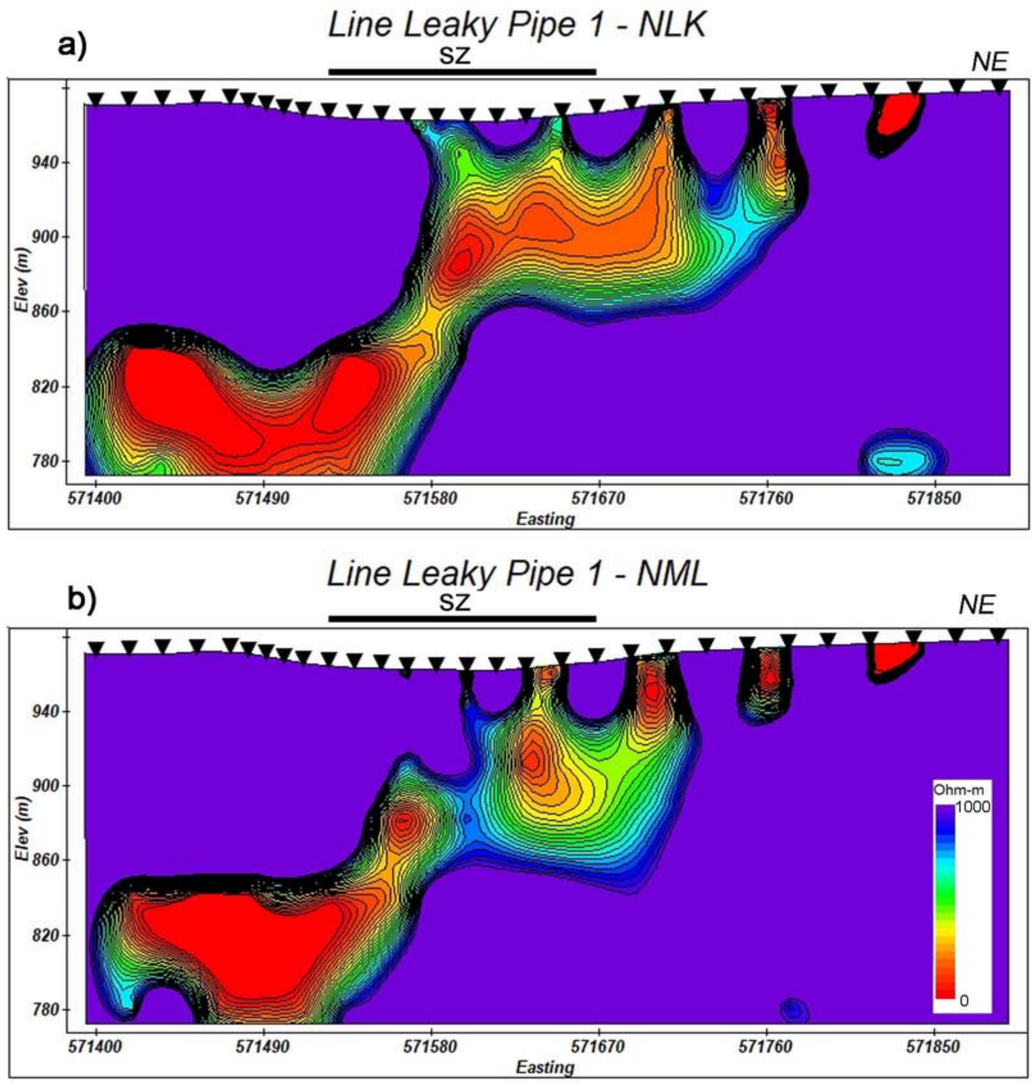

Figure 16. a) Inversion of the data from line 1 for the Seattle (NLK) transmitter. View is to the NW; b) Same as (a) for the North Dakota (NML) transmitter. 'SZ' is the approximate location of the shear zone in the road cut. The colour scale in the lower right applies to both images.

9.2 VLF-EM Data: Correlations with Geology

Although the VLF line represents a single cross section, it appears to detect a prominent anomaly that is spatially associated with the shear zone on the surface. Furthermore, the results from each transmitter are remarkably similar, thus providing confidence in the resulting geometry.

In addition, however, the geometry of the elevated conductivity appears like a set of small channels, or conduits, off of a broader zone at 50m depth or so. This shallow conductive zone appears to be further connected with a deeper zone at 130-150m depth on the southwest end of the line (Figure 16). These characteristics are significant because rock samples taken from the shear zone on the surface have anomalously high values of Zn, Cu and As. The conduit-like geometry may indicate that the source for these anomalous metals is at depth.

10.0 Conclusions

Analyses of the digitized magnetic data and VLF-EM data from the Leaky Pipe property has lead to the following findings:

1. A nearly circular magnetic anomaly was found in the southeast quadrant of the Leaky Pipe property. The source for this anomaly appears to be shallow (~120m or less) and probably dips southward; however, there is no indication of the source in existing geological maps;
2. A long, linear north-south anomaly east of the property is likely a north-south dyke;
3. A possible northwest-southeast structure that may be responsible for offsets in the magnetic anomalies and that may correlate with a shear zone that was crossed by the VLF line has not been clearly imaged, even on directionally imaged GDO data. This could mean either that the structure does not exist southeast of the property, or that the contrasts in magnetic properties across the structure are insufficient to map any features associated with the (interpreted) structure;
4. A single reconnaissance VLF line shows a clear image of conductive zones branching upwards toward the surface from regions of elevated conductivity in the subsurface.

10.0 References

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11.0 Statement of Costs

Property: Leaky Pipe

	Date		Amount	Rate	Total	Notes
1. 2019 VLF - Field Work						
	14-Aug-19	Craig	1 day	500	500	(1)
		Fred	1 day	800	800	(1)
		Truck	1 day	150	150	(1)
					1,450.00	
2. 2019 VLF - Data Processing						
	16-Aug-19	Fred	1 day	800	800.00	
3. Airborne Magnetic Data Reprocessing - Digitize TMI Map from AR 26452						
	13-Jan-20	Fred	1	800	40	(2)
	14-Jan-20	Fred	1	800	40	(2)
	15-Jan-20	Fred	1	800	40	(2)
	16-Jan-20	Fred	1	800	40	(2)
					160	
4. Airborne Magnetic Data Reprocessing - Gradient Analyses/Structure						
	18-Jan-20	Fred	1	800	800.00	
	19-Jan-20	Fred	1	800	800.00	
	20-Jan-20	Fred	1	800	800.00	
					2,400.00	
5. Report					3,000.00	
6. Travel & L/O					121.6	
			TOTAL		$7,931.60	

Note (1): Work done on tenures 1066470 and 1068445
Note (2) Amount prorated (5%) to Leaky Pipe

15.0 Statements of Qualifications

I, Frederick A. Cook do hereby certify that:

1) I attained the degree of Doctor of Philosophy (Ph.D.) in geophysics from Cornell University in Ithaca, New York in 1981.
2) I have a B.Sc. in geology (1973) and an MSc. in Geophysics (1975) from the University of Wyoming in Laramie, Wyoming.
3) I am a registered member of the Association of Professional Engineers and Geoscientists of British Columbia (P. Geo. 2009). Previously, from 1984-2009, I was registered with the Association of Professional Engineers, Geologists and Geophysicists of Alberta as both a P. Geol. and a P. Goph.
4) I am a member of the American Geophysical Union and the Geological Society of America.
5) I have worked as a geophysicist/geologist for a total of 38 years since my graduation from university.
6) I have worked for the Continental Oil Company (1975-1977) and the University of Calgary (1982-2010).
7) I was the Director of the Lithoprobe Seismic Processing Facility at the University of Calgary from 1987-2003.
8) I have recently (2011) been appointed an International Consultant for the Chinese SinoProbe project.
9) I have a thorough knowledge of the geology of southern British Columbia based on extensive geological and geophysical field work since 1980.
10) I have authored more than 125 scholarly publications in peer-reviewed journals and books.
11) I was retained to undertake analyses of the geophysical data in the vicinity of the property.
12) I am the author of this report.
13) I am not aware of any material fact or material change with respect to the subject matter of this report, which is not reflected in this report.

“signed and sealed” at Salt Spring Island, B.C.

Frederick A. Cook, P. Geo.
Salt Spring Imaging, Ltd
128 Trincomali Heights
Salt Spring Island, B.C.

Dated at Salt Spring Island, B.C. this 22nd day of April, 2020
Registration License No. 34585
Association of Professional Engineers and Geoscientists of British Columbia

Appendix 1: Magnetic Anomaly Map RTP

Scale 1:25000

Magnetics: IGRF-RTP

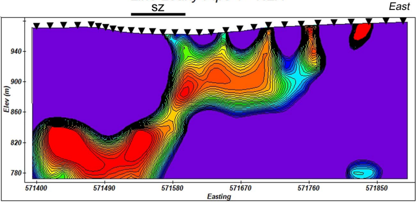
Appendix 2: VLF Field Data

Leaky Pipe VLF - 2019

Line Name	*UTMe*	*UTMn*	*Elev (m)*	*NLK-IP*	*NLK-OP*	*NML-IP*	*NML-OP*
1	571400.00	5443102.00	973.00	-15.00	5.00	16.00	0.00
1	571418.00	5443118.25	973.50	-12.00	5.00	13.00	0.00
1	571436.00	5443134.50	974.00	-4.00	2.00	10.00	-1.00
1	571454.00	5443150.75	974.50	-8.00	4.00	8.00	0.00
1	571472.00	5443167.00	975.00	-6.00	5.00	9.00	-1.00
1	571481.75	5443190.75	973.25	-5.00	7.00	5.00	-2.00
1	571491.50	5443214.50	971.50	-11.00	3.00	13.00	3.00
1	571501.25	5443238.25	969.75	-17.00	1.00	16.00	5.00
1	571511.00	5443262.00	968.00	-20.00	-3.00	21.00	7.00
1	571525.00	5443282.50	967.25	-19.00	-1.00	20.00	7.00
1	571539.00	5443303.00	966.50	-24.00	-5.00	29.00	10.00
1	571553.00	5443323.50	965.75	-30.00	-7.00	23.00	11.00
1	571567.00	5443344.00	965.00	-33.00	-7.00	25.00	15.00
1	571583.00	5443363.50	965.00	-25.00	-3.00	22.00	7.00
1	571599.00	5443383.00	965.00	-21.00	0.00	21.00	5.00
1	571615.00	5443402.50	965.00	-20.00	0.00	19.00	4.00
1	571631.00	5443422.00	965.00	-14.00	-1.00	15.00	4.00
1	571649.75	5443437.75	967.25	-13.00	-2.00	16.00	7.00
1	571668.50	5443453.50	969.50	-15.00	-4.00	16.00	7.00
1	571687.25	5443469.25	971.75	-15.00	-7.00	14.00	8.00
1	571706.00	5443485.00	974.00	-14.00	-6.00	14.00	9.00
1	571727.75	5443497.00	975.00	-13.00	-7.00	14.00	9.00
1	571749.50	5443509.00	976.00	-13.00	-5.00	15.00	9.00
1	571771.25	5443521.00	977.00	-15.00	-5.00	15.00	9.00
1	571793.00	5443533.00	978.00	-15.00	-8.00	16.00	10.00
1	571815.75	5443544.50	978.50	-20.00	-10.00	17.00	12.00
1	571838.50	5443556.00	979.00	-21.00	-10.00	20.00	14.00
1	571861.25	5443567.50	979.50	-21.00	-9.00	20.00	13.00
1	571884.00	5443579.00	980.00	-20.00	-10.00	18.00	12.00

Appendix 3: VLF Inversions
Scale 1:10000

Line Leaky Pipe 1 - NLK



Line Leaky Pipe 1 - NML