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BC Geological Survey
Assessment Report
39182

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 on the Haze **TOTAL COST:** $5,585.60

AUTHOR(S): Frederick A. Cook **SIGNATURE(S):** Frederick A. Cook Digitally signed by Frederick A. Cook DN: cn=Frederick A. Cook, o, ou, email=fcook@ucalgary.ca, c=CA Date: 2020.08.10 11:21:41 -07'00'

NOTICE OF WORK PERMIT NUMBER(S)/DATE(S): **YEAR OF WORK:** 2020

STATEMENT OF WORK - CASH PAYMENTS EVENT NUMBER(S)/DATE(S): Event 5803000, Dates: January 13-16, 2020; May 1-3, 2020

PROPERTY NAME: Kenco

CLAIM NAME(S) (on which the work was done): Hazel's Yahk (Title No. 1068561)

COMMODITIES SOUGHT: massive sulphides

MINERAL INVENTORY MINFILE NUMBER(S), IF KNOWN:

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

LATITUDE: 49 ° 06 ' 34.5 " **LONGITUDE:** 116 ° 08 ' 02.5 " **(at centre of work)**

OWNER(S):
1) Craig Kennedy 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); Gal and Weidner (26121); Stevenson and Staargaard (07626A), Stephenson (20827)

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			
Induced Polarization			
Radiometric			
Seismic			
Other	Data Processing	1068561	2400.00
Airborne	Digitization		185.60
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		$3,000.00
		TOTAL COST:	$5,585.60

Assessment Report:

Analyses of Digitized Airborne Magnetic Data on the Hazel's Yahk Property, Southeastern British Columbia

MTO event 5803000

North 49° 06' 34.5"; West 116° 08' 02.5"

UTM Zone 11: 563200E, 5440000N, WGS84

NTS map sheet 82G

Fort Steele Mining Division

by

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

for

Property Owner/Operator:

Craig Kennedy
2290 DeWolfe Ave.
Kimberley, B.C. V1A1P5

August, 2020

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1.0 Summary

Application of modern data processing techniques to existing geophysical data on the Hazel's Yahk property in southeastern British Columbia has provided new insights into structures delineated on aeromagnetic data. The results include identification and delineation of prominent magnetic features and truncations in anomaly trends that may be related to structures, some of which are not visible on existing geologic maps. In some cases these structures may have been used as fluid pathways for movement and deposition of 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. 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 Hazel's Yahk 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. Units used in this report are metric.

3.0 Property Description and Location

The Hazel's Yahk Property ('the property') is located approximately 25-30 kilometres south of Moyie in the Fort Steele Mining Division of southeastern British Columbia (Figure 1). The single tenure (106856; Table 1) covers an area of 1078.36 hectares and is centred at approximate UTM coordinates 563200E, 5440000N, zone 11N WGS84, or 49° 06' 34.5" North Latitude; 116° 08' 02.5" West Longitude within map sheet 082G. Access to the property is via Highway 3 southwest of Moyie and then via the forest service roads about 3-4 km south of Yahk. Mineral cell titles were acquired online, and as such, there are no posts or lines marking the location of the property on the ground.

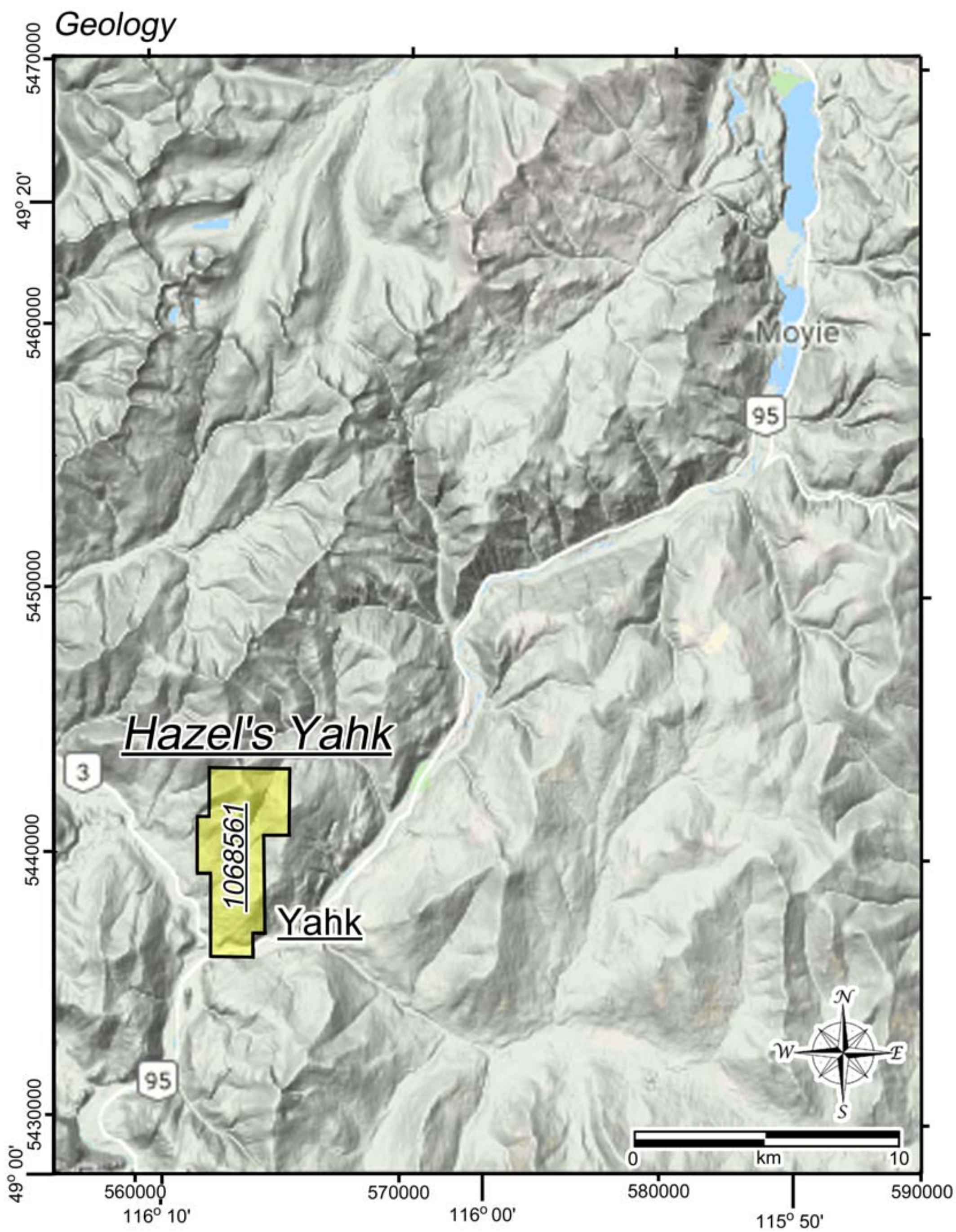

Figure 1. Shaded relief elevation map of the area near Moyie, British Columbia with the Hazel's Yahk property indicated in yellow.

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
1068561	HAZEL'S YAHK 01-19	2019/MAY/15	2020/MAY/15	2021/MAY/20	370	1078.36	$ 5465.66	$ 0.00

Table 1. Description of Hazel’s Yahk property mineral title.

4.0 Geological Setting

The geology in the vicinity of the Hazel’s Yahk 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 during several stages of deformation. 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 and that is probably 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 cratonic basement. The property is situated in the vicinity of some of the stratigraphically deepest rocks of the Aldridge Formation that host the Sullivan deposit approximately 60 km to the north.

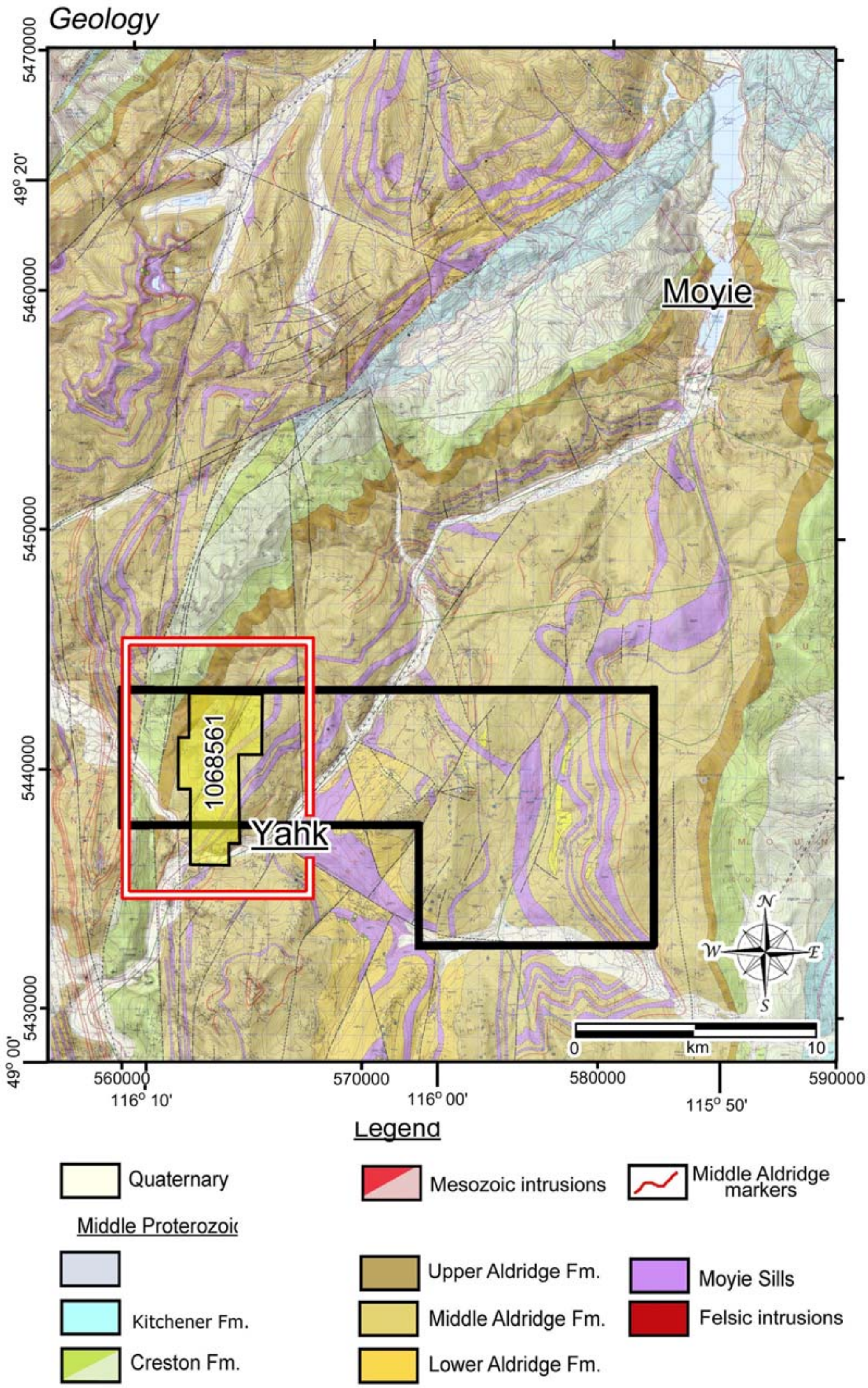
Geology
5470000
49° 20'
5460000
5450000
5440000
5430000
49° 00'
560000
116° 10'
570000
116° 00'
580000
115° 50'
590000
Moyie
Yahk
1068561
N
W
E
S
0
km
10
Legend
Quaternary
Middle Proterozoic
Kitchener Fm.
Creston Fm.
Mesozoic intrusions
Upper Aldridge Fm.
Middle Aldridge Fm.
Lower Aldridge Fm.
Middle Aldridge markers
Moyie Sills
Felsic intrusions

Figure 2. Geological map in the vicinity of the Hazel's Yahk property (yellow; modified from Brown and Macleod, 1998).

5.0 Historical Development

The area of the Hazel's Yahk property has been part of large-scale claim blocks in the past, most notably the western edge of the Yak claim block (e.g., Woodfill, 1996) that was owned by Abitibi & Sedex Mining Corp. Kennco Explorations discovered stream sediment samples that showed elevated Zn, Pb and Cu leading to discovery of a significant soil anomaly with anomalous Zn, Pb and Cu.(Stevenson and Staargaard, 1979) in the nearby Kenco property (Cook, 2020). This work was followed up by a variety of geophysical EM techniques and, eventually, drilling. Prospecting in the area of the Hazel's Yahk property has shown similar alteration features that are visible in the Kenco property. In 1996, Woodfill (1996) described an airborne magnetic survey of a large area that included all of the Hazel's Yahk property. Analyses of these data provide the basis of the present study.

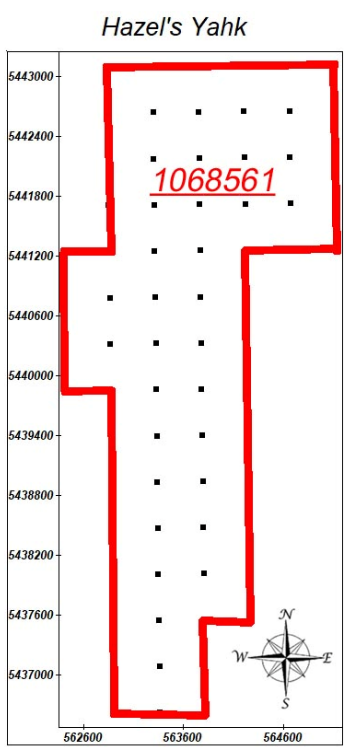

Figure 3. Map of Hazel's Yahk tenure with corners of each claim block indicated by dots.

6.0 Work Done in 2020

Work completed on the Hazel's Yahk property in 2020 consisted of the analysis of digitized airborne magnetic data in an effort to delineate key structures that may be associated with metal deposits. 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 advanced methods that help to delineate structure.

7.0 Data

7.1 General

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.

7.2 Magnetic Data

The magnetic data utilized here were recorded by High Sense Geophysics with much higher resolution (200m line spacing, allowing for 50m grid spacing; Woodfill, 1996) than the regional magnetic data from Natural Resources Canada (200m grid spacing). 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 (again, with 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 4a displays the regional magnetic data from Natural Resources Canada (http://gdr.agg.nrcan.gc.ca/gdrdap/dap/search-eng.php) with ~200m grid spacing. Figure 4b is the same map as in Figure 4a with the higher-resolution digitized of the map from Woodfill (1996) superimposed. The results of the high resolution data analysis shown in Figure 4b include 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 regional trend of the IGRF to be removed.

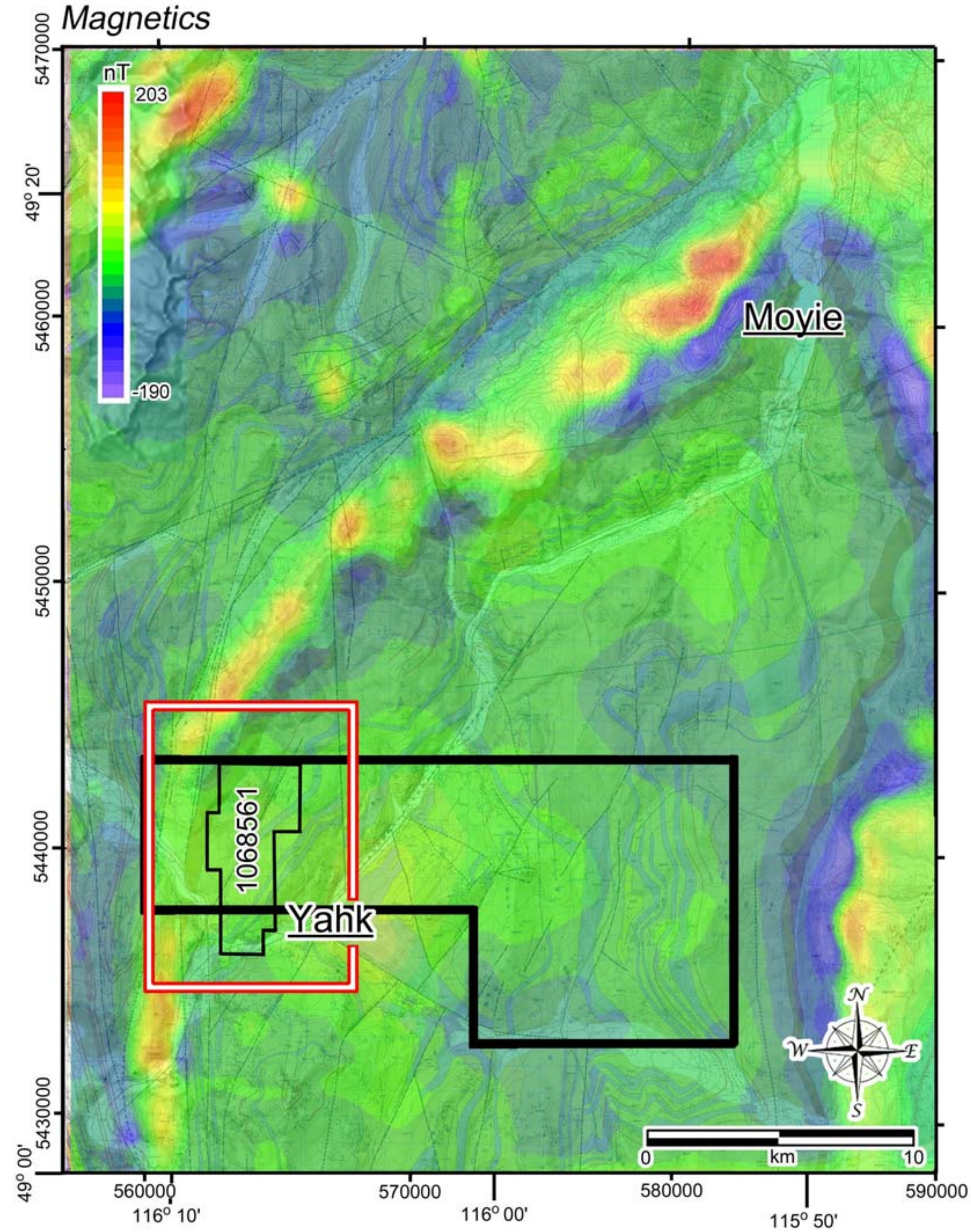

Figure 4a. Regional aeromagnetic map (200m grid spacing) from Natural Resources Canada (data available from http://gdr.agg.nrcan.gc.ca/gdrdap/dap/search-eng.php). The black rectangle outlines the Hazel's Yahk property and the red outlines the area of the digitized magnetic data from Woodfill (1996).

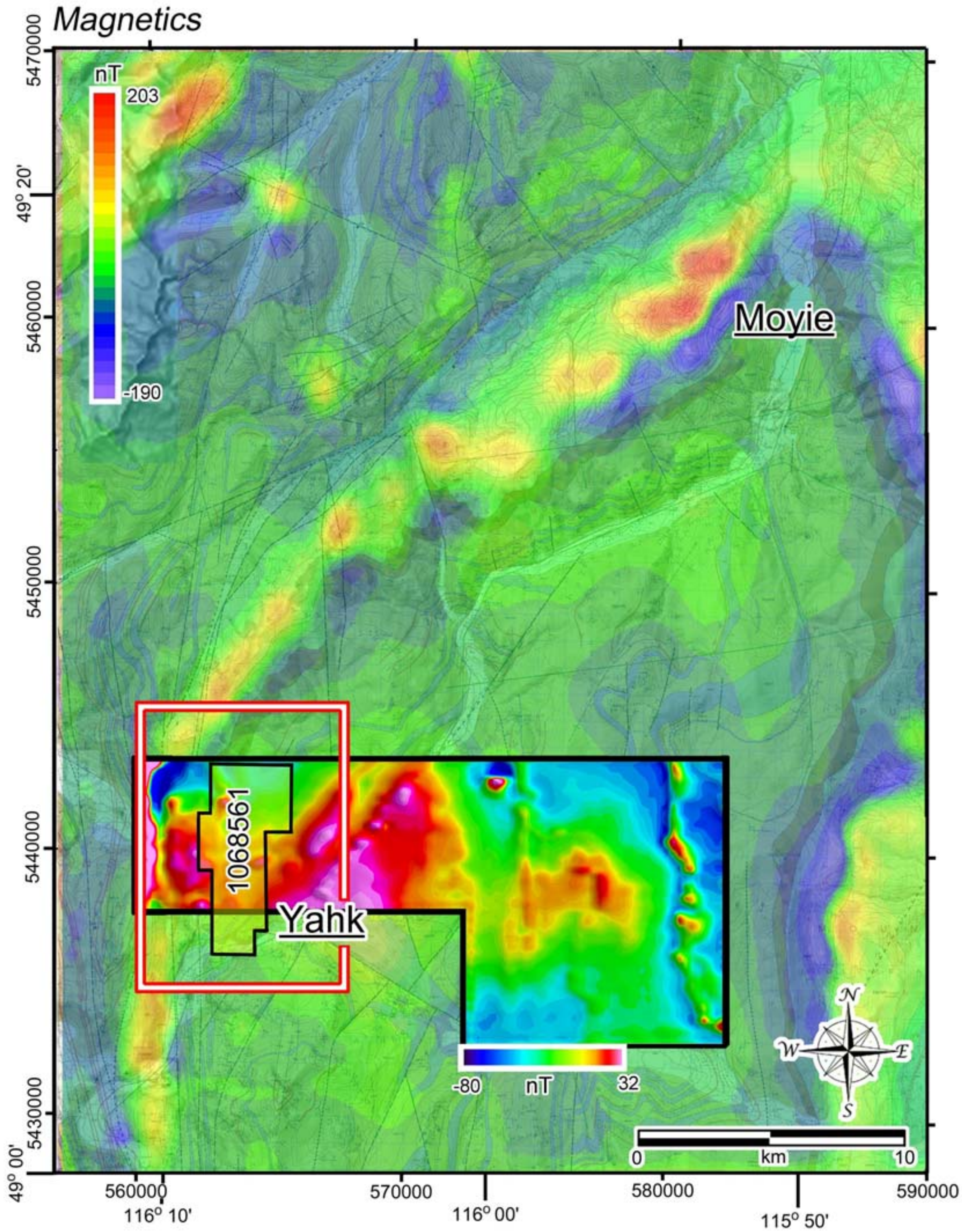

Figure 4b. Regional aeromagnetic map from Figure 4a with the newly digitized data within the red outline. Note that the colour scales are different between the regional and the local data sets.

8.0 Results: Magnetic Data

8.1 Magnetic Data: General

Analyses of magnetic data can be undertaken in two ways: 1) to analyse specific anomalies in order to estimate depths and sizes of sources, and, 2) to delineate structural features in the data. In these data, although some specific anomalies are noted, the major effort has been to delineate structural features that may be relevant to concentrations of minerals. To accomplish these objectives, and 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, normalized standard deviation, etc.) were applied and the results were compared with the geological mapping.

8.2 Magnetic Anomaly Data: Property Scale Results

Filtering is the process of modifying the data set to either enhance desirable signal, or to attenuate undesirable noise, or both. 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), and Normalized Standard Deviation (Cooper and Cowan, 2008).

Figure 5 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 the inset in Figure 4b and it is clear the digitized map provides significantly higher resolution results than the regional NRCan data set (~200m grid spacing). The results in the vicinity of the Hazel's Yahk property are shown in Figure 5.

In general the map in Figure 5 appears to show gently undulating contours with no large or large-amplitude anomalies. The total range of anomaly amplitudes on the map varies from about -140 nT to +140 nT (Figure 5). The strongest amplitudes are visible in the western edge of the map, west pf the property. These anomalies are associated with magnetite in the Creston Formation. However, within the property, the anomalies range from only about -50 to +50 nT. There are two point-source like anomalies in the north, one on the property at UTMe=5564200, UTMn=5441800 and another west of the property at

UTMe=562000, UTMn= 5441700. These are not large (about 20-25 nT above background) and are of unknown origin.

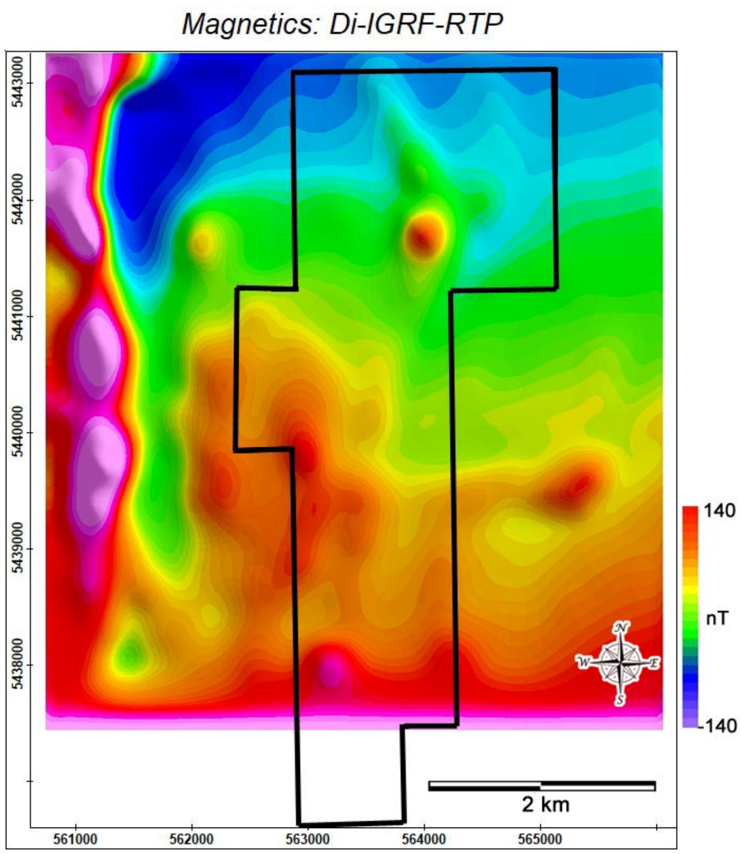

Figure 5. Map of digitized magnetic data after removal of the Diurnal effect, the (approximated) IGRF and, reduction to the North Pole (RTP). The location of the Hazel's Yahk claim block is shown by the outline. This map forms the basis for the structural analyses as well as the anomaly-based analyses.

Application of the tilt angle (Figure 6) provides a first look at geometry. The tilt angle tends to equalize amplitudes such that low-amplitude anomalies on the reduced-to-pole version appear as anomalies that are nearly equivalent (in amplitude) to those of the prominent anomalies because calculation of the tilt angle depends on the gradients of the anomalies, rather than the amplitudes. In addition, the tilt angle can be effective for identifying the map locations of the magnetic sources.

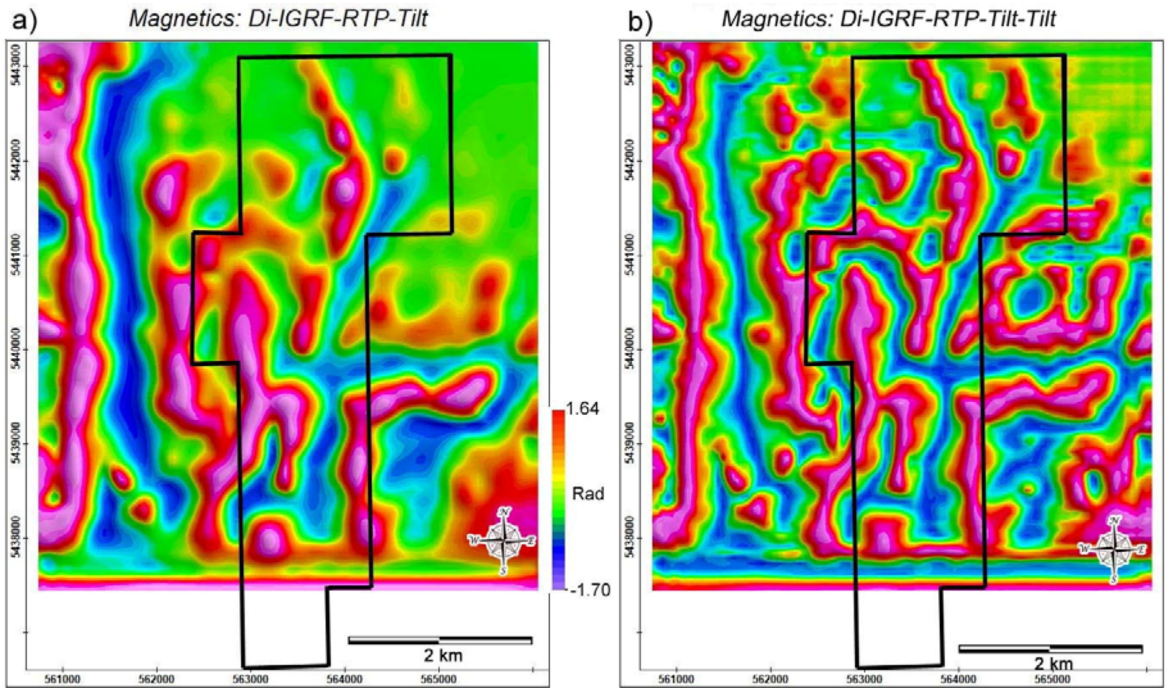

Figure 6. a) Same map as in Figure 5 after application of the tilt angle, b) Same map after application of the tilt angle a second time (Cooper and Cowan, 2006).

Cooper and Cowan (2006) proposed that, in some instances, the tilt angle could be applied a second time to enhance the locations of sources. A major consideration when applying the tilt a second time is that the gradient analysis can significantly increase the effects of noise. If the noise is not a major factor, or if the data can be filtered before applying the tilt, the second application of the tilt may not be seriously impacted by the noise. This has been done in Figure 6b. The result is very similar to Figure 6a, although the anomalies are somewhat better defined.

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 6, for example, the anomalies in the property tend to be oriented north-south or east west, with an apparent intersection near the centre of the property.

Another technique, first described by Cooper and Cowan (2008), that can be effective in delineating structure is the Normalized Standard Deviation, or NSTD. The NSTD calculates the normalized standard deviation within a user-defined moving window around each grid location. The method does tend to equalize amplitudes, but is effective at delineating structural features.

The NSTD window size can be varied for but typically are 3x3, 5x5 or a similar number of grid points. Because the procedure is a windowing method, the larger window sizes will tend to lose more data at the edges. However, small windows tend to increase the noise. Figure 7a shows the magnetic data in Figure 5 after applying a 3x3 window in the NSTD and Figure 7b shows the same data with a 5x5 window. Note that in Figure 7 a series of horizontal lines that appear in the blue area (Figure 7a) are reduced in Figure 7b. These are probably corrugation effects due to the flight lines in the original data.

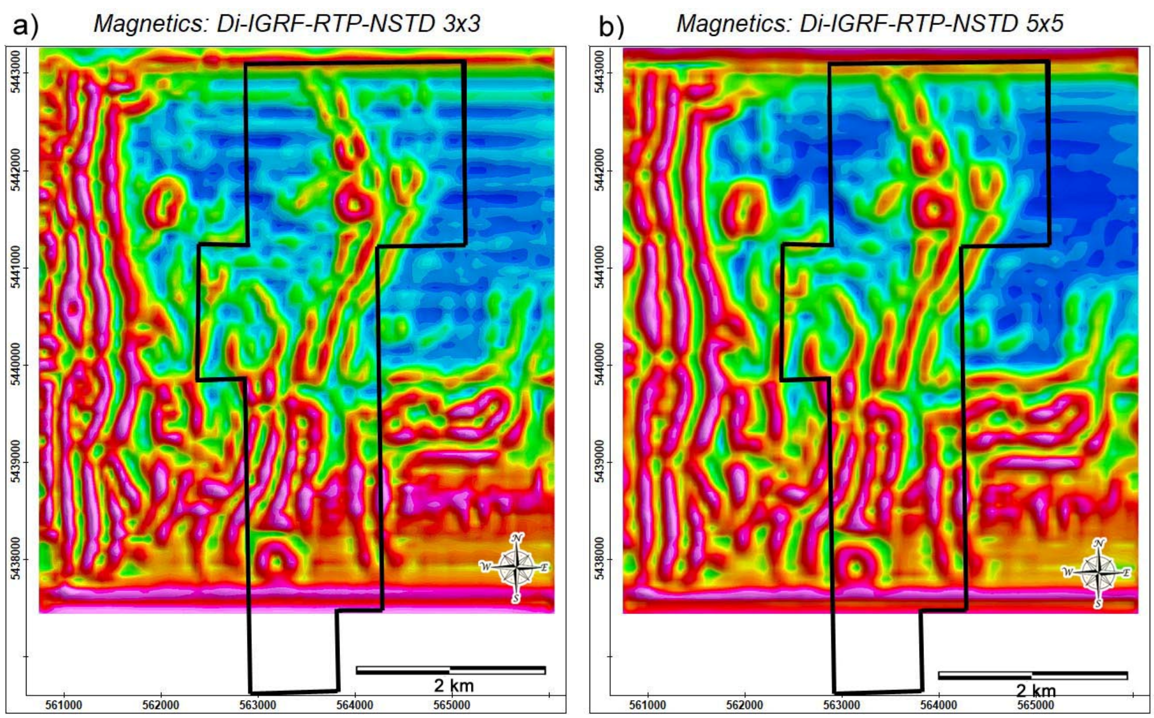

Figure 7. a) Application of the NSTD on the data in Figure 5 with a window of 3x3 grid points; b) same with a window size of 5x5 grid points note that some of the linear 'noise' in a) has been reduced in b). The horizontal lines at the top of the magnetics are edge effects caused by the windowing operator in the NSTD procedure.

8.3 Magnetic Anomaly Data: Comparisons with the Geology

In order to enhance the interpretation of the anomalies and their significance, the magnetic anomaly patterns were correlated to the geology. Figure 8 shows the geology in the vicinity of the property as well as an outline of the property. Note the orientation of the structures as being dominantly northeast-southwest. Specifically, the sills (and associated strata) have an azimuth of about 040°, whereas structures (e, g,, the fault running most of the length of the property) have an azimuth of about 025°.

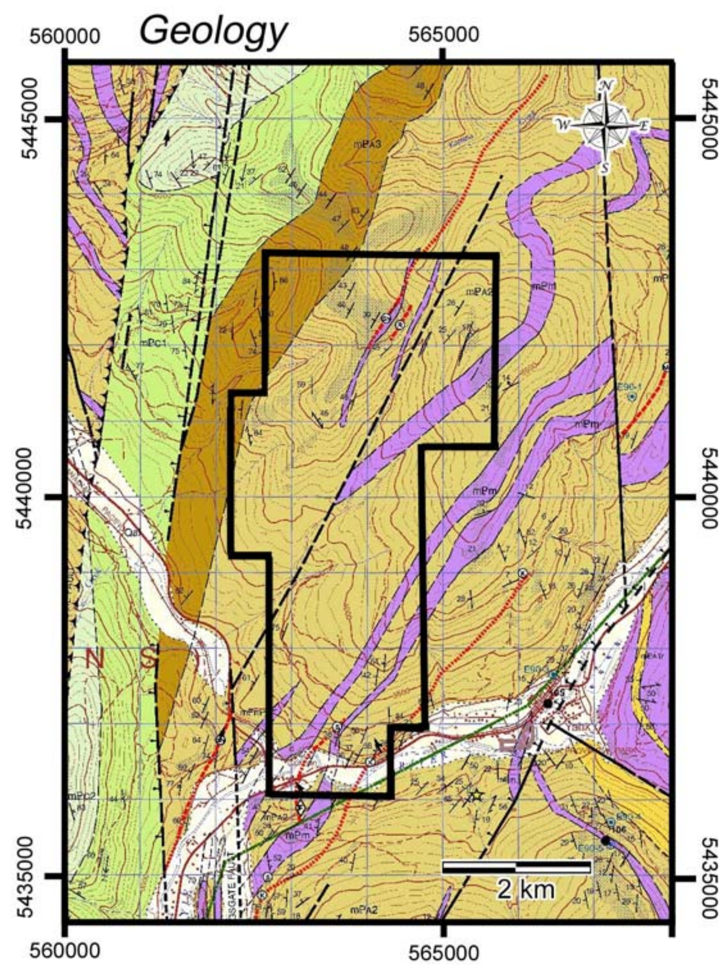

Figure 8. Map of geology in the vicinity of the Hazel's Yahk property with the location of the property outlined. Note that structures and strata tend to strike primarily northeast-southwest; there is little or no evidence for east-west or northwest-southeast features within the property.

Figure 9 is the same geological map with the magnetic data (reduced to pole) overlain. There are three significant characteristics in the map. First, the strongest anomalies are oriented north-south on the west side of the map, and west of the property. These are caused by disseminated magnetite in the Creston Formation. Second, there are two point-like anomalies in the northern part of the map as note previously. The origin of these is unknown, and there is nothing on the mapped geology in the vicinity of these features that could account for them. Third, in the southern part of the magnetic map, the anomalies are broad and low amplitude.

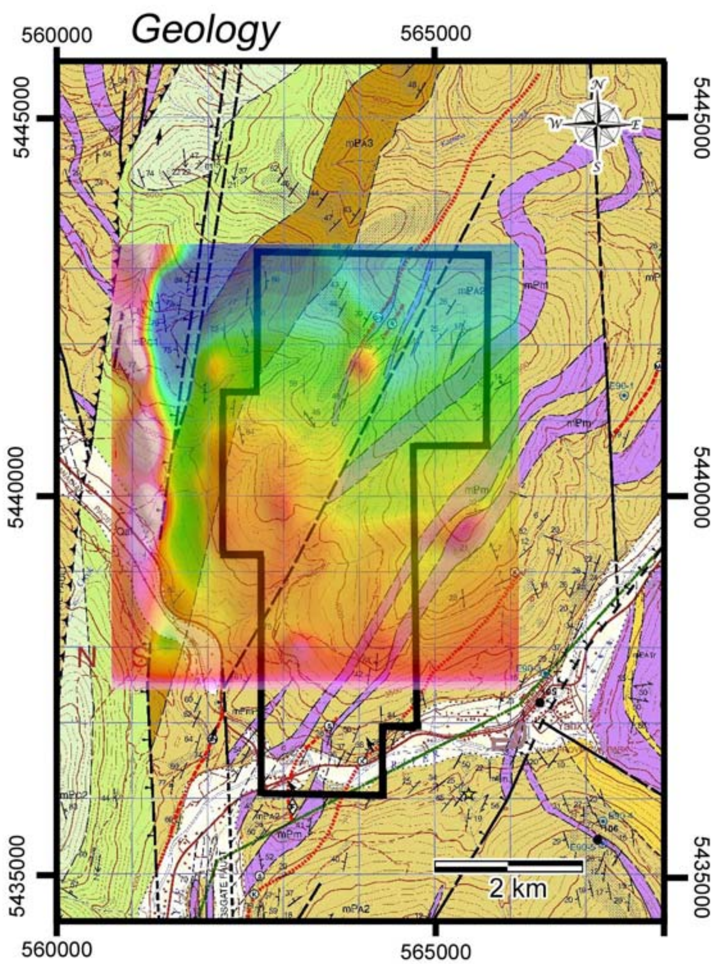

Figure 9. Same map as Figure 8 overlain with the reduced-to-pole version of the magnetic data (Figure 5). Other than the strong north-south anomalies on the west side of the map that are associated with the Creston Formation, the map appears to have broad, low amplitude anomalies.

Application of filtering techniques at the property-scale produced significant results that are important for structure, even if the anomaly amplitudes are small. For example, application of the tilt angle is shown overlain on the geology in Figure 10. Four potentially important features are labelled. First, linear magnetic anomalies appear to correlate with the northeast-southeast fault that runs through the property (labelled '1' on Figure 10. This is clear from the southwest to about UTMn=5442000 where it appears to veer to the northwest (labelled '2' in Figure 10). Anomaly number 2 appears to cross the structure and stratigraphy at high angle and there is no obvious correlative feature in the geology. Anomaly 3 (Figure 10) is oriented east-west from the east side of the property to the centre of the property where it appears to intersect with anomaly 1 (circled). As with anomaly 2, there are no features on the geology map that correlate with anomaly 3.

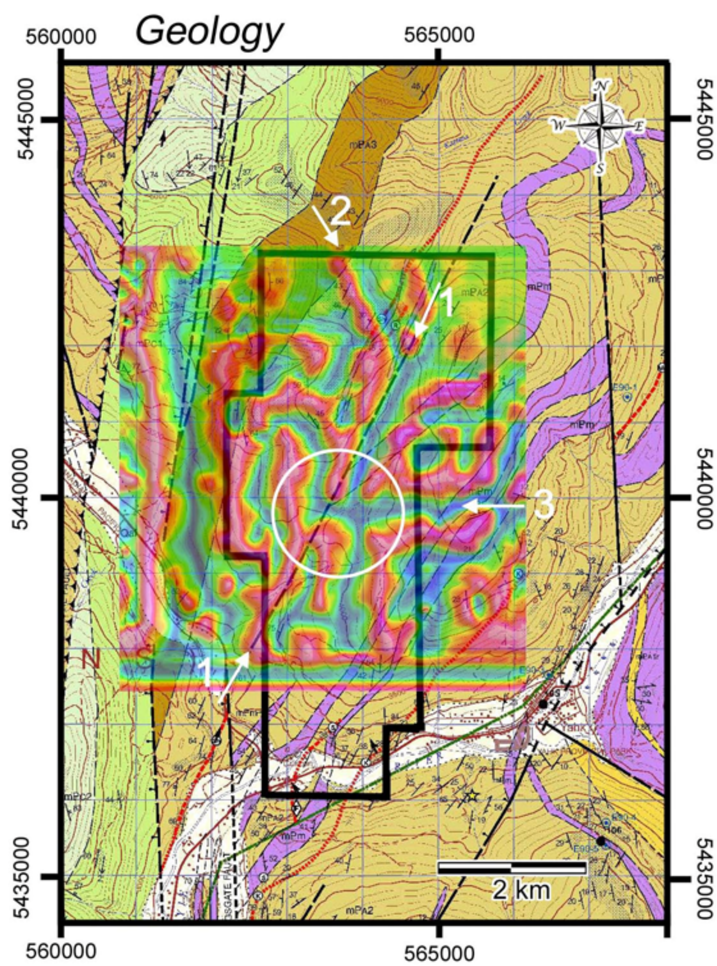

Figure 10. Geology map of the property area overlain with magnetics after application of the tilt derivative twice.

Application of the NSTD technique clarifies some of these relationships. In this case, the relative highs are located on the edges of the anomalies so that each magnetic anomaly appears as two. Nevertheless, the results show clear correlations with the trends that were outlined above. Perhaps most significant is the intersection of anomaly 3 and anomaly 1 in the circled areas where substantial disruption in the anomalies may indicate an intersection of structural trends.

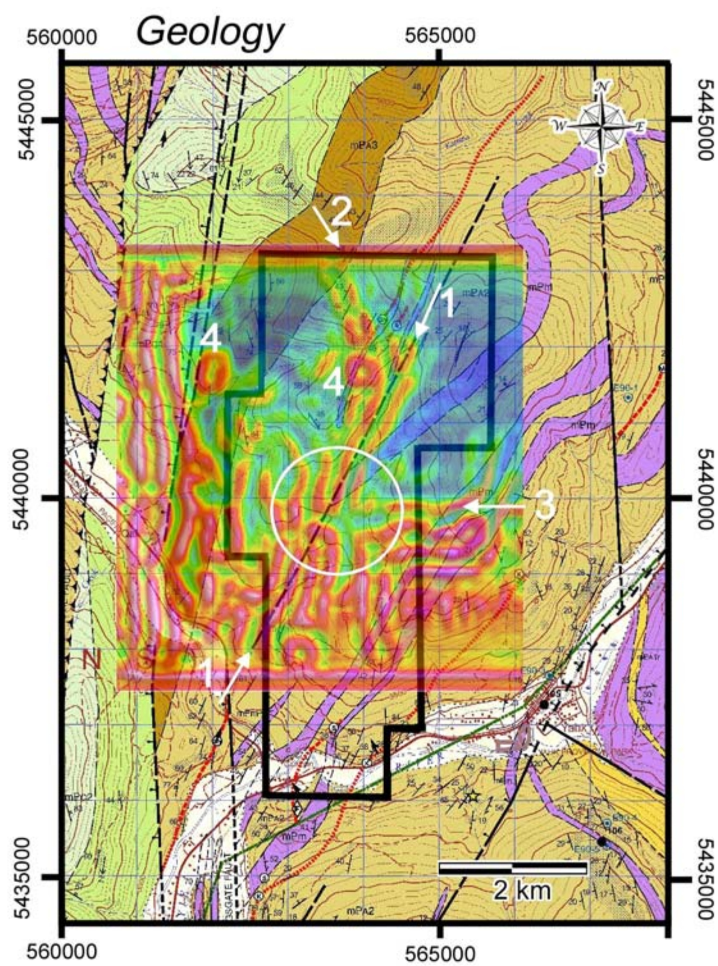

Figure 11. Same map as in Figure 7b with arrows to show the northwest-southeast feature. b) Same map as in (a) with the NSTD version of the data overlain.

8.4 Significance of the Results for Exploration

The observation of the magnetic anomalies that appear to cross structures or stratigraphy can be explained in a number of ways. Some of these include:

1. There could be structures that have not been mapped yet;
2. They could be structures in the subsurface that are not exposed. For example, they may be fractures or shear zones that acted as conduits for fluid migration.

Fluid flow may cause significant oxidation of sulphide minerals, including Fe-sulphides. Hence, where fluids may be channelled, for example along permeability contrasts such as fractures or faults, it is likely that conditions (temperature, pressure) could have provided environments for the precipitation of iron oxides, some of which are magnetic. The observations that magnetic anomalies in some areas are located along structures (e.g., anomaly '1' in Figures 10 and 11), and in other areas intersect mapped structures (e.g., anomaly '3' in Figures 10 and 11) are consistent with fluid migration and alteration that produced magnetic minerals.

9.0 Conclusions

Analyses of the digitized magnetic data from the Hazel's Yahk property has lead to the following findings:

1. A linear northeast-southwest magnetic anomaly (anomaly 1) has been found that spatially correlates with a mapped fault;
2. The northeast-southwest magnetic anomaly appears to veer across structure to the northwest in the northern area of the property (anomaly 2);
3. This 'kink' geometry may be indicative of a structure in the subsurface that is not exposed, and,
4. A prominent east-west anomaly appears to intersect anomaly 1 near the centre of the property. This crossing geometry may also be indicative of structures that are not exposed, but that may include magnetic minerals, perhaps as a result of fluid migration and alteration.

10.0 References

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Woodfill, R., 1996. Assessment Report on Geophysics. Yak, Tour and Cold Claims, Yahk area, British Columbia Ministry of Energy and Mines, Assessment Report 24652, 97pp.

Miller, H. G., and Singh, V. 1994. Potential field tilt – A new concept for location of potential field sources, J. Applied Geophysics, v. 32, p. 213-217.

11.0 Statement of Costs

Property: Hazel's Yahk

Date		Amount (days)	Rate	Total	Notes	Totals
3. Airborne Magnetic Data Reprocessing - Digitize TMI Map from AR 26452					(1)	
13-Jan-20	Fred	1	800	46.40	(2)	
14-Jan-20	Fred	1	800	46.40	(2)	
15-Jan-20	Fred	1	800	46.40	(2)	
16-Jan-20	Fred	1	800	46.40	(2)	
				185.60		$185.60
4. Airborne Magnetic Data Reprocessing - Gradient Analyses/Structure (1)						
03-Feb-20	Fred	1	800	800.00	(1)	
03-Feb-20	Fred	1	800	800.00	(1)	
03-Feb-20	Fred	1	800	800.00	(1)	
				2400.00		$2,400.00
5. Report						$3,000.00
		TOTAL				***$5,585.60***

Note (1): Work done on tenure 1068561
Note (2) Amount prorated (5.8%) to Hazel's Yahk area

12.0 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 7th day of August, 2020
Registration License No. 34585
Association of Professional Engineers and Geoscientists of British Columbia

Appendix 1: Magnetic Anomaly Map RTP
Scale 1:10000

Magnetics: Di-IGRF-RTP