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Impala Canada Ltd.

2018 Exploration Geophysics (UAV-borne Magnetic Survey) Assessment Report on the East Mine Block Project

Lac des Iles Mine

CLM 252 (LEA-107911), CLM 253 (LEA-107909), CLM 254 (LEA-107908), CLM 430 (LEA-108139), 120294, 128850, 131683, 176875, 177477, 184337, 184338, 192880, 243588, 249040, 249041, 251630, 263048, 263651, 298188, 581124, 581353, 581354

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Thunder Bay, Ontario

June 8, 2020

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Introduction

Impala Canada Ltd. (IC) and its wholly owned predecessor, Lac des Iles Mines Ltd. (LDIM) completed a drone supported magnetic survey conducted using an unmanned aerial vehicle (UAV), covering an area of 5.9 km^2 over the East Mine Block (EMB) project area from September 17 to October 4, 2018. The EMB project area is located on the Lac des Iles Mining Lease package; a portion of the survey coverage extends to adjacent mining claims which are 100% held by Impala Canada Ltd.

The target area lies in close proximity to existing mine infrastructure and holds the potential to host palladium (Pd) mineralization plus base and other precious metals. The area carries potential to host a near-mine, shallow depth source of additional or supplementary ore for the LDI mill. The objective of the program was to evaluate the efficacy of this geophysical method at highlighting the distribution of prospective lithologies common to the property, as well as potential major structures, and enhance geological understanding of an area with sparse drill data.

Survey work was carried out by MWH Geo-Surveys Ltd over the course of 18 days (mobilization to demobilization).

This report is submitted to satisfy assessment work requirements. A total expenditure of $21,922.00 is submitted for assessment. Activities documented herein include:

- 240 km flight line-kilometers of UAV magnetic survey covering an area of 5.9km^2
- Data processing and map/report generation

Land Tenure, Location, and Access

The East Mine Block (EMB) Project is located approximately 90 km north of Thunder Bay in Northwestern Ontario (Figure 1). The project is part of the Thunder Bay Mining District on provincial grid 52H04I. To access the claim blocks from Thunder Bay, head north approximately 90 kilometers on Hwy 527 to the Lac Des Iles Mine Access Road. The access road is fifteen kilometers in length and leads to a manned security entrance. The 2018 targets are accessible via secondary gravel roads and trails using a truck (Figure 2).

This report, submitted to obtain assessment work credit, details the activities and results associated with UAV-borne geophysical activities on mining leases CLM 252 (Lease #107911), CLM 253 (Lease #107909), CLM 254 (Lease #107908) and CLM 430 (lease #108139) – as well as mining claims 120294, 128850, 131683, 176875, 177477, 184337, 184338, 192880, 243588, 249040, 249041, 251630, 263048, 263651, 298188, 581124, 581353, and 581354.

Impala Canada Ltd. holds the mining and surface rights for CLM252 to CLM254 and CLM430 under 21 year leases with expiry dates of August 31st, 2027 for CLM 252-CLM 254 and September 30th, 2027 for CLM430 (Table 1 and Figures 2 & 3). See Table 1 for mining claims anniversary dates.

Table 1: Impala Canada Mining Leases and Mining Claims relevant to assessment work contained in this report.

Tenure Number	Type	Anniversary	Holder	Area (ha)
CLM252 (LEA 107911)	Lease	2027-08-31	(100) IMPALA CANADA LTD.	341.40
CLM253 (LEA 107909)	Lease	2027-08-31	(100) IMPALA CANADA LTD.	395.70
CLM254 (LEA 107908)	Lease	2027-08-31	(100) IMPALA CANADA LTD.	497.40
CLM430 (LEA 108139)	Lease	2027-09-30	(100) IMPALA CANADA LTD.	348.80
120294	Claim	2020-09-09	(100) IMPALA CANADA LTD.	21.13
128850	Claim	2020-09-09	(100) IMPALA CANADA LTD.	21.13
131683	Claim	2020-06-29	(100) IMPALA CANADA LTD.	21.12
176875	Claim	2021-03-06	(100) IMPALA CANADA LTD.	21.12
177477	Claim	2020-06-29	(100) IMPALA CANADA LTD.	21.12
184337	Claim	2020-06-29	(100) IMPALA CANADA LTD.	21.12
184338	Claim	2020-06-29	(100) IMPALA CANADA LTD.	21.12
192880	Claim	2021-03-06	(100) IMPALA CANADA LTD.	21.12
243588	Claim	2020-06-29	(100) IMPALA CANADA LTD.	21.12
249040	Claim	2021-03-06	(100) IMPALA CANADA LTD.	21.12
249041	Claim	2020-09-09	(100) IMPALA CANADA LTD.	21.12
251630	Claim	2020-06-29	(100) IMPALA CANADA LTD.	21.12
263048	Claim	2021-03-06	(100) IMPALA CANADA LTD.	21.12
263651	Claim	2020-06-29	(100) IMPALA CANADA LTD.	21.12
298188	Claim	2020-09-09	(100) IMPALA CANADA LTD.	21.12
581124	Claim	2021-04-21	(100) IMPALA CANADA LTD.	274.46
581353	Claim	2020-11-19	(100) IMPALA CANADA LTD.	84.45
581354	Claim	2020-11-19	(100) IMPALA CANADA LTD.	63.33

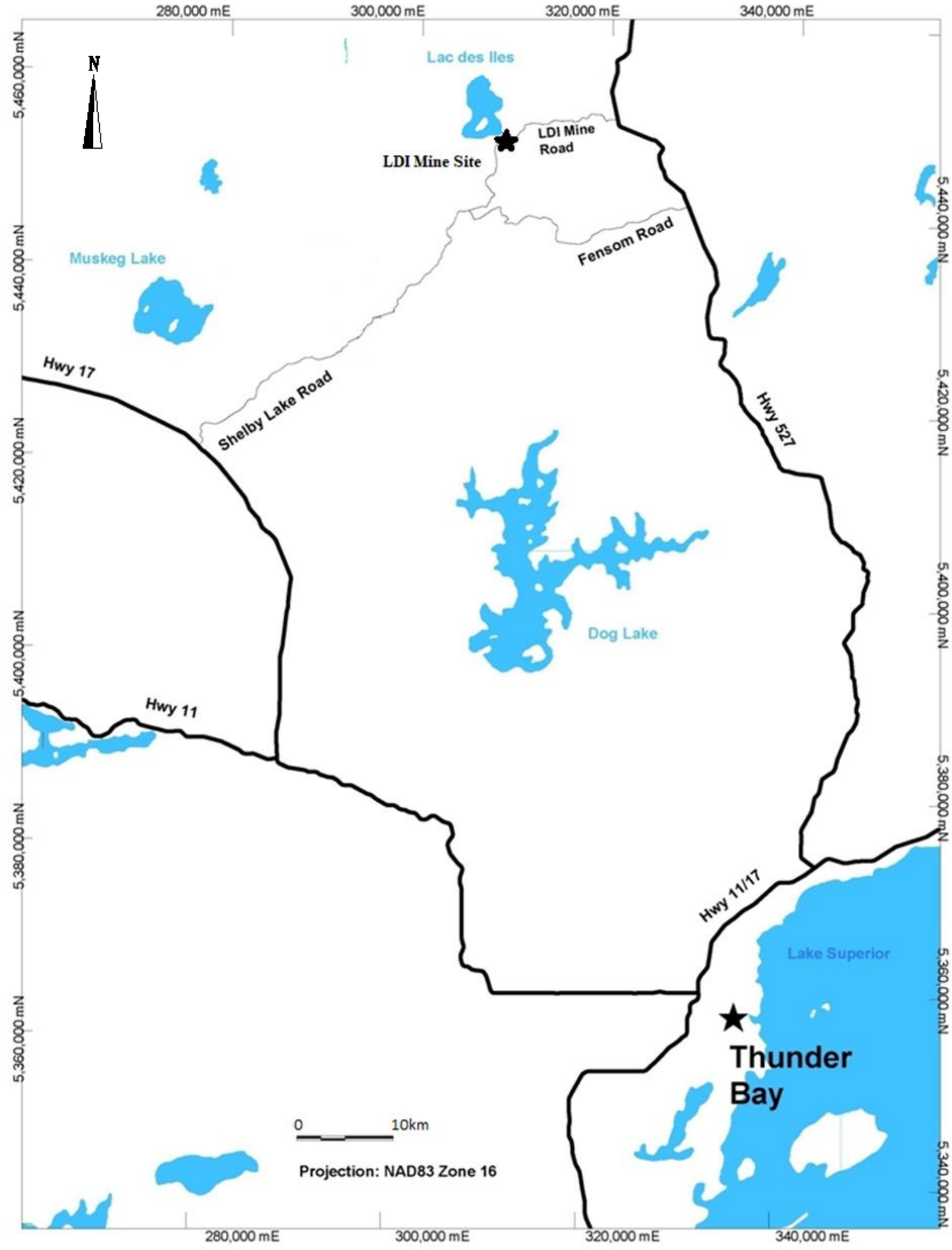

Figure 1. LDI mine property location map.

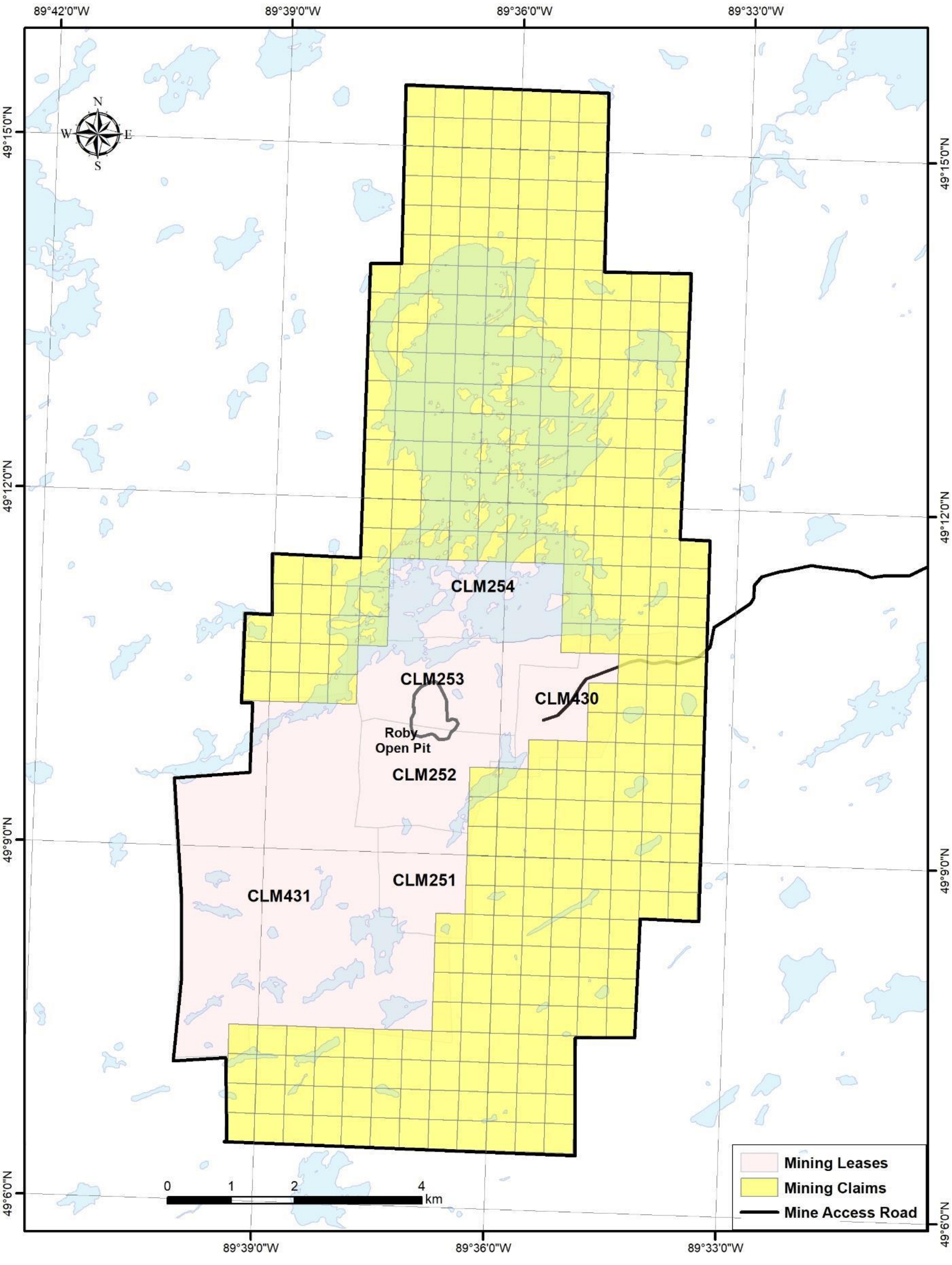

Figure 2. Land tenure of the Lac des Iles Mine Lease property (from Decharte et al. 2018)

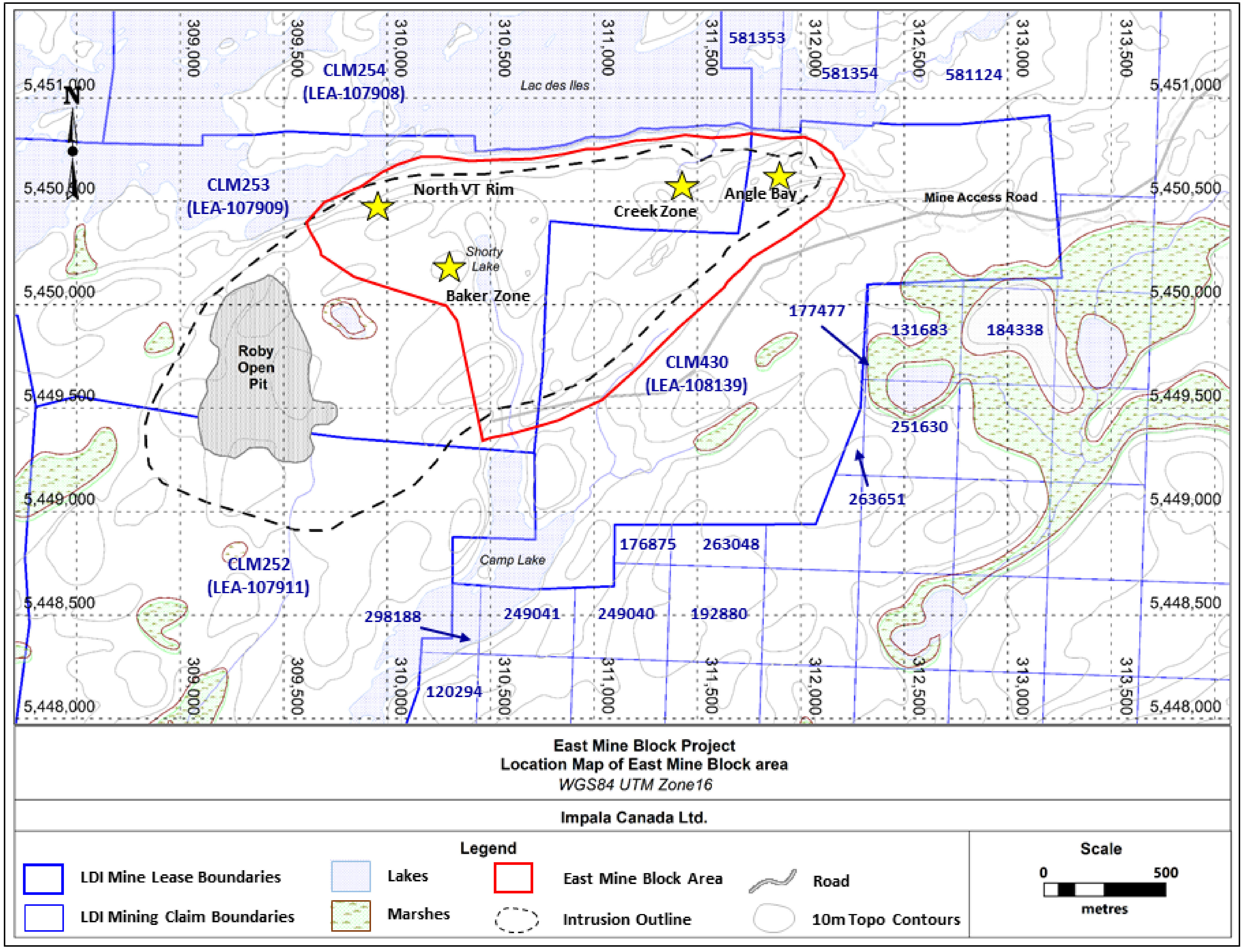

Figure 3. Target area location map. Red line differentiates the East Mine Block area of interest from the known deposits and infrastructure of the West Mine Block of the Mine Block Intrusion

Regional Geology

Much of the information presented in this section is sourced from the Open File Report OFR6120 Project Unit 95-014; *Regional Geology of the Lac des Iles Area* (Stone et al. 2003). Information presented here was also sourced from *NI 43-101 Technical Report: Feasibility Study Incorporating the Life of Mine Plan for Lac des Iles Mine, Thunder Bay, Ontario, Canada* (Buss et al. 2017). Additional sources are referenced where appropriate.

The Lac des Iles mine is located in the eastern part of the Central Wabigoon subprovince of the Archean Superior Structural Province. It is part of the Lac des Iles Suite of Neoarchean mafic to ultra-mafic intrusions that occur within an approximately 42 kilometer diameter circular perimeter comprising the Lac des Iles intrusions, the Tib Lake intrusion, the Buck Lake intrusion, the Wakinoo/Demars intrusion, the Bullseye intrusion, the Chisamore Intrusion, Shelby River Intrusion and the Dog River intrusion (see Figure 4). The intrusions are located immediately to the north of the Quetico Subprovince and directly west of the Nipigon embayment of the Mid-continent Rift System. These intrude a series of tonalite and tonalite gneiss, with some biotite granodiorite, granite, and sanukitoid rocks in the immediate area. The Quetico terrain boundary runs SW-NE immediately to the south of these intrusions. (Stone, D. 2010)

The easternmost bodies of the Lac des Iles suite of intrusions are the LDI Igneous Complex (LDI-IC) and the Legris Lake complex. Both the LDI-IC and the Legris Lake complex appear to have been emplaced along northeast-trending splay structures (e.g., Shelby Lake fault) emanating from the Quetico Fault Zone (*see* Figure 4). The Quetico Fault Zone is a collisional structural boundary between the Quetico and Wabigoon subprovinces that formed during the Shebandowanian orogeny at approximately 2695 Ma (Corfu and Stott 1986). Similarly, many of the Lac des Iles suite intrusions located in the western part of the Lac des Iles area are spatially associated with northeast- to north-striking faults that splay off this collisional boundary.

The intrusions range in size from 1 to 10 km and vary compositionally from leucogabbro and gabbronorite with rare anorthosite to peridotite and pyroxenite. The intrusions crosscut most rock types except for biotite granite dikes and Proterozoic-aged intrusions. Archean rocks are observed to be intruded by Proterozoic-aged (~1100 Ma) diabase dikes and sills of the Nipigon Sill Complex of the Mid-Continent Rift (MCR). They are typically medium grained, massive, and dark grey weathering brown and locally pyroxene phyric.

Uranium-lead age determinations for zircons contained in the mafic rocks show that the Lac des Iles suite intrusions were likely emplaced between 2699 and 2686 Ma (Stone and Davis 2006). This age overlaps with regional sanukitoid magmatism in both the Wabigoon Terrane and the Quetico Subprovince.

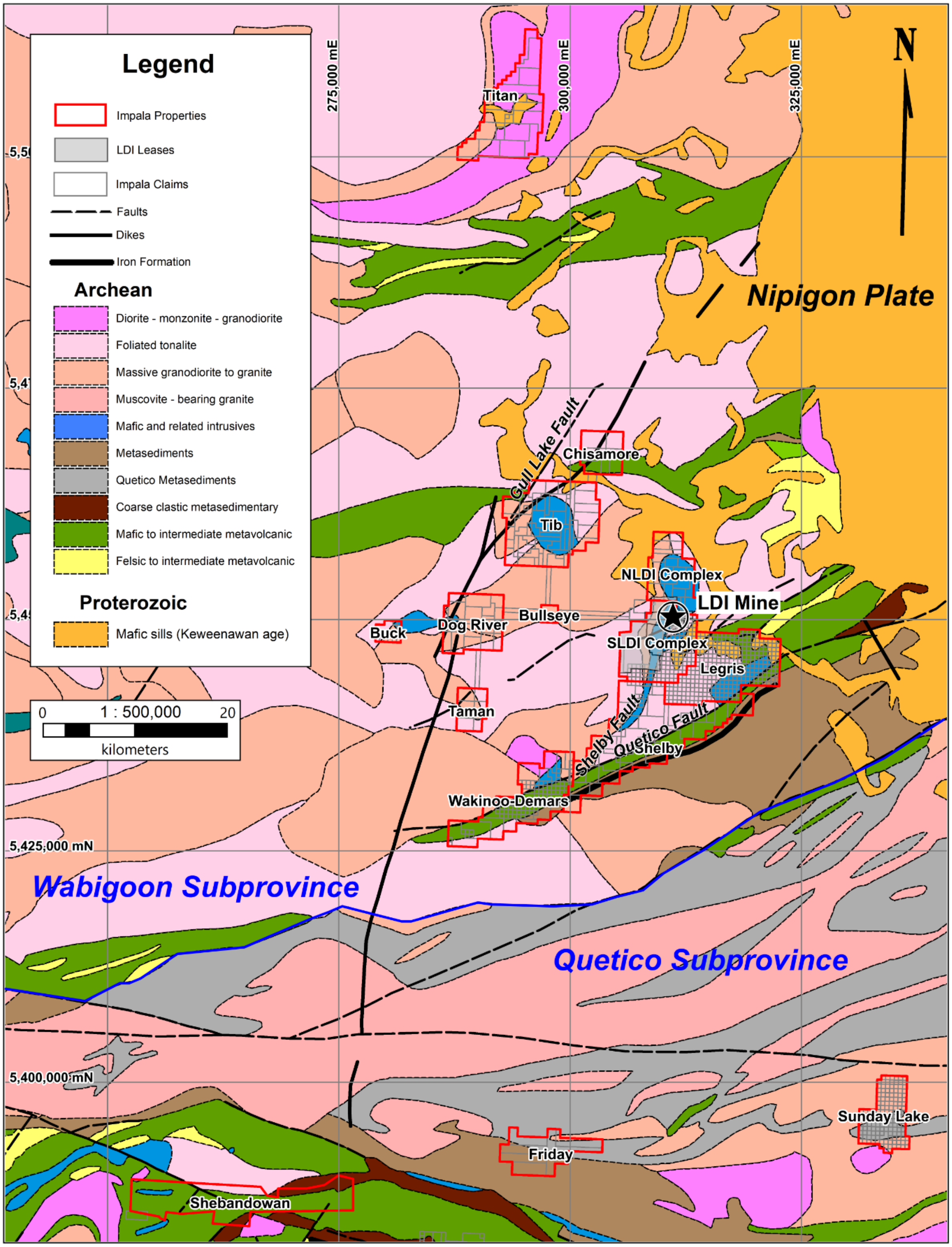

Figure 4. Regional geology of the Lac des Iles suite intrusions.

Property Geology

A recent NAP Technical Report (Buss et al. 2017) describes the LDI mine property as follows:

The Property captures the known extent of the Lac Des Iles Intrusive Complex, an irregularly shaped Neoarchean-age mafic-ultramafic intrusive body having maximum dimensions of approximately 9 km in the north-south direction and approximately 4 kilometers in the east-west direction (Figure 5). The complex is interpreted to be made up of three discrete intrusive bodies:

- The North Lac des Iles intrusion (NLDI) characterized by a series of relatively flat-lying and nested ultramafic bodies with subordinate mafic rocks;
- The Mine Block intrusion (MBI); and
- The Camp Lake Intrusion; a poorly exposed/documented gabbroic to dioritic intrusion, in the southwestern part of the property

The principal rock types in and adjacent to the LDI Igneous Complex are discussed below with reference to the host intrusion and the property geology map (Figure 5 and Figure 6). The term gabbro or gabbroic is applied as a general indicator of any mafic intrusive rock having a mineral assemblage dominated by plagioclase and pyroxene (either orthopyroxene or clinopyroxene). The 2018 UAV magnetics geophysical survey focused on the eastern portion of the Mine Block Intrusion (East Mine Block).

Mine Block Intrusion

The MBI is a small, teardrop-shaped mafic complex with maximum dimensions of 3 by 1.5 kilometers with an elongation in an east-northeast direction (Figure 6). The MBI consists of gabbroic (noritic) rocks and metamorphosed and/or hydrothermally altered equivalents with highly variable plagioclase-pyroxene proportions, textures and structures. Accessory igneous minerals include magnetite and titanium-rich magnetite, ilmenite, and quartz-feldspar granophyre. The MBI was emplaced into predominantly intermediate composition orthogneiss basement rocks. The emplacement age of the MBI has been established by precise uranium-lead zircon methods as 2,689 to 2,693 Ma (Stone and Davis 2006 and references contained therein). The MBI geology is dominated by gabbroic, melanogabbroic and leucogabbroic rock types. The common reference to gabbroic rather than noritic rocks in the many historical reports on the geology of the MBI is a reflection of the continued difficulty in distinguishing the composition of igneous pyroxenes in both outcrop and drill core. This difficulty has resulted in a mixed lithological nomenclature for the MBI in which gabbro, norite, and gabbronorite rock names have been somewhat interchangeably used. However, recent internal and external research has shown that the majority of the mafic rocks in the MBI, especially those associated with palladium mineralization, have clear noritic affinities such that orthopyroxene (as opposed to clinopyroxene) is the earliest-formed and generally most abundant igneous pyroxene in the rocks. In this way, the MBI has affinities to the mafic portions of better-documented mafic-ultramafic complexes such as the Bushveld Complex in South Africa, the Great Dyke in Zimbabwe and the Stillwater Complex in Montana, USA. In terms of its rock types, textures, and mineralization styles the western part of the MBI is generally analogous to the Platreef Deposit of the northern lobe of the Bushveld Complex (Kinnaird and MacDonald 2005; Kinnaird et al. 2005).

Textural and mineralogical variability is greatest in the outer margins of the MBI, especially along the well-documented western and northern margins that host most of the known palladium resources and palladium-rich mineralized zones on the Property. Commonly observed textures in the noritic marginal units of the MBI include equigranular, fine- to coarse-grained (seriate textured), porphyritic, pegmatitic and varitextured. The interior portions of the MBI consist of more regularly textured and evolved rock types including magnetite gabbro and leucogabbro (Figure 6).

Varitextured gabbroic (VGAB) units in the northern and western margins locally occur within irregular shaped heterolithic gabbro breccia zones. The most common style of breccia in these areas contains cognate mafic to ultramafic xenoliths of highly variable form and size within a matrix of VGAB. Other styles of igneous breccias are locally observed in the MBI, including those containing abundant basement gneiss clasts and others having a pyroxenitic matrix and leucogabbro and/or VGAB clasts. Internal to the varitextured rim of the western and northern MBI is a foliated medium-grained gabbro referred to as equigranular gabbro (EGAB; formerly named “East Gabbro”). In the westernmost part of the MBI an informally named unit (pyroxenite = PYXT) is commonly developed along the contact between the VGAB unit (footwall side) and the EGAB unit (hanging wall side). In the central parts of both the Roby and Offset zones, the PYXT unit hosts most of the highest-grade palladium mineralization. Recent research has demonstrated that the PYXT unit is a highly sheared, schistose and recrystallized norite to melanorite originally comprising cumulus orthopyroxene, disseminated magmatic sulfides, cumulus and intercumulus plagioclase and minor intercumulus clinopyroxene. The continued use of this informal but petrologically inaccurate name (i.e., PYXT) reflects a decision to maintain consistency in referencing the major geological units in the LDI mine.

East Mine Block

The EMB is part of an upright, homoclinal sequence of northeast striking and steeply south-dipping stratigraphy, in contrast to stratigraphy at the West Mine Block (WMB) of the Mine Block Intrusion where major units exhibit roughly north-striking and steep eastward to vertical dips; Figure 6 (NI 43-101 Technical Report, 2018). Each domain is interpreted to represent the influence that major, pre-existing structures had on the emplacement of LDI magmas (WMB – combined influence of Shelby Lake Fault (Stone et al., 2003) and Central Roby Fault; EMB - Central Roby Fault).

The Central Roby Fault (CRF) is a major east-northeast striking structure with a moderate to steep southerly dip, which intersects the northeastern fraction of the South LDI Complex and is believed to be the primary feeder for the EMB; Figure 6 (NI 43-101 Technical Report, 2018). This structure has been inferred through evaluation of drill hole logs, geological and geophysical data, lineaments, and metal grade trends. Magmas at the EMB may also have been emplaced by one or more vertical to subvertical, roughly north-south striking secondary feeder structures. Such secondary structures may occur immediately adjacent to the Creek Zone as currently defined, as well as underlying Shorty Lake (internal correspondence, 2018).

Dominant rock types of the EMB include a gabbronoritic series, a melanoritic to leuconoritic series, as well as a noritic to leuconoritic breccia series. The gabbronorite series is interpreted to represent the earliest stage in the emplacement of the MBI. The series is comprised by plagioclase-rich equigranular noritic phase (EGAB) and a magnetite-rich gabbronorite unit (Gab-Mt).

The gabbronorites were succeeded by a significant stage of norite-dominated magmatism that produced the sulfur-saturated rocks of the norite and breccia series (NI 43-101 Technical Report, 2018). The norite series is characterized by massive, equigranular, medium to very coarse grained and variably altered melanorite, norite, and leuconorite. The breccia series is typically comprised by a varitextured 'gabbro' that is largely compositionally comparable to a leuconorite. The lithic fragment populations are highly varied with respect to relative abundance and proportions of rock type, size, shape, crystallization stage, and geometry. Lithic fragment populations include clasts of the earlier gabbronorite series, coeval inclusions derived from the norite series magmas, and basement/orthogneiss xenoliths at various stages of digestion.

Palladium mineralization at the EMB typically, but not exclusively, exhibits an association with sulfide mineralization. Sulfides commonly occur as fine to medium-grained disseminations of chalcopyrite, pyrrhotite, and pentlandite +/- pyrite, hosted within the norite and breccia/varitextured series and are typically preferentially concentrated at or near the boundary between cumulate norite and breccia/varitextured series rocks. These characteristics are common to both domains of the MBI. The notable influence of the Central Roby Fault is represented by the persistent south-plunge of the majority of known mineralized zones across the east-west extent of the MBI, including Baker Zone and Creek Zone of the EMB (Figure 2).

Following cessation of active magma emplacement, the South LDI Complex was affected by multiple stages of syn- to post-magmatic brittle to ductile faulting and shearing in northwest, northeast, and east-northeast orientations. The influence of these features on the distribution of known significant Pd mineralization at EMB is not yet well defined.

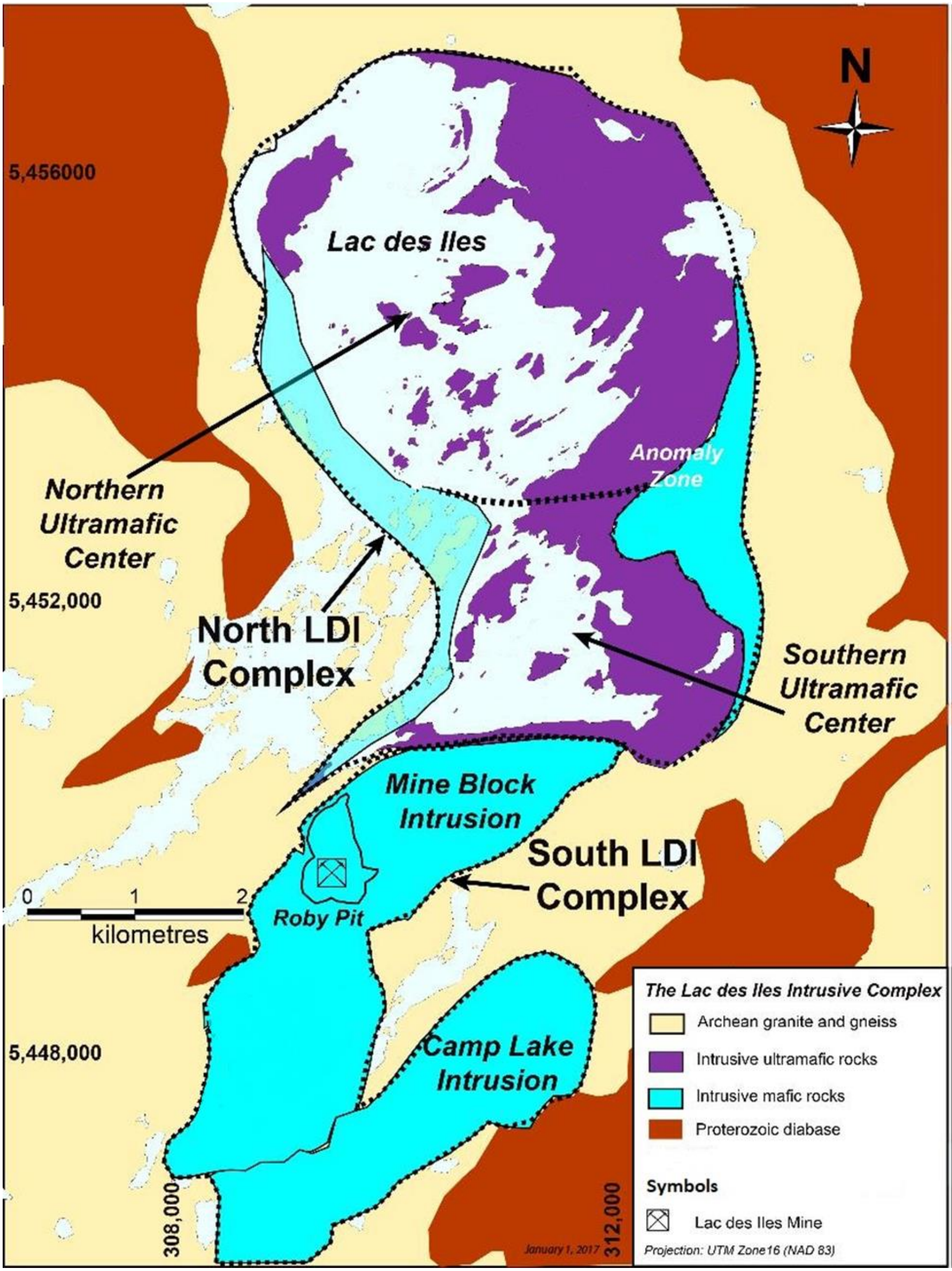

Figure 5. Simplified geology of the LDI intrusive complex (modified from Buss et al. 2017).

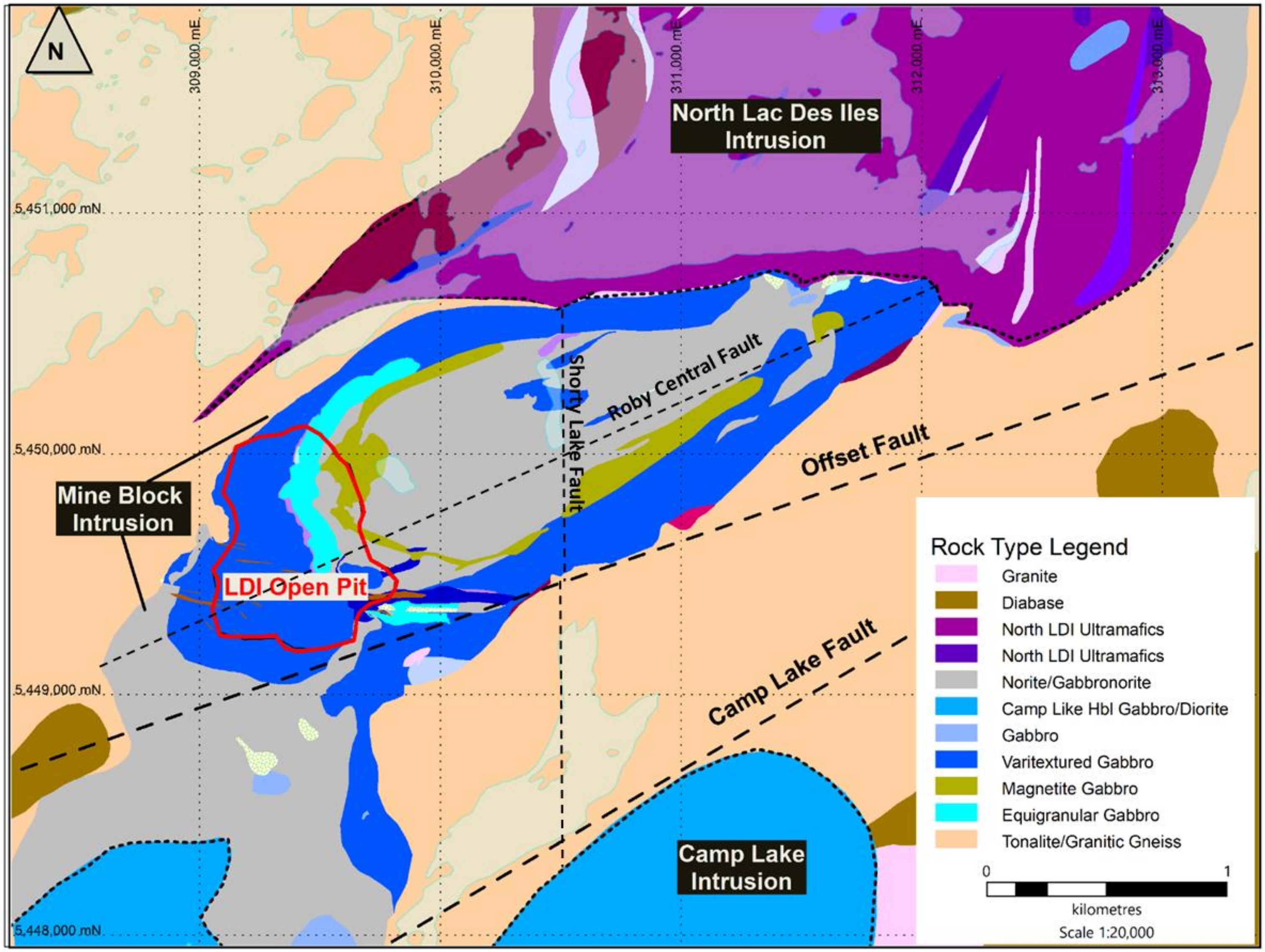

Figure 6. Simplified property geology, (modified from Buss et al. 2017)

Exploration History

1963: Discovery of Cu-Ni sulphide mineralization south of Lac des Iles by W. Baker and G. Moore.

1963-1966: Gunnex/Boston Bay/Anaconda performed ground geophysics, geological mapping/sampling and diamond drilling (DDH A66-19, A66-20). Delineated 8 zones in total, including Baker Zone, containing anomalous Pd-Pt.

1987–1989: American Platinum Ltd. drilled ~2000m at Angle Bay with the intent to test for Pd-Pt potential. Drilling encountered isolated meter-wide intervals of Pd mineralization (<8 g/t Pd). Due to financial reasons, Creek Zone exploration was halted in 1989 and the claims immediately south of Lac des Iles were staked by Madeleine Mines.

1999-2001: North American Palladium (NAP) expanded its claims package to include Creek Zone and conducted ~3000m of trenching, mapping, and sampling over a three-year period. The trenching was focused at the North Creek Zone Rim and a few extended to the South Creek Zone Rim.

2004: NAP consulted Geosig Inc to complete a ground IP survey over portions of the Creek Zone/Angle Bay target areas.

2005: NAP drilled two holes (total of 342m) along the northern margin of the Creek Zone as follow up to anomalously high trench sample assay results from the previously mentioned 1999-2001 program. The results were sporadic with the highest being 3.45 g/t Pd over 1.5m.

2008: NAP conducted an exploration drill program and identified multi-meter intervals of Pd mineralization by targeting Creek Zone at depth by gridding assays from historical trench samples. The highest value returned was 7.08 g/t Pd and the highest multi-meter intercept of 2.47 g/t Pd over 25m.

2010: NAP outlined new low-grade multi-meter intervals of Pd mineralization (~1.09-1.93 g/t Pd over 4.0-9.0 m intercepts) with additional drilling. These intercepts correlated with those from the 2008 drilling in the area and attempts to extend the mineralization westward returned modest (2.87 g/t Pd over 4m) or sporadic results.

2013: NAP conducted a three diamond drill hole program totaling 681m on the eastern edge of the "North VT Rim" to follow-up the 2008 and 2010 Creek Zone drilling. As a result, the mineralized zone extended 45m to the northeast. Despite the consistent thickness of the intercept, lower grades were returned than in 2008-2009. The best intercept was 1.34 g/t Pd over 20m, including 2.52 g/t Pd over 7m with a maximum grade of 3.62 g/t over 1m; all mineralized intervals were hosted within noritic rocks.

NAP also completed nine diamond drill holes totaling 2,479 meters testing the "South VT Rim". The best results included 14 meters of 1.01 g/t Pd.

2015: NAP validated historical surface mapping and re-logged seven historical drill holes as part of an ongoing study through Laurentian University. Eighty-six samples were collected from surface exposures and drill core for whole rock lithogeochemistry and polished thin section. Additionally, Abitibi Geophysics conducted a ground magnetic survey of the mine block intrusion.

2016-2017: NAP rented a portable SCIP unit from GDD Geophysics for two rounds of testing of select mineralized and unmineralized lithologies at the MBI. In total, 84 SCIP samples from three historic drill holes at Creek Zone were selected for preliminary review and evaluations.

2018: NAP completed 2,973 meters in nine drillholes to test the Creek Zone Target and 1,376 meters in 4 drillholes to test Baker Zone. The best intercept returned from Baker zone included 164.0 meters of 1.37 g/t Pd. The best intercept returned from Creek Zone included 47.0 meters of 2.36 g/t Pd.

Exploration Plans and Permits

Exploration activities contained in this report lie on Lac des Iles Mining Leases and Impala Canada Ltd Mining Claims. The survey was airborne by design; work permits were not required to complete the geophysical survey.

UAV Magnetic Survey

The survey was conducted by MWH Geo-Surveys Ltd from 17 September to 4 October, 2018 for Impala Canada Ltd (formerly North American Palladium Ltd.) on the East Mine Block project area at the Lac LDI Mine. The drone-supported, low-altitude magnetics survey was designed to acquire high-resolution data with lower noise than ground methods due to the increased distance of sensors from anomalies, and evaluate the efficacy of the method as a whole to assess its suitability for local and regional exploration applications. Specifically at the EMB, this survey hopes to delineate the distribution of contrasting magnetic responses internal to the Mine Block Intrusion to establish the distribution of lithologies with known potential to host Pd mineralization.

Activities were based from the LDI Mine site; the survey area was accessed by pick-up truck. The survey period occurred over a total of 18 days, including mobilization/demobilization and one day of safety induction. The UAV magnetic survey had 10 days of active data collection; 4 days of data collection were lost to weather. The survey coverage totaled an area of 5.9km^2 comprised by 240 flight line km at 25m spacing; lines were flown in at north-northwest orientation, largely perpendicular to stratigraphy at East Mine Block, at an elevation of roughly 40m above surface. Final datasets consisted of 338,463 magnetic readings.

For additional details pertaining to personnel, physical activities undertaken, instrumentation, flight specifications and parameters used including calibration and quality control methods, corrections and processing steps, as well as location map, please see MWH Geo-Surveys final report provided in Appendix A.

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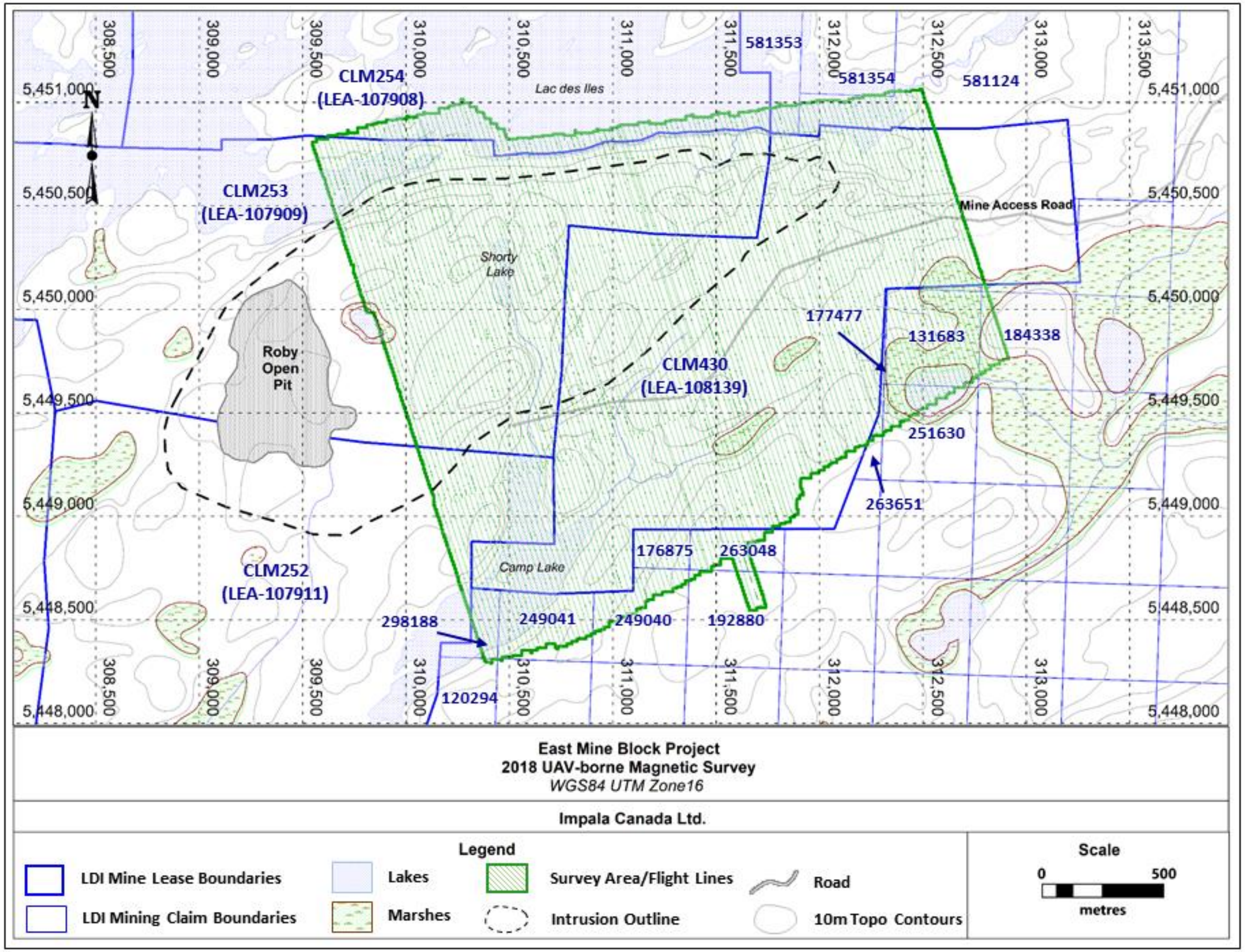

Figure 7. Map of East Mine Block area relative to the LDI Mine Roby Open Pit with location of survey boundary and flight lines for MWH Geosurveys UAV Magnetics survey.

Conclusions and Recommendations

Survey data revealed a northeast striking magnetic response represented as an apparent low magnetic signature, coincident with a noritic body, believed to represent a remanently magnetized pulse of fertile magma within the EMB along the northern margin of the project area. The presence of this anomaly lends support to the current geological interpretation suggesting the notable influence of the pre-magmatic Central Roby Fault on the distribution of sulfide-bearing noritic magma at the EMB. High resolution datasets should be viable to acquire using wider line spacing in future surveys. See Appendix A for high resolution plan view maps of results (total magnetic intensity and reduced to pole).

Additional processing of data to produce both 3D magnetic susceptibility and magnetic vector inversions are jointly recommended to evaluate this northeast-trending remanently magnetized body with known potential to host Pd mineralization. Subsequent inversions should be evaluated by future drill testing to better understand the efficacy of this survey method at exploring for noritic bodies with potential to host Pd mineralization internal to an intrusion of the LDI Suite of intrusions. This may prove to be relevant at both local and regional scales

Statement of Expenditures

The total value of work completed on the East Mine Block property claims with allocation of expenditures by individual lease or claim block is summarized in Table 2.

Table 2. Statement of expenditures for claims on the East Mine Block Property, 2018 UAV magnetic geophysical survey.

Tenure Number	Type	DroneMagCoverage (km2)	% of survey area	Allocation of expenditure	
CLM252 (LEA 107911)	Lease	0.260	4.39%	$	961.31
CLM253 (LEA 107909)	Lease	1.700	28.67%	$	6,285.51
CLM254 (LEA 107908)	Lease	0.170	2.87%	$	628.55
CLM430 (LEA 108139)	Lease	2.610	44.02%	$	9,650.11
120294	Claim	0.001	0.02%	$	3.70
128850	Claim	0.0001	0.00%	$	0.35
131683	Claim	0.200	3.37%	$	739.47
176875	Claim	0.040	0.67%	$	147.89
177477	Claim	0.005	0.08%	$	18.49
184337	Claim	0.001	0.02%	$	3.70
184338	Claim	0.030	0.51%	$	110.92
192880	Claim	0.020	0.34%	$	73.95
243588	Claim	0.006	0.10%	$	22.18
249040	Claim	0.050	0.84%	$	184.87
249041	Claim	0.120	2.02%	$	443.68
251630	Claim	0.040	0.67%	$	147.89
263048	Claim	0.040	0.67%	$	147.89
263651	Claim	0.007	0.12%	$	25.88
298188	Claim	0.038	0.64%	$	140.50
581124	Claim	0.080	1.35%	$	295.79
581353	Claim	0.510	8.60%	$	1,885.65
581354	Claim	0.001	0.02%	$	3.70
TOTAL		**5.929**	**100.00%**	**$**	**21,922.00**

References

Buss, B., Roney, C., Peck, D., Decharte, D., Marrs, G., Canosa, J., Hutton, K., Ritchie, L., and Therrien, L., 2017. NI 43-101 Technical Report: Feasibility study incorporating the life of mine plan for Lac des Iles Mine, Thunder Bay, Ontario, Canada; North American Palladium and Nordmin Resource & Industrial Engineering, Report# 16378-2017, 925 p.

Corfu, F. and Stott, G.M., 1986. U-Pb ages for late magmatism and regional deformation in the Shebandowan Belt, Superior Province, Canada; Canadian Journal of Earth Sciences, v. 23, p. 1075–1082.

D. Decharte, et al. (October, 2018). NI 43-101 Technical Report: Feasibility Study for Lac des Iles Mine Incorporating Underground Mining of the Roby Zone. North American Palladium. Thunder Bay, ON.

http://s21.q4cdn.com/326998455/files/doc_downloads/2018/10/NAP-43-101-Technical-Report-October-2-2018.pdf

Maxwell, J., 2018. 2018 East Mine Block Drill Proposal. Internal Document.

McGuinness, C., Miller, K., Maxwell, J., Benson, D., 2020. Assessment report – 2018 exploration assessment report on the East Mine Block project, Lac des Iles Mine.

Mumin, A., 2015. Assessment report – 2013 diamond drilling assessment report on the Wakinoo/Demars property. NTS: 052A13, 052H04, Senga Lake, Shelby Lake, Orbit Lake, Eayrs Lake claim area; North American Palladium.

Stone, D., 2010. Ontario Geological Survey Open File Report 5421 “Precambrian Geology of the Central Wabigoon Subprovince Area, Northwestern Ontario”, Pg.42.

Stone, D. and Davis, D.W., 2006. Revised tectonic domains of the south-central Wabigoon Subprovince; *in* Summary of Field Work and Other Activities 2006, Ontario Geological Survey, Open File Report 6194, p. 11-1 to 11-18.

Stone, D., Lavigne, M.J., Schnieders, B., Scott, J., and Wagner, D. 2003. Regional geology of the Lac des Iles area; *in* Summary of Field Work and Other Activities 2003, Ontario Geological Survey, Open File Report OFR6120, Project Unit 95-014 p. 15-1–15-25.

Statement of Qualifications

DAVID CHARLES BENSON
5 JAGUAR PLACE
BRANDON, MB   R7B 3P1
(204) 223-2281

1. I, David Benson, am a practicing professional geologist in both Ontario and Manitoba: APGO (#2302) and EGM (#25701).
2. I am a licenced Prospector in the Province of Ontario (#1012682) and have completed the Mining Act Awareness Program for Supervisors (#B7A9-447E-B5B3-CF67).
3. I graduated with a Bachelor's of Sciences degree (First Class Honours) in the Geological Sciences from the University of Manitoba in 2001.
4. I am currently the Exploration Manager for Impala Canada Ltd. and have been continually been employed by the company and predecessors since 2012.
5. I have authored or co-authored seven (7) NI 43-101 Mineral Property Reports.

Respectfully submitted,

June 8, 2020

David Benson
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Logistical and Processing Summary
Lac des Iles UAV Magnetic Survey, Ontario
for North American Palladium Ltd.

MWH Geo-Surveys Ltd.
November 2018

Figure 1: DJI M600 D-RTK with GEM GSMP-35U

Beginning September 17 and concluding October 4, 2018 MWH Geo-Surveys Ltd. carried out a UAV magnetic survey on the East Mine Block at the Lac des Iles mine in Ontario at the request of North American Palladium.

OPERATIONS and SCHEDULING:

Survey Personnel: The personnel involved on this project were:

• Thomas Hetrick	• UAV Pilot
• Morgan Silver	• Assistant and observer
• Kevin MacNabb	• UAV pilot and observer

The following is the project time-line:

- Survey Crew Mobilization: September 17
- Survey Production starts at Lac des Iles, ON: September 19
- Weather days: September 21, 23, 24, 26
- East Mine block complete, survey operations suspended: October 2
- Demobilization from site: October 3, 4

A total of 240 line kilometers (post processing) of UAV magnetic survey was flown at 25m line spacing in an area of 5.9 km². The final data file consists of 338,463 magnetic readings collected during 10 production days. Access to all flight staging sites was by truck.

UAV MAGNETIC FIELD PROCEDURES:

Our UAV mag system uses a GEM Systems GSMP-35U sensor flown under a DJI Matrix 600 pro hexacopter with the D-RTK navigation upgrade. Technical information on the airborne sensor is attached as an appendix. The GSMP-35U sensor takes 10 readings per second and is flown at a maximum speed of 7m/second. The GSM19 base mag cycles at 2 readings per second to provide diurnal corrections. Flight lines were flown at a bearing of N 20 W with a line spacing of approximately 25 meters at approximately 40 meters above ground level with a tolerance of +/- 4 meters. As the UAV location is determined by differential GPS the altitude is precisely controlled within the flight planning variables with respect to a supplied digital elevation model.

A portable generator was used to run the navigational planning and control software on a field PC and to charge the flight batteries.

DATA REDUCTION and MAPPING:

Base and aerial magnetic data was downloaded and diurnally corrected each day. A total file consisting of approximately 360 line kilometers of magnetic data was then processed and the results were used to map the Total Magnetic Intensity (TMI) field and calculate the Reduced to Pole (RTP) TMI. All data points are shown in Figure 2. Blue points resulted from the editing and are used for final mapping. Green points were removed from the acquired dataset and not used for final mapping.

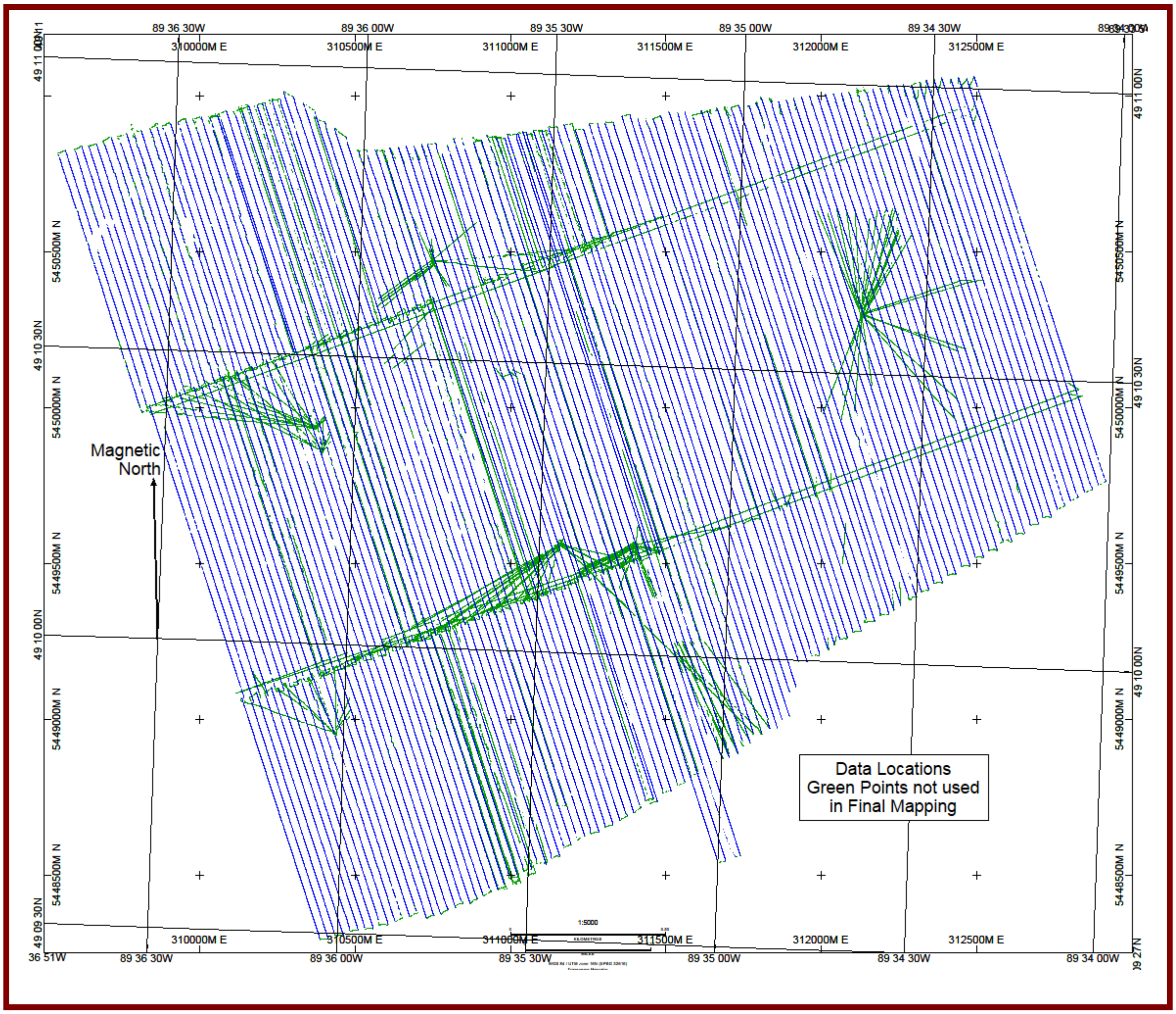


Figure 2. NA Palladium Lac-des-Iles, Ontario. UAV Aeromagnetic data acquisition. Blue points used for final mapping; Green points removed from survey dataset.

Data Editing: Flight lines were flown along a bearing of N 20 W. The purpose of the editing was to isolate the points along flight lines and remove points associated with five occurrences:

1) "Transit" lines which connect the ends of flight lines with takeoff and landing locations.
2) "Loops" which connect ends of adjacent flight lines.
3) "Hovers" which occur at takeoff and landing where there is little or no lateral travel.
4) "Re-flights" when a line is reflown and a duplication is acquired, only one flight must be selected.
5) "Spikes" when a single reading is anomalously much greater or lower than adjacent points. A point was rejected if its value was 5 nT greater or less than the average value of its four adjacent points; that is the two points recorded approximately 0.2 seconds (1.4 meters) before and after it.

International Geomagnetic Reference Field (IGRF) Correction: The IGRF is a mathematical representation of the smoothly varying earth's magnetic field. The aeromagnetic acquisition records a magnetic value which is the sum of the IGRF and the magnetic anomalies caused by the local geology. Therefore, to isolate the anomalies, the IGRF must be calculated for each acquired data point and subtracted from it. The value of the IGRF for a point depends on the time and location of acquisition: date, time of day, latitude, longitude and elevation (above sea level). Using the Geomagnetic Field Calculator from the National Oceanic and Atmospheric Administration (NOAA), the method used here calculates a grid of the IGRF at the start of the survey then applies the change of the IGRF through the time of the acquisition of each subsequent data point. The value of the IGRF for each magnetic reading is then subtracted from the Diurnally Corrected Magnetic Value producing the IGRF correction, sometimes called the IGRF anomaly. The Final TMI was calculated by then adding a constant to the IGRF correction of 56,513 nanoTesla, the average value of the IGRF for the entire survey.

Total Magnetic Intensity (TMI): The final TMI values were gridded at a grid interval of 15 meters. Data were of high quality and were contoured at a 10nT increment.

Reduction-to-Pole (RTP): The TMI grid was then used to calculate the RTP grid using an Inclination= 74.4° and Declination=-3.7°. The RTP was applied and then 50,750 nT were added; this value is the approximate average difference between the TMI and calculated RTP grids. Contouring was at 10 nT as with the TMI map.

The RTP data enhancement map results from a mathematical operator which corrects for position offset of the skewing of the magnetic anomaly due to the earth's magnetic inclination and declination. The reduction-to-pole mathematically transforms the total magnetic intensity (TMI) field at its observed inclination (I) and declination (D) to that of the north magnetic pole (i.e., I=90°, D=0°); thereby centering the magnetic anomaly directly over the causative body and so assisting the interpretation process. For example, the anomaly signature for a body located in an area of high (steep) magnetic inclination such as Ontario (I ≈ 74°N) is illustrated in Figure 3.

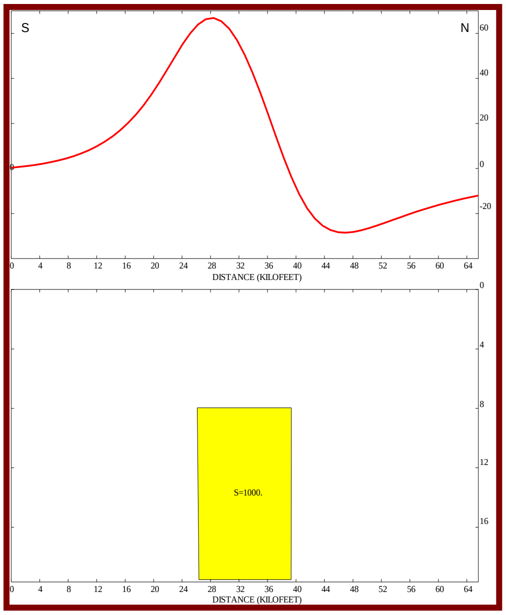


Figure 3. Magnetic inclination affect due to a body located at 74° Inclination along a 0° azimuth south-north traverse.

The RTP operator is applied to the TMI grid to adjust the steeply dipping inclination effect to the vertical 90° inclination angle of the magnetic north pole as illustrated in Figure 4.

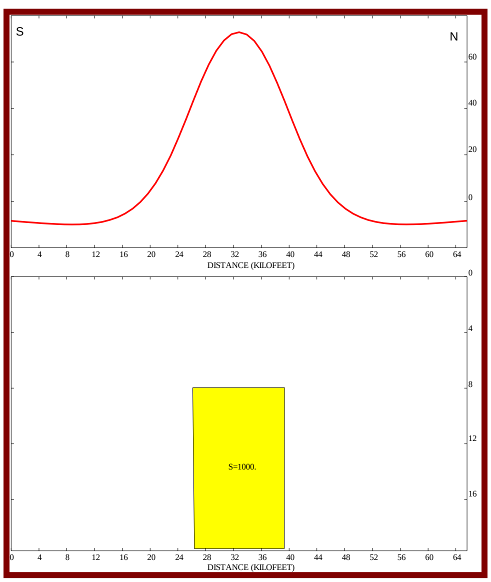


Figure 4. Magnetic inclination effect due to a body located at magnetic north pole along a 0° azimuth south-north traverse.

DATA DELIVERABLES:

Mapping Parameters
The Grids for the 2 maps are provided in Geosoft GXF ASCII format

Distance Units: meters
Projection: UTM zone 16N (EPSG 32616)
Datum: WGS84
Magnetic (z) Units: nanoTesla (nT) or nT/meter
Grid increment: 15 meters
Null value: 99999

Files delivered:
Data:
MWH_NAP_Lac-des-Iles_UAV_mag_20181015_csv.zip

Maps:
MWH_NAP_Lac-des-Iles_UAV_mag_TMI_20181015.pdf
MWH_NAP_Lac-des-Iles_UAV_mag_RTP_20181015.pdf

Grids:
MWH_NAP_Lac-des-Iles_UAV_mag_TMI_20181015_rmg.asc
MWH_NAP_Lac-des-Iles_UAV_mag_TMI_20181015_xyz.asc
MWH_NAP_Lac-des-Iles_UAV_mag_RTP_20181015_rmg.asc
MWH_NAP_Lac-des-Iles_UAV_mag_RTP_20181015_xyz.asc

The Grids for the maps are provided in 2 ASCII formats:
XYZ and Row-Major (rmg)

Distance Units: meters
Projection: UTM zone 16N (EPSG 32616)
Datum: WGS84
z Units: nanoTesla
grid increment: 15 meters
null value: 99999

An ASCII csv formatted file of the edited data is delivered.
The header records and first 2 point records for the file are:

Line,Easting,Northing,Latitude,Longitude,Date,hhmmss.s,UAV #,GPS ASL,Elev AGL,Raw Magnetics,Diurnal correction,Diurnally Corrected Magetics,IGRF value,IGRF correction,Final IGRF & Diurnally Corrected Mag
5,309549.25,5450807.58,49.1804930,-89.6134210,28-Sep-18,145621.5,1,522,33.00,56655.9290,10.26,56666.1890,56515.8522,150.3368,56663.3368
5,309550.73,5450803.43,49.1804359,-89.6133887,28-Sep-18,145622.6,1,521,32.00,56677.5839,10.19,56687.7739,56515.8402,171.9337,56684.9337

Appendix I

- GEM Systems GSMP-35U specifications
- Data Maps

UAV Solutions

NEW!

Fixed-wing, Multicopter and Rotary-wing platforms featuring ultra-light Potassium Magnetometer

Since 1980

Leading the World of Magnetics

GEM Systems is the number one global leader in the manufacture and sale of high precision magnetometers.

GEM is the only commercial manufacturer of Overhauser magnetometers, that are accepted and used at Magnetic Observatories over the world.

Our Potassium Magnetometers are the most precise magnetometers in the world.

Our Proton sensors are considered the most practical and robust magnetometers for general field use.

Proven reliability based on R+D since 1980.

We deliver fully integrated systems with GPS and additional survey capability with VLF-EM for convenience and high productivity

Today we are creating the absolute best in airborne sensors and are leading the way in Airborne sensors with smaller and lighter sensors for practical UAV applications. We are also making very large sensors with the best sensitivity (30-50 fT) for use in natural hazard research and global ionospheric studies.

Our Leadership and Success in the World of Magnetics is **Your key to success** in applications from Archeology, Volcanology and UXO detection to Exploration and Magnetic Observation **Globally.**

The GSMP-35U magnetometer has been installed on a multitude of unmanned platforms.

Surveying with UAV's

UAVs can be used to perform airborne geophysical surveys, in particular aeromagnetic surveys where mapping the spatial variations in the Earth's magnetic field can be used to further the understanding of the geology in areas where the mineral potential is being explored.

UAV borne magnetic surveys are less expensive than both airborne and ground surveys. They can be carried out in areas that are too dangerous, too remote, or too expensive to carry out with manned aircraft. UAV borne magnetic surveys can deliver better data quality in environments where topography and safety standards prohibit manned aircrafts from acquiring data at optimum terrain clearances.

Practical applications of UAVs are limited by several factors. Aviation regulations and flight restrictions must be adhered to when operating most fixed wing UAVs. In addition limitations are also imposed around the use of rotory-wing UAVs in and around built up areas. From a logistical point of view, one of the largest limiting factors with respect to UAVs is that they have limited payload. In order for UAVs to make practical survey flights, the survey equipment must be light. GEM has developed light weight geophysical instrumentation for UAVs.

Light Weight - High Sensitivity Potassium Magnetometer

Gem Systems developed the GSMP-35U to be the first lightweight , highly sensitive magnetometer for UAVs. It has been installed and successfully tested in the Monarch fixed wing Gradiometer, GEM Copter and GEM Hawk UAV's.

The GSMP-35U magnetometer with 0.3 pT sensitivity forms the core of GEM's UAV solutions. The sensors are based on GEM's popular optically pumped Potassium magnetometer sensor, that offers the highest sensitivity, absolute accuracy and gradient tolerance available in the industry.

The sensors stream RS-232 or RS-485 data which can be visualized for quality control purposes, if hardware is on board facilitating a down link of data. The GSMP-35U magnetometer is supplied complete with 128 Mb of on board data storage, suitable for long flights.

Advantages of Potassium Optically Pumped Technology

- Highest sensitivity, absolute accuracy and gradient tolerance optically pumped magnetometers available on the market
- Potassium narrow spectral line minimizes heading and orientation errors
- Low maintenance cost on sensors
- High quality results in areas of high gradients

Our World is **Magnetics.**

GEM Systems, Inc.

135 Spy Court Markham, ON Canada L3R 5H6

Phone: 1 905 752 2202 • Fax: 1 905 752 2205

Email: info@gemsystems.ca • Web: www.gemsystems.ca

Integration Options with UAV's

The light weight GSMP-35U magnetometer can be supplied as a stand alone magnetometer allowing the customer to complete integration into existing platforms. In addition, a variety of options exist.

The nose of the Airbird houses all of the navigation and ancillary instruments, complete with a window for the laser range finder

Option 1 - For UAVs operating with PIXhawk autopilots

This Option includes the lightweight GSMP-35U modified to facilitate recording the rich data stream from the Pixhawk autopilot found in so many UAVs. A full, multi-parameter database, which includes the mag data and all of the UAV's sensor data, such as altimeter and GPS is created onboard the Magnetometer's custom electronics module. Data is retrieved post flight.

Option 2 - For customers with their own UAV that wish to add a complete geophysical system along with specialised ancillary equipment

GEM will supply and integrate GPS, Laser altimeter, IMU and data radio link. The system runs completely independent of the onboard autopilot. The electronics box for the magnetometer system is modified to include a multiplexor (**GEMDAS**) to handle data acquisition and storage for a variety of parameters. The data can be retrieved at the end of the flight or it can be delivered in realtime to the ground via radio link. (a separate DAS system can also be provided)

Option 3 - Standalone light weight towed bird for VTOL UAVs (Turnkey System)

GEM Systems' stand-alone magnetometer **Airbird** for Vertical Take Off and Landing (VTOL) UAVs, comes complete with 1 GSMP-35U Potassium Magnetometer, laser altimeter for terrain clearance control, IMU, GPS navigation, battery, radio link and tow cable. The magnetometer performs all of the functions of a data acquisition unit.

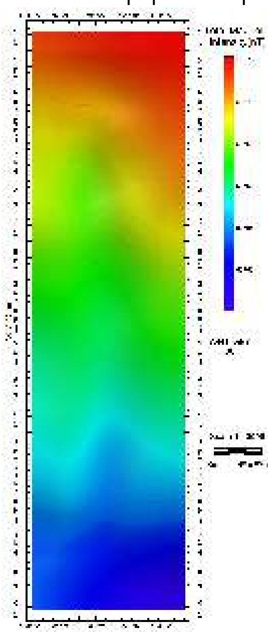
AirBird

The self contained, self powered stand alone system does not require any integration with the UAV's navigation or electrical systems.

AirBird - Lightweight complete towable system to house; Magnetometer, GPS, Laser Altimeter, IMU and GEMDAS data acquisition module.

AirBird Specifications

The overall length of the **Airbird** is 2.2 metres with the GSMP-35U sensor, installed on a gimbal in the tail to allow for +/- 45 degree rotation of the sensor. The housing shell weighs only 1.6 kg. With all components added, including power, the bird weighs just under 3.3 kg. The battery allows for 1 hour of equipment operation.



Magnetic data collected with the GSMP-35U during a test flight of the GEM Hawk UAV in southern Ontario.

Customer provided UAV's

Before deciding on a particular UAV aircraft with adequate range and payload for the geophysical instruments, it is recommended that the magnetic interference generated by the vehicle be assessed with a high sensitivity portable magnetic gradiometer, operated by an experienced geophysicist. The UAV vehicles should have a payload capacity of at least 1.5 kg for minimum requirements. But before purchasing a UAV contact GEM to discuss your plans.

Magnetomometer Specifications

Performance

Sensitivity: 0.0003 nT @ 1 Hz
Resolution: 0.0001 nT
Absolute Accuracy: 0.1 nT
Dynamic Range: 20,000nT to 120,000 nT
Low/High Field Options: 3000 to 350,000 nT
Gradient Tolerance: 50,000 nT/m
Sampling Rate: 1, 5, 10, 20 Hz

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 & Weights

Sensor: 161mm x 64mm (external dia) with 2m cabling ; 0.43 kg
Electronics Box: 236mm x 56mm x 39mm; 0.46 kg
Option 1 cabling; .125kg
Option 3 light weight battery; .250kg

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 & ship case.

GEM Systems provide an industry leading 3 year Warranty

GEM SYSTEMS

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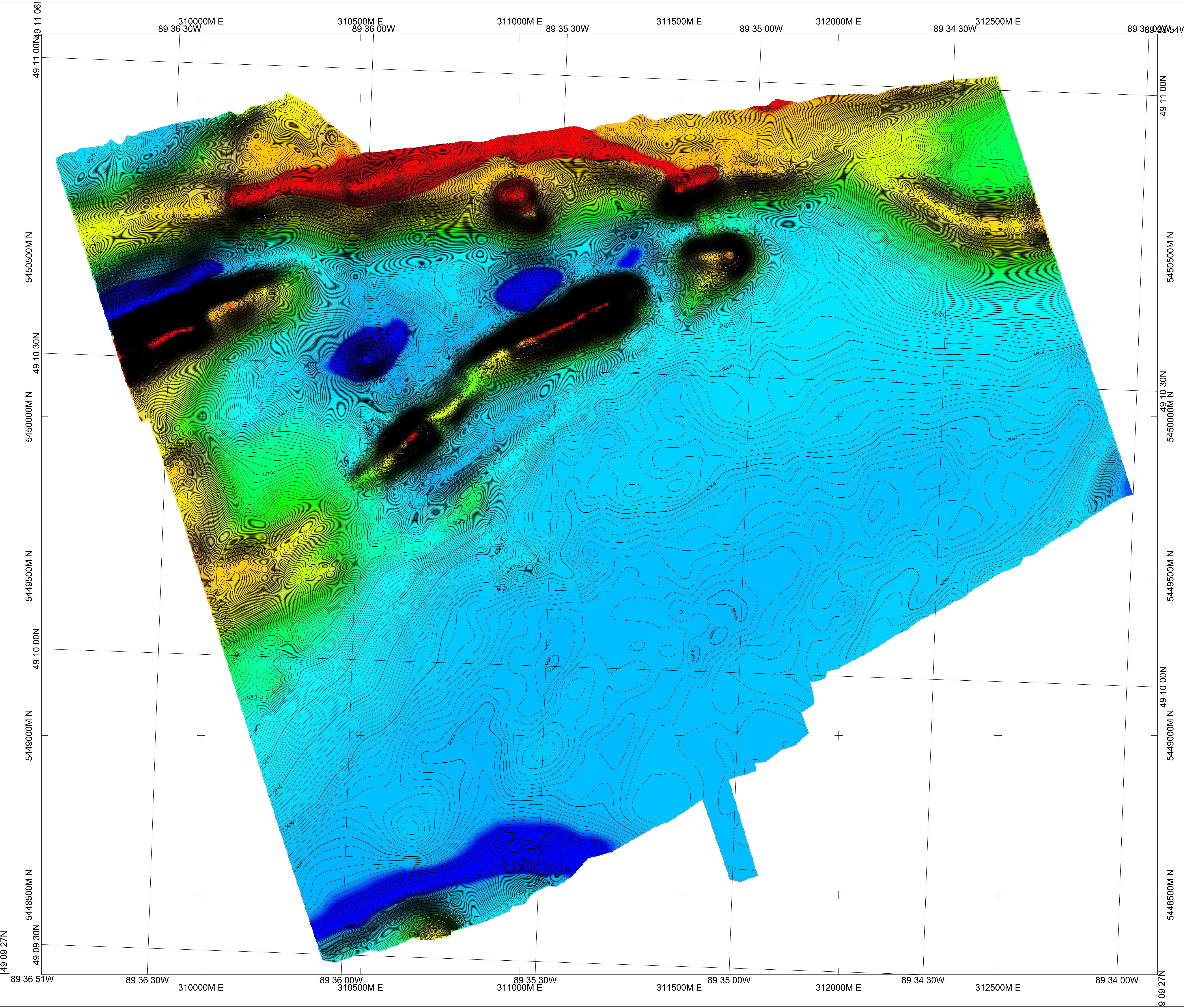

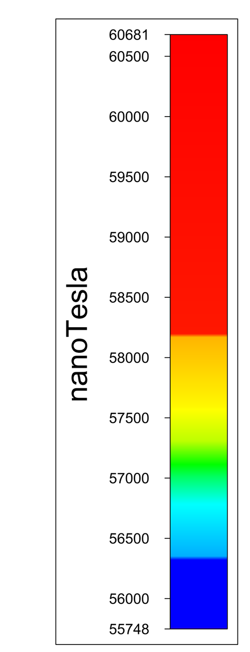

1:5000

0 0.50
KILOMETRES

0 0.25
MILES

WGS 84 / UTM zone 16N (EPSG 32616)
Transverse Mercator
WGS 84 spheroid
Natural origin: [87 00 00W, 0 00 00N]

North American Palladium

East Mine
Lac des Iles, Ontario

Total Magnetic Intensity
UAV Aeromagnetics acquisition by
MWH Geo-Surveys

Scale: 1:5000	The IGRF was applied then 56513 nT were added
Date: 15-Oct-2018	Grid increment = 15 m
C.I.= 10 nT	Project No.:

Data Source:
Data Acquired between 19-Sept to 2-Oct 2018
Flown ~ 40 m AGL
Line direction NW-SE; Spacing ~ 25 m


nanoTesla
60681
60500
60000
59500
59000
58500
58000
57500
57000
56500
56000
55748
1:5000
0
0.50
KILOMETRES
0
0.25
MILES
WGS 84 / UTM zone 16N (EPSG 32616)
Transverse Mercator
WGS 84 spheroid
Natural origin: [87 00 00W, 0 00 00N]
North American Palladium
East Mine
Lac des Iles, Ontario
Reduced to Pole
Total Magnetic Intensity
UAV Aeromagnetics acquisition by
MWH Geo-Surveys
Scale: 1:5000
The RTP was applied then 50750 nT were added
Date: 15-Oct-2018
Grid increment = 15 m
C.I.= 10 nT
Project No.:
Inc = 74.4 ; Dec = -3.7
Data Source:
Data Acquired between 19-Sept to 2-Oct 2018
Flown ~ 40 m AGL
Line direction NW-SE; Spacing ~ 25 m
310000M E
310500M E
311000M E
311500M E
312000M E
312500M E
89 36 30W
89 36 00W
89 35 30W
89 35 00W
89 34 30W
89 34 00W
89 36 51W
49 11 00N
49 10 30N
49 10 00N
49 09 30N
49 09 27N
49 11 06N
5450500M N
5450000M N
5449500M N
5449000M N
5448500M N