We are committed to providing accessible customer service.
If you need accessible formats or communications supports, please contact us.

Nous tenons à améliorer l’accessibilité des services à la clientèle.
Si vous avez besoin de formats accessibles ou d’aide à la communication, veuillez nous contacter.

QEMScan and SEM-EDX Mineralogy on Magnetic Separates
Chrome-Puddy Property

Claims 4265987, 4265988, 4254346, 4265978, 4265979, 4265980
Puddy Lake Area (G-0118)
Thunder Bay South District, Thunder Bay Mining Division
UTM WGS84 Zone 16U 319833 mE, 5538575 mN
Latitude 49^{o} 58’ 20” N, Longitude 89^{o} 30’ 46” W
NTS 52H 13/14

For:
Pavey Ark Minerals Inc.
Client number 411465

Prepared by:
Richard Sutcliffe, P.Geo. (Client # 225603),
100 Broad Leaf Crescent
Ancaster, ON, L9G 3R8

March 15, 2016

Executive Summary

This assessment report documents results of QEMScan and Scanning Electron Microscopy - Energy Dispersive X-Ray Spectrometry (SEM-EDX) analysis on magnetic concentrates from two samples of the Chrome-Puddy serpentinite. The analysis reports on the mineralogy of the magnetic concentrates, with a focus on deportment of nickel-bearing minerals. Total expenditures were $2,686.

The Chrome-Puddy Property is located 179 km north of the city Thunder Bay, Ontario. Highway 527, a paved highway that extends north from Thunder Bay to Armstrong, is located 25 km west of the Property. Recent logging activity has created logging access roads to within 2 km from the east boundary of the Property. Access to the Property is also by float equipped aircraft that can be chartered in Armstrong.

The Chrome-Puddy Property is a contiguous property comprised of eleven patented claims covering 227 ha and 9 staked claims (4265987, 4265988, 4254343, 4254345, 4254346, 4244587, 4265978, 4265979, 4265980) totaling 51 claim units covering 816 ha. The Property is 100% owned by Pavey Ark Minerals Inc., a private Ontario Corporation. The present work was done on samples from claims 4265987 and 4254346 and is being applied to claims 4265978, 4265979, 4265980.

The western part of the Chrome-Puddy Serpentinite is a pervasively altered ultramafic intrusion with elevated Fe and widespread magnetite content that occurs as veins and disseminations. Davis Tube test work has determined that a high-grade Fe concentrate with over 95% $Fe+FeO+Fe_2O_3$ can be magnetically separated from samples of the Chrome-Puddy Serpentinite. Several of the magnetic fractions contained in excess of 1% Ni.

The QEMScan mineralogical investigation indicates that nickel is present in the magnetic separate fraction as a minor element in Fe-oxides, and as high-Ni trevorite and Ni-sulphide. These results indicate that a relatively unique style of Fe-oxide/Ni mineralization occurs on the Chrome Puddy Property and that there is potential to produce a high-grade Fe concentrate with approximately 1% Ni by magnetic separation.

Further work on this mineralization type should include drilling and or surface trenching to obtain representative samples for larger scale determination of Fe-oxide/Ni mineralization grades and metallurgical characteristics.

Table of Contents

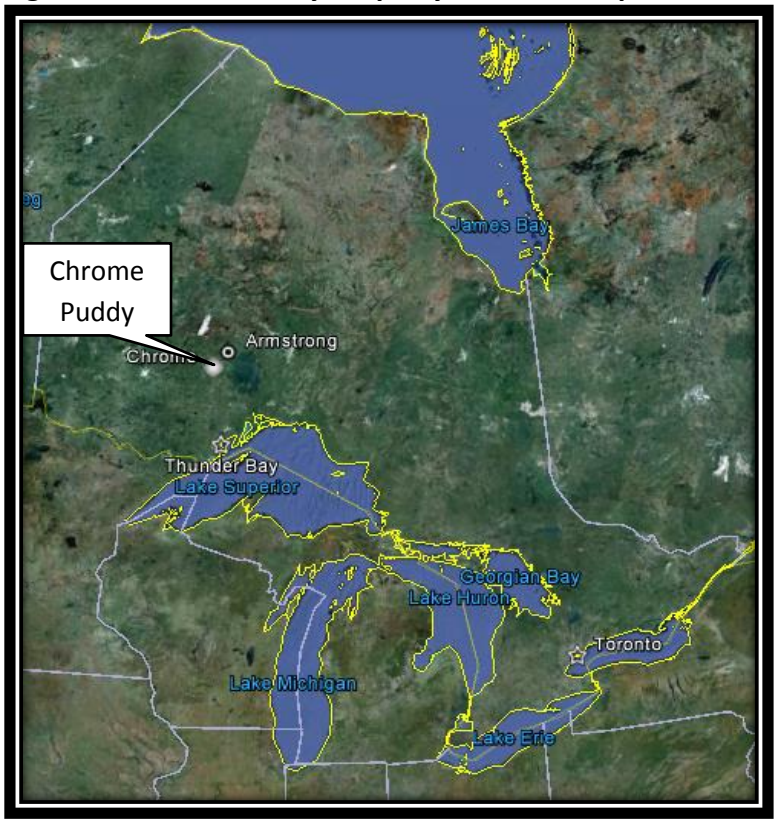
1.0 Introduction

This report documents results of QEMSCAN and SEM-EDX analysis on magnetic concentrates from two samples of the Chrome-Puddy serpentinite. The samples were analyzed to determine mineralogy and mineral associations, with a focus on deportment of nickel-bearing minerals. The QEMSCAN and SEM-EDX analysis was carried out by AGAT Laboratories in Calgary, Alberta. The work primarily targets iron-oxide/nickel mineralization in the Archean Chrome-Puddy serpentinite intrusion.

2.0 Location and Access

The Chrome-Puddy Property is located in the Thunder Bay Mining District of northwestern Ontario. The property is 179 km north of the city Thunder Bay, 49 km southwest of the town of Armstrong Station, and 1,043 km northwest of Toronto, Ontario (Figure 1). Highway 527, a paved highway that extends north from Thunder Bay to Armstrong, is located 25 km west of the Property. Recent logging activity has created logging access roads to within 3.5 km of Chrome Lake and 2 km from the east boundary of the Property. The logging road access route to the property is from the "Obonga Lake Road" which is a signed gravel road west of highway 527 and located 30 km south of Armstrong Station. The logging roads are not maintained. A hiking trail has been established to connect the logging roads with Chrome Lake.

Figure 1. Chrome-Puddy Property Location Map



Source Google Earth 2013

3.0 Claim Holdings and Property Disposition

The Chrome-Puddy Property (Figure 2) is a contiguous property comprised of eleven patented claims covering 560.45 acres (226.81 ha) and 9 contiguous staked claims (4265987, 4265988, 4254343, 4254345, 4254346, 4244587, 4265978, 4265979, 4265980) totalling 51 claim units for a total of 2,016 acres (816 ha). Staked claims are listed in table 1. The Property covers approximately 90% of the Chrome-Puddy Serpentinite and the major known mineral occurrences in the serpentinite. A claim map is provided as Map 1 and a sketch showing contiguity is shown in Figure 2.

Table 1. List of Staked Claims comprising the Puddy Property

THUNDER BAY Mining Division - 411465 - PAVEY ARK MINERALS INC.

Township/Area	Claim Number	Recording Date	Claim Due Date	Status	Percent Option	Work Required	Total Applied	Total Reserve	Claim Bank
OBONGA LAKE AREA	4244587	2012-Oct-22	2016-Oct-22	A	100 %	$ 800	$ 1,600	$ 0	$ 0
OBONGA LAKE AREA	4254345	2012-Nov-27	2016-Nov-27	A	100 %	$ 2,400	$ 4,800	$ 0	$ 0
OBONGA LAKE AREA	4254346	2012-Nov-27	2016-Nov-27	A	100 %	$ 3,200	$ 6,400	$ 124	$ 0
PUDDY LAKE AREA	4254343	2012-Nov-27	2016-Nov-27	A	100 %	$ 4,000	$ 8,000	$ 0	$ 0
PUDDY LAKE AREA	4265978	2013-Mar-21	2016-Mar-21	A	100 %	$ 400	$ 400	$ 0	$ 0
PUDDY LAKE AREA	4265979	2013-Mar-21	2016-Mar-21	A	100 %	$ 400	$ 400	$ 0	$ 0
PUDDY LAKE AREA	4265980	2013-Mar-21	2016-Mar-21	A	100 %	$ 400	$ 400	$ 0	$ 0
PUDDY LAKE AREA	4265987	2012-Oct-22	2016-Oct-22	A	100 %	$ 6,000	$ 12,000	$ 494	$ 0
PUDDY LAKE AREA	4265988	2012-Oct-22	2016-Oct-22	A	100 %	$ 2,800	$ 5,600	$ 0	$ 0

The present work was done on samples from claims 4265987 and 4254346 and is being applied to claims 4265978, 4265979, 4265980.

4.0 Previous Work

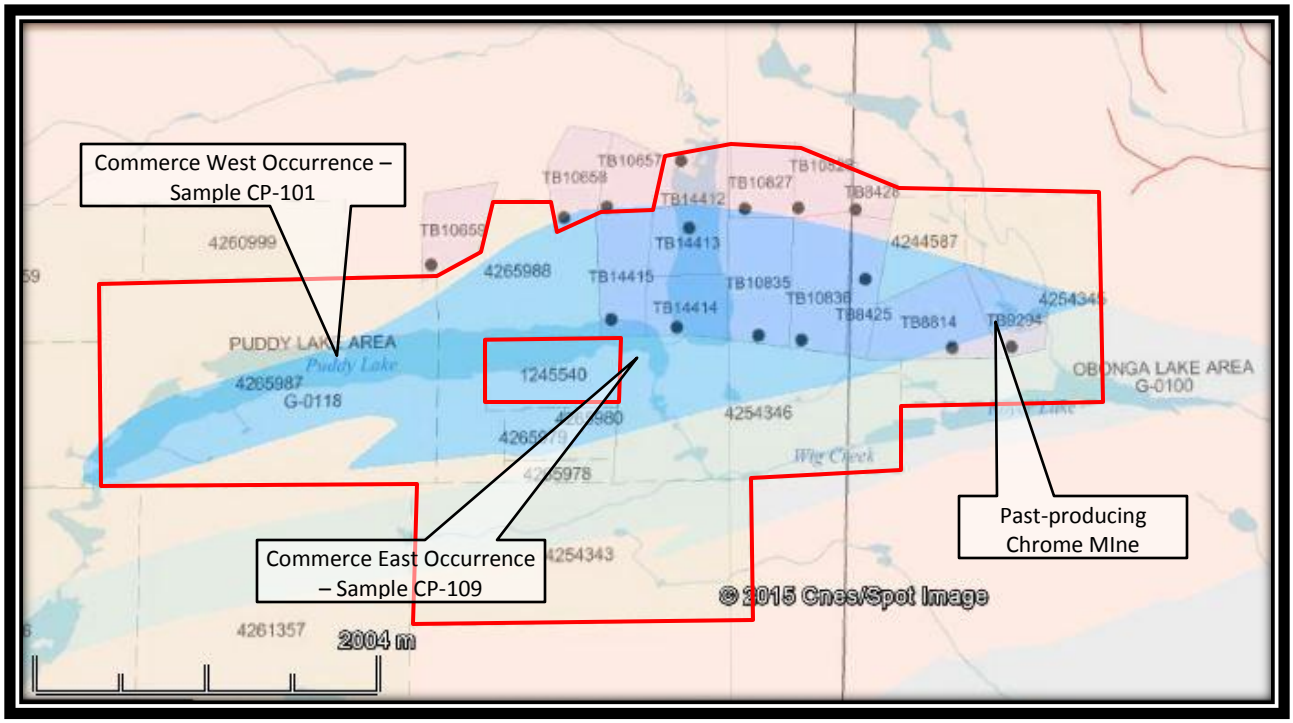
Historically, exploration and development in the eastern portion of the Chrome-Puddy serpentinite has targeted chromite, while the western portions of the intrusion have been explored for nickel and precious metals. The following summarizes exploration in the western portion of the intrusion.

Between 1964 and 1967, Commerce Nickel Mines carried out the first significant exploration program targeting nickel in the western portion of the Puddy serpentinite, including trenching, geological mapping, geochemical and geophysical surveys and diamond drilling (24 diamond-drill holes, totalling 5,590 feet). Between 1967 and 1968, Newmont Mining Corp. of Canada completed trenching, electromagnetic surveying and diamond drilling (10 holes, totalling 3106 feet). By the mid- to late-1980s, the area began to receive attention for its PGE potential. Between 1985 and 1993, K. Kuhner carried out prospecting, outcrop stripping, surface sampling and ground geophysical surveys on claims located on the south side of Puddy Lake. The property was transferred to Obongo Precious Metals Ltd. in 1993, and Obongo completed approximately 20 diamond-drill holes between 1993 and 1996. Imperial Platinum Corp. carried out geological mapping, sampling and ground geophysical surveys in 1987 and 1988 over an adjacent property encompassing areas west, north and southeast of Puddy Lake. The most recent exploration activity includes ground magnetic and electromagnetic surveys conducted by Vale Inco Ltd. in 2007 over a property covering the western half of the Puddy Lake serpentinite that identified a number of east west trending conductors, particularly north of Puddy Lake. D. Plumridge has carried out prospecting and sampling of a claim near the southeast end of Puddy Lake since 2004. Pavey Ark Minerals Inc reported results of mapping, portable XRF analysis and prospecting in 2014 and 2015.

5.0 Geology

The Chrome-Puddy Property is located in the Obonga metavolcanic and metasedimentary greenstone belt of the Archean Superior Province. The Obonga greenstone belt is a relatively small (approximately 10 x 40 km) greenstone belt, situated between the Sturgeon-Savant belt on the west and the Onaman-Tashota belt to the east, and has been considered to be part of the Wabigoon Subprovince (Percival and Stott 2000).

Figure 2. Chrome-Puddy Property Claims, Geology and Mineralogy Sample Locations



Pavey Ark Chrome Puddy Property outlined in red
Source: MNDM CLAIMaps, 2015

The Chrome Puddy Property is underlain by the Chrome-Puddy Serpentinite Intrusion that is exposed for 7 km along strike and is approximately 1 km in width (Figure 2). Whittaker (1986) reports that rocks of the intrusion include dunite, peridotite, and minor pyroxenite, all of which are serpentinized. Medium-grained, biotite tonalite bounds the Serpentinite to the north. South of Puddy Lake, the Serpentinite intrusion is bound by mylonite and mixed metasedimentary and granitic rocks. North-striking and east-striking diabase dikes of probable middle Proterozoic age cut the Serpentinite.

The ultramafic rocks have been completely altered to serpentine, talc, chlorite, carbonate, magnetite, and amphibole. The alteration, metamorphism and deformation of the serpentinite has made the interpretation of protoliths in the intrusion difficult (Graham 1930; Hurst 1931; Simpson and Chamberlain 1967; Whittaker 1986). Although no ultramafic rocks with primary mineralogy remain, the original rock types in some areas can be inferred with some confidence by comparison with the results of studies on known types of serpentine pseudomorphs (Wicks and Whittaker 1977).

6.0 Samples for QEMScan Mineralogy Program

Ten samples of magnetite-bearing serpentinite from the 2014 sampling program with nickel values greater than 1,600 ppm had been previously selected for Davis Tube test work at AGAT Laboratories in Mississauga to extract magnetic particles from pulverized rock. After

separation, the magnetic fraction was analyzed for metallic Fe, Fe_2O_3, FeO, Ni, Pt, Pd and Au. The Davis Tube test work showed that a Fe-rich magnetic concentrate with up to 1.65% Ni can be obtained from the magnetite bearing serpentinite. Results were previously reported by Pavey Ark Minerals (Sutcliffe 2016).

For the mineralogical investigation, two samples of the magnetic separates were selected to reflect different locations and occurrence of magnetite. Sample CP-101 is from a white coloured ultramafic host rock containing 75% magnetite in 0.5 to 3 cm wide veins from the Commerce NW occurrence, on the north shore of Puddy Lake. Sample CP-109 is an altered serpentinite with 5% magnetite occurring as fine wisps (mm thick, 2 cm long) from the Commerce East occurrence south of Puddy Lake. Sample locations and descriptions are provided in table 2. Sample locations are shown on Figure 2.

Table 2. Sample Locations and Descriptions for CP-101 and CP-109

Sample ID	Sampler	Easting	Northing	Description
CP-101		316784	5537855	Magnetite veins, Commerce NW occurrence, interconnected magnetite veinlets ranging from 0.5 to 3 cm in white u/m, 75% magnetite
CP-109		319450	5537934	Serpentinite with 5% magnetite, magnetite occurs as unusually fine wisps (mm thin, 2 cm long) within heterogenously coloured (altered) u/m.

Table 3. Summary of whole rock assay results, Davis Tube test results, and magnetic separate assays for CP101 and CP-109

	Whole Rock Assay Results			Davis Tube Magnetic Fraction Assays				
Sample #	Fe%	Mg%	Ni ppm	wt% magnetics	Metallic Fe	Fe_2O_3	FeO	Ni %
CP-101	48.77	5.14	9,376	77.90	0.15	69.10	27.60	1.21
CP-109	35.18	8.52	6,336	70.50	0.21	69.70	25.80	0.73

Results by Agat Laboratories, previously reported by Pavey Ark Minerals (Sutcliffe 2016)

7.0 QEMScan Mineralogy Program and Results

For QEMSCAN and SEM-EDX, 1.0 gram sub-samples of the magnetic concentrate were split, dried, de-agglomerated and mixed with graphite at a ratio of 1.0 g sample to 2.0 g graphite. The sample and graphite mixture was added to epoxy to make polished sections. Polished sections were ground, polished, and carbon-coated for QEMSCAN and SEM-EDX analyses.

The graphite-impregnated polished epoxy grain mounts were analyzed using the QEMSCAN Particle Mineral Analysis (PMA) mode at 3.0µm and 2.5µm point spacing (depending on fractionized sizes) was used to analyze a minimum of 40,000 particles in each sample to

determine modal mineralogy and mineral association characteristics. A Species Identification Protocol (SIP) based on a combination of Energy Dispersive Spectrometric (EDS) and Backscatter Energy (BSE) qualities of the sample was used to identify the minerals present.

The magnetic separates from CP-101 and CP-109 have similar mineralogy dominated by a combination of magnetite-limonite-goethite (FeOxide/Hydroxide) (93.65% and 93.95%, respectively), with minor amounts of fine Ni-minerals (4.46% and 4.50%), plus trace amounts of carbonates (1.12% and 0.65%), silicates (0.49% and 0.54%) and pyrite (0.29% and 0.32%). Ni-minerals are dominated by Fe-oxides with low Ni-Mg-Si, with lesser high-Ni trevorite and Ni-Sulphides being present in both samples.

Scanning Electron Microscopy - Energy Dispersive X-Ray Spectrometry (SEM-EDX) elemental analysis of relatively abundant Ni-mineral and Fe-Ox (limonite-goethite) phases, shows significant detectable and variable % Ni between phases and between samples. EDX spectra show a significant difference in Ni concentration between the Fe-Oxide/Hydroxide, trevoite and Ni-Sulphide phases. Magnetite may contain 2 to 4% Ni with Ni minerals such as trevorite containing in excess of 10% Ni and Ni-sulphides containing up to 33% Ni.

AGAT Laboratories QEMScan mineralogy report is attached in Appendix 1.

8.0 Conclusions and Recommendations

The western part of the Chrome Puddy Serpentinite is a pervasively altered ultramafic intrusion with elevated Fe and widespread magnetite content that occurs as veins and disseminations. Magnetic separation test work has determined that a high-grade Fe concentrate with over 95% $Fe+FeO+Fe_2O_3$ can be separated from samples of the Chrome-Puddy Serpentinite. Several of the magnetic fractions contained in excess of 1% Ni.

The QEMScan mineralogical investigation indicates that nickel is present in the magnetic separate fraction as a minor element in Fe-oxides, and as high-Ni trevorite and Ni-sulphide. These results indicate that a relatively unique style of Fe-oxide/Ni mineralization occurs on the Chrome Puddy Property and that there is potential to produce a high-grade Fe concentrate with approximately 1% Ni by magnetic separation.

Further work on this mineralization type should include drilling and or surface trenching to obtain representative samples for larger scale determination of Fe-oxide/Ni mineralization grades and metallurgical characteristics.

Richard Sutcliffe
March 16, 2016

9.0 References

Graham, A.R., 1930, Obonga Lake Chromite Area, District of Thunder Bay, in the Thirty-Ninth Annual Report of the Ontario Department of Mines, Vol. XXXIX, Part II, pp. 51-60.

Hurst, M.E., 1931, Chromite Deposits of the Obonga Lake Area, District of Thunder Bay, in the Fortieth Annual Report of the Ontario Department of Mines, Vol. XL, Part IV, pp. 111-119.

Percival, J.A., and Stott, G.M. 2000, toward a revised stratigraphy and structural framework for the Obonga Lake greenstone belt, Ontario, Geological Survey of Canada, Current Research 2000-C22, 8 p.

Puumala, M., et al. 2013, Report of Activities 2012, Resident Geologists Program, Thunder Bay South District, Ontario Geological Survey P6285.

Simpson, P.R., and Chamberlain, J.A., 1967: Nickel Distribution in Serpentinites from Puddy Lake, Ontario; Geo. Assoc. Canada Proceedings, Vol. 18, p.67-91.

Sutcliffe, R.H., 2016, Assessment Report on 2015 Mapping, Prospecting and Davis Tube Magnetic Test Work Chrome-Puddy Property, for Pavey Ark Minerals Inc., January 2016.

Whittaker, P.J., 1986, Chromite Deposits in Ontario, Ontario Geological Survey, Study 55, 97p.

Wicks, F.J. and Whittaker, E.J.W., 1977, Serpentine Textures and Serpentinization, Canadian Mineralogist, Vol. 15, p.459-488.

10.0 Statement of Qualifications

I, Richard H. Sutcliffe, of 100 Broadleaf Crescent, Ancaster, Ontario, do hereby certify that:
I am a graduate of University of Toronto (B.Sc. Geology, 1977, M.Sc Geology 1980), and a graduate of University of Western Ontario (Ph.D. Geology, 1986) and I have been practising my profession as a geologist since.
I am a member with the Association of Professional Geoscientists of Ontario (#852).
I have direct knowledge of the exploration work performed for this assessment and I am indirectly the owner of the claims on which the work was performed.

Signed
"R.H. Sutcliffe"

Richard H. Sutcliffe, Ph.D., P.Geo.
March 16, 2016
Ancaster, Ontario

ONTARIO CANADA

MINISTRY OF NORTHERN DEVELOPMENT AND MINES

PROVINCIAL MINING RECORDER'S OFFICE

Mining Land Tenure Map

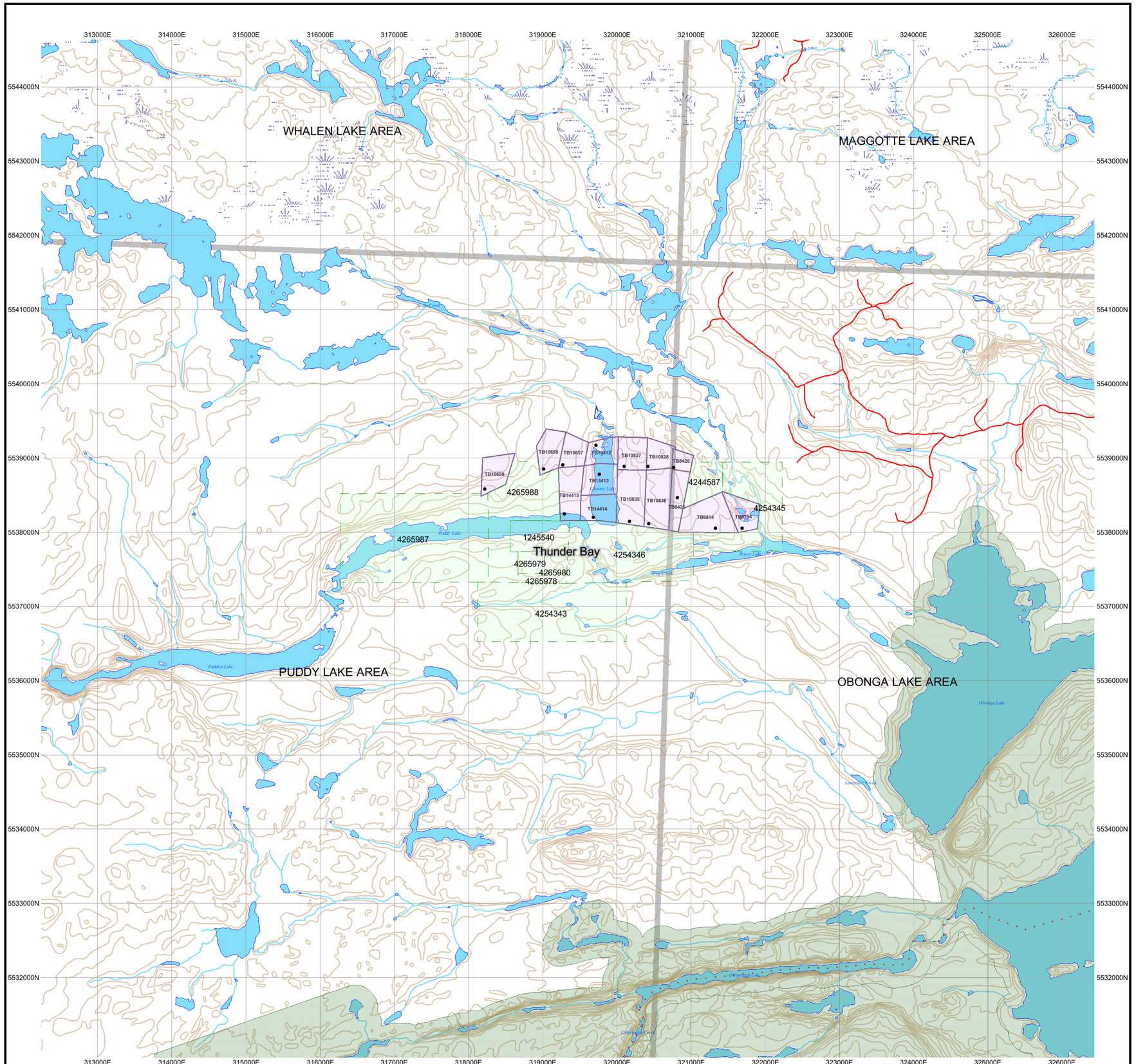
Date / Time of Issue: Tue Mar 15 21:51:20 EST 2016

TOWNSHIP / AREA **PLAN**

PUDDY LAKE AREA **G-0118**

ADMINISTRATIVE DISTRICTS / DIVISIONS

Mining Division	Thunder Bay
Land Titles/Registry Division	THUNDER BAY
Ministry of Natural Resources District	THUNDER BAY



TOPOGRAPHIC

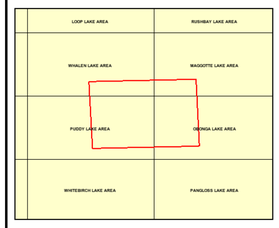
- Administrative Boundaries
- Township
- Concession, Lot
- Provincial Park
- Indian Reserve
- Cliff, Pit & Pile
- Contour
- Mine Shafts
- Mine Headframe
- Railway
- Road
- Trail
- Natural Gas Pipeline
- Utilities
- Tower

Land Tenure

Freehold Patent
- Surface And Mining Rights
- Surface Rights Only
- Mining Rights Only

Leasehold Patent
- Surface And Mining Rights
- Surface Rights Only
- Mining Rights Only

Licence of Occupation
- Uses Not Specified
- Surface And Mining Rights
- Surface Rights Only
- Mining Rights Only
- LUP: Land Use Permit
- OIC: Order In Council (Not open for staking)
- WPLA: Water Power Lease Agreement
- 1234567: Mining Claim
- 1234567: Filed Only Mining Claims



LAND TENURE WITHDRAWALS

1234 — Areas Withdrawn from Disposition

Mining Acts Withdrawal Types
- Wsm: Surface And Mining Rights Withdrawn
- Ws: Surface Rights Only Withdrawn
- Wm: Mining Rights Only Withdrawn

Order In Council Withdrawal Types
- W˚sm: Surface And Mining Rights Withdrawn
- W˚s: Surface Rights Only Withdrawn
- W˚m: Mining Rights Only Withdrawn

Ns — IMPORTANT NOTICES

Scale 1:20000

700m 0m 2.1km

LAND TENURE WITHDRAWAL DESCRIPTIONS

Identifier	Type	Date	Description
W-787	Ws	Jan 1, 2001	W-787 NCR SRO WITHDRAWN.
W-TB-45/95	Wsm	Jan 1, 1995	SURFACE AND MINING RIGHTS WITHDRAWN FROM STAKING ORDER NO. W-TB-45/95 NWR FOR PROPOSED WABAKIMI PARK EXPANSION (SEE WABAKIMI PARK LAND ROLL)

Those wishing to stake mining claims should consult with the Provincial Mining Recorders' Office of the Ministry of Northern Development and Mines for additional information on the status of the lands shown hereon. This map is not intended for navigational, survey, or land title determination purposes as the information shown on this map is compiled from various sources. Completeness and accuracy are not guaranteed. Additional information may also be obtained through the local Land Titles or Registry Office, or the Ministry of Natural Resources.

The information shown is derived from digital data available in the Provincial Mining Recorders' Office at the time of downloading from the Ministry of Northern Development and Mines web site.

General Information and Limitations

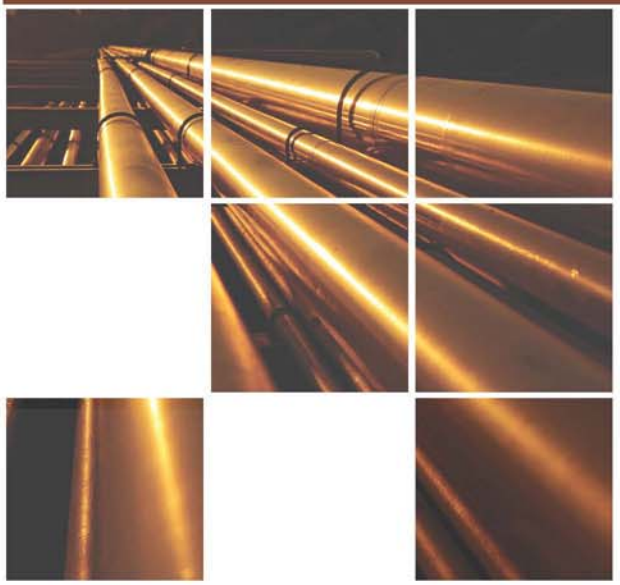
Contact Information:
Provincial Mining Recorders' Office
Willet Green Miller Center 933 Ramsey Lake Road
Sudbury ON P3E 6B5
Home Page: www.mndm.gov.on.ca/MNDM/MINES/LANDS/mlsmrpge.htm

Toll Free
Tel: 1 (888) 415-9845 ext 5742
Fax: 1 (877) 670-1444

Map Datum: NAD 83
Projection: UTM (6 degree)
Topographic Data Source: Land Information Ontario
Mining Land Tenure Source: Provincial Mining Recorder's Office

This map may not show unregistered land tenure and interests in land including certain patents, leases, easements, right of ways, flooding rights, licenses, or other forms of disposition of rights and interest from the Crown. Also certain land tenure and land uses that restrict or prohibit free entry to stake mining claims may not be illustrated.

QEMSCAN Mineralogy Investigation of Two Mining Samples (As Received)



Company: Pavey Ark Minerals

Work Order: A17926

Date: March, 2016

Peter Hu (Petrologist/Geologist, P.Geo.)
phu@agatlabs.com

AGAT Laboratories
3801 – 21st Street N.E.
Calgary, Alberta T2E 6T5

AGAT Laboratories

Service Beyond Analysis

TABLE OF CONTENTS

Executive Summary

Two mining samples identified as 15T41322-7187477 (CP 101) and 15T41322-7187482 (CP 109) from Pavey Ark Minerals were received by AGAT Laboratories, to be analyzed for mineralogy and elemental composition using a combination of method. QEMSCAN technique was used to decipher mineral composition and nickel deportation of the samples. In addition, SEM-EDX was introduced to verify nickel occurrence. The following is the findings on mineralogy and nickel deportation that were reached through the QEMSCAN investigation and SEM-EDX analysis of the two samples:

- 15T41322-7187477 (CP 101) and 15T41322-7187482 (CP 109) have similar mineralogy dominated by FeOx/Hydrox combination of magnetite-limonite-goethite (93.65% and 93.95%, respectively), with minor amounts of Ni-minerals (4.46% and 4.50%), plus trace amounts of carbonates (1.12% and 0.65%), silicates (0.49% and 0.54%) and pyrite (0.29% and 0.32%). Ni-minerals are dominated by Fe-oxides with low Mg&Si (also with low-Ni). Minor portions of high-Ni trevorite and Ni-Sulphides are also present in both samples.

- Liberation-Association analysis demonstrates that the samples are almost identical.

- Nickel deportment analysis reveals that Ni concentrates in low-Ni Fe-Ox/hydro (magnetite-limonite-goethite). Sample CP 101 contains 0.43% Ni, while the Ni abundance of CP 109 is 0.50%. Differentiate Ni contents between two samples may result from different mineral composition. Ni abundance detected by QEMSCAN is lower than that of chemical analysis (1.12% and 0.75%, respectively), suggesting that portion of Ni-minerals might not be acquired by QEM Scanning due to the extremely fine nature of analyzed particles (<3µm).

- SEM-EDX elemental analysis of relatively abundant suspected Ni-mineral and Fe-Ox (limonite-goethite) phases, shows significant detectable and variable % Ni between phases and between samples. EDX spectra show a significant difference in Ni% occurrence in the suspected phases especially the Fe-Ox/Hydrox., trevoite and Ni-Sulphides.

Introduction

Two (2) pulverized samples were received by AGAT Laboratories Advanced Mineral Investigation Services (QEMSCAN Division), from Pavey Ark Minerals. The two samples were to be analyzed by QEMSCAN and SEM-EDX for mineralogy, with a focus on possible nickel-bearing minerals. The sample information is summarized in the following Table A.

Table A: Sample Information of Two Mining Samples

Lab #	Sample ID	Type of Analysis
A17926-01	15T41322-7187477 (CP 101)	QEMSCAN, SEM-EDX
A17926-02	15T41322-7187482 (CP 109)	QEMSCAN, SEM-EDX

Testing and Analysis Summary

The multi-pronged method to investigate nickel in pulverized samples received in February 2016 is comprised of: (1) QEMSCAN Modal Mineralogy investigation to determine and contrast the mineral species and groupings in the crushed mining samples, targeting suspected mineral groups or species containing Ni; (2) Scanning Electron Microscopy-Energy Dispersive Spectrometry (SEM-EDS) investigation of QEMSCAN delineated mineral and confirmation of Ni content.

1. Sample Preparation & Analysis Method

Two (2) mining samples (4g and 5g in mass, respectively) received in plastic bags from Pavey Ark Minerals were dried at low temperature (30-50ºC) and gently de-agglomerated. Then the homogenized samples were split down to approximately 1.0 gram sub-samples, for QEMSCAN-SEM-EDS polished sections preparation.

QEMSCAN and SEM-EDS Polished Section Preparation:

For QEMSCAN and SEM-EDX, the 1.0 gram sub-samples were dried, de-agglomerated and mixed with graphite at a ratio (1 **:** 2; i.e. 1.0 g sample **:** 2.0 g graphite). The graphite is used for QC purposes to de-aggregate any particle agglomerations, homogenize the sample, and to provide a useful conductive material for electron microscopy. The mixture of particles and graphite were added to epoxy in molds to make polished sections. Polished sections were ground, polished, and carbon-coated for subsequent QEMSCAN and SEM-EDS analyses.

2. QEMSCAN Analysis

The graphite-impregnated polished epoxy grain mounts were analyzed using the QEMSCAN Particle Mineral Analysis (PMA).QEMSCAN Particle Mineralogical Analysis (PMA) mode at 3.0µm and 2.5µm point spacing (depending on fractionized sizes) was used to analyze a minimum of 40,000 particles in each sample (**Table 1** in Appendix) and modal mineralogy (& other information) was produced, from a species identification protocol (S.I.P.) library, which is based on a combination of Energy Dispersive Spectrometric (EDS) and Backscatter Energy (B.S.E.) qualities of the sample; QEMSCAN analysis is a definitive quantitative method. QEMSCAN instrument calibration to ensure accuracy is performed, including B.S.E. calibration of stage standards of quartz, copper, and gold.

The PMA is a particle mapping measurement which gives a complete analysis of mineralogy of the sample. It allows for a robust determination of the bulk mineralogy, with mineral identities, and normalized proportions. Where desired, the PMA can provide an analysis of the spatial characteristics of minerals, such as deportment (i.e. which minerals carry which elements), association characteristics, and grain size information. Taking into account the fine nature of crushed mining samples, fraction sizes were introduced during QEM scanning, which are +75, -75/+25, and -25/0 for each sample. The weight percentage of each fraction was calculated after scanning (**Table 2** in Appendix).

The QEMSCAN portion of this report focuses on the modal mineralogy, mineral association, the mineralogical variations between samples, and the determination of the Ni-bearing or related minerals. A client mineral short list with simplified mineral categories or groups was extracted from a larger raw “primary” list of minerals.

QEMSCAN calculates modal mineralogy to a trace level (0.05% -1.00%), or minor (1.00% – 30.0%), and major (>30.0%). Based on repeat analysis of select QC lab-made samples, pseudo-detection limits were calculated, and generally, any mineral abundance below 0.05% is insignificant.

2.1. Modal Mineralogy

The mining samples in this report contain mineral phases from a short-list that is result of data interpretation and condensation of significantly occurring minerals from the original S.I.P. file.

Table B is the client specific mineral list that was developed with QEMSCAN data processing software (iExplorer) including the chemical formulas of the minerals; these minerals occurred in the two samples. Based on repeat analysis for select samples, pseudo-detection limits were calculated, and generally, any mineral abundance below 0.05% is insignificant. The mineral distributions from the QEMSCAN analysis are tabulated in **Table C**.

Sample 1: 15T41322-7187477 (CP 101)

The sample 1 is comprised mainly of iron oxides (93.65%), with minor Ni-bearing minerals (4.46%) and carbonates (1.12%). In addition, trace amounts of silicates (0.49%) and pyrite (0.29%) are also present. Iron oxides consist of limonite (37.91%), magnetite (30.25%) and goethite (24.71%), plus trace hematite (0.18%). Ni-bearing minerals are dominated by Fe-oxides with low Magnesium and Silicon (also with low, variable Ni). Low-Ni serpentine (Fe-Mg-Silicate) and high-Ni trevorite, Ni-Sulphides and Ni-magnetite were also detected. Silicates are composed mainly of pyroxene (augite).

Sample 2: 15T41322-7187482 (CP 109)

The sample 2 is dominated by iron oxides (93.95%), with minor Ni-bearing minerals (4.50%). Additionally, trace amounts of carbonates (0.69%). silicates (0.58%) and pyrite (0.32%) are also present. Iron oxides consist primarily of magnetite (47.50%), with lesser amounts of limonite (25.51%) and goethite (19.66%), plus trace hematite (0.42%). Ni-bearing minerals comprise mainly of Fe-oxides with low Magnesium and Silicon (also with low, variable Ni). Low-Ni serpentine (Fe-Mg-Silicate) and high-Ni trevorite and Ni-Sulphides were also detected. Silicates are composed mainly of pyroxene (augite).

Table B List of Mineral Phases Used in QEMSCAN for Two Mining Samples

Mineral	Composition or QEMSCAN Elemental Ratio	% Ni Content (SEM-EDX)
Pyrite	Pyrite-FeS2 and other Sulfides	0
Silicates	Pyroxene (Augite)-$(Ca,Mg,Fe)_2(Si, Al)_2O_6$, Serpentine-$Mg_3Si_2O_5(OH)_4$, Olivine-$(Mg,Fe)_2SiO_4$, Quartz-$SiO_2$ and Muscovite-$KAl_2(AlSi_3O_{10})(OH)_2$	0
Carbonates	Calcite-$CaCO_3$	0
Oxides	Magnetite-Fe_3O_4, Goethite/Limonite-$FeO.OH.nH_2O$, and Hematite-Fe_2O_3	2-4%
Ni-Minerals	Fe-oxide with low Mg&Si, Fe-oxide with low Ni 2-6%, sometimes up to 15 to 25%Ni, probably a Ni-goethite. Rare trevorite with Ni>10%, or Ni-magnetite were also found. The highest Ni abundance is present in Ni-sulfides (up to Ni 33%)	2% to 33%

Table C: QEMSCAN Modal Mineralogy and Sizes of Two Mining Samples

Mineral	Mineral Mass (%)		Calculated ESD Size (µm)	
	Sample 1	Sample 2	Sample 1	Sample 2
Pyrite	0.29	0.32	3.74	3.83
Silicates	0.49	0.54	4.13	3.95
Carbonates	1.12	0.69	3.48	3.53
Oxides	93.65	93.95	8.66	9.32
Ni-Minerals	4.46	4.50	3.52	3.77

Two mining samples contain very similar mineral composition, consisting mainly of oxides, with minor amounts of nickel-bearing Fe-oxides, plus trace amounts of carbonates, silicates and pyrite. QEMSCAN analysis illustrates that the calculated ESD (Estimated Spherical Diameter) sizes of the pulverized samples are also very close for each mineral. Mineral sizes in sample 2 are slightly larger than those in sample 1. All ESD are below than 10µm, and Ni-bearing minerals are no more than 4µm in average sizes.

2.2. Mineral Association

In QEMSCAN, pixel adjacency defines association which is calculated based on the % area of pixels for paired minerals. Mineral Association illustrates what QEMSCAN's iDiscover SW calculates as average mineral association of both two (2) samples of this investigation. Each mineral is associated with the background since the particles of mining samples were suspended in a background of epoxy; otherwise the balance of the association percentages (or transitions) is the actual degree of association of each minerals with other minerals.

The following **Figures (1 & 2)** feature the mineral association for samples 1 and 2. Based on association graphs these two samples show very similar mineral association. Minerals containing nickel are mainly Fe oxides for both samples.

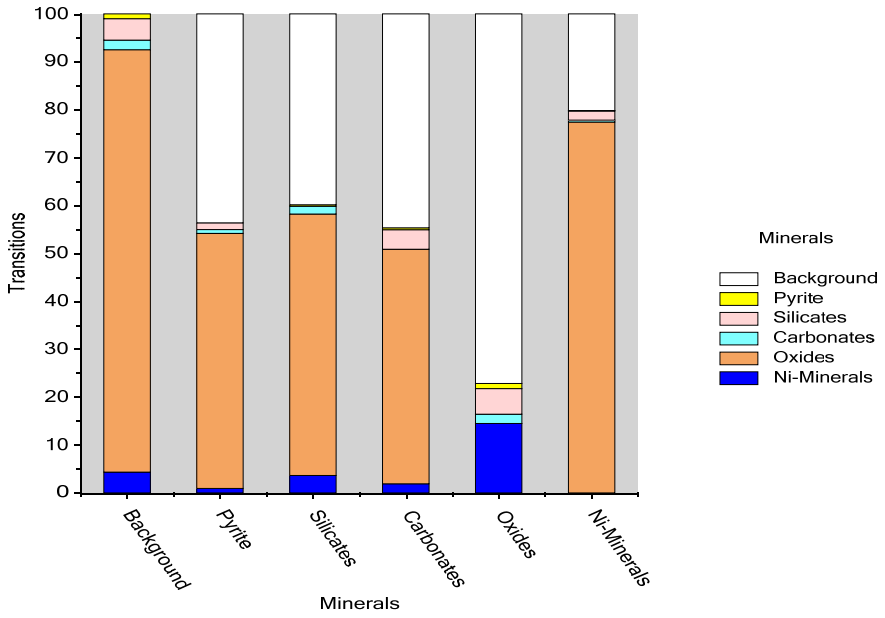


Figure 1: Mineral Association in Sample 1

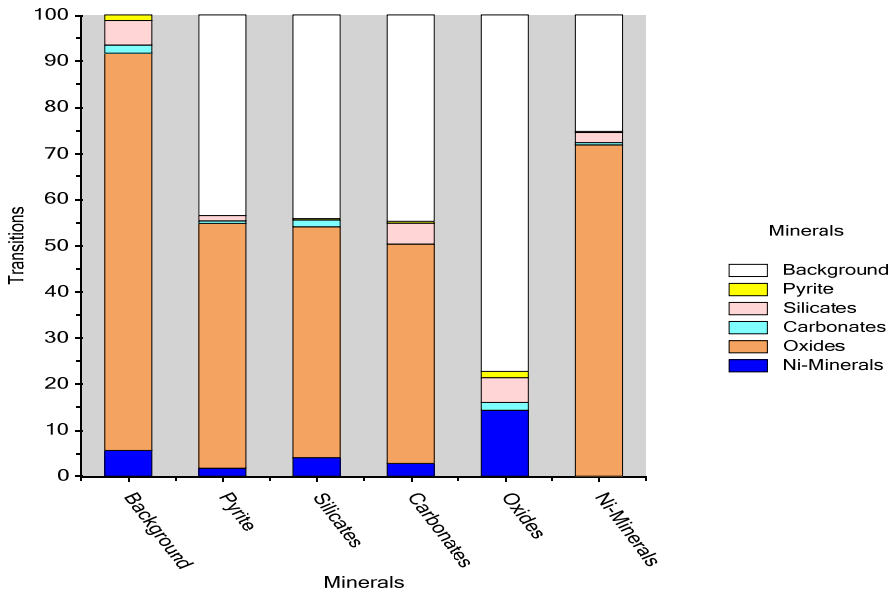


Figure 2: Mineral Association in Sample 2

2.3. Nickel Deportment

Elemental deportment identifies the minerals that carry a particular element of focus. For the purpose of this project we are offering nickel deportment. The following **Figures 3 & 4** illustrate the deportment data of nickel (Ni) between the two samples. Ni deportment in sample 1 is dominated by Ni-minerals. Sample 2 shows the same trend in Ni deportment, which is also characterized by Ni-minerals. Detected total nickel percentages are 0.43% and 0.50% for the two samples, respectively. Mass % in fraction data clearly reflects a very similarity of nickel deportment between sample 1 and sample 2. More than 80% Ni occurs in extremely fine Ni-minerals (<25µm) for both samples, indicating Ni abundance is strongly associated with particle size. Around 10% nickel is distributed in oxides (limonite and goethite) for both samples.

It should be noted that chemical analysis reveals a higher Ni abundance, containing 1.21% and 0.75% respectively in two samples. One plausible reason of this Ni abundance difference between QEMSCAN and chemical analysis is that part of tiny Ni-minerals were not acquired during QEMSCAN scanning since these “lost” Ni-minerals are likely less than 3 µm or 2.5µm in size, which are below the spacing sizes of the QEMSCAN scanning (Table 1 in Appendix). Sample 1 lost more Ni abundance than sample 2 is probably due to the fine particle size occurring in sample 1 is smaller than that of sample 2. Another factor regarding the differentiated Ni content is might related to the number of scanning fields. Only around 5% (12/221 and 14/221 respectively) area of polished sections were scanned for the smallest fraction size of “-25/0µm” (Table 1 in Appendix).

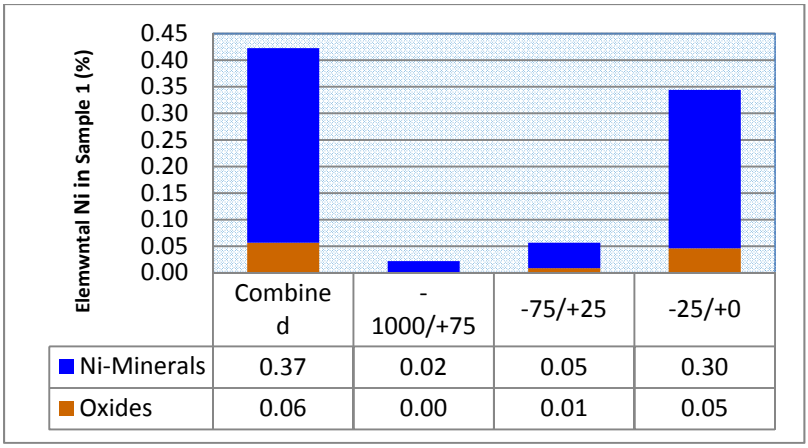


Figure 3: Nickel (Ni) Deportment in Mass% and Mass % in Fraction in Sample 1

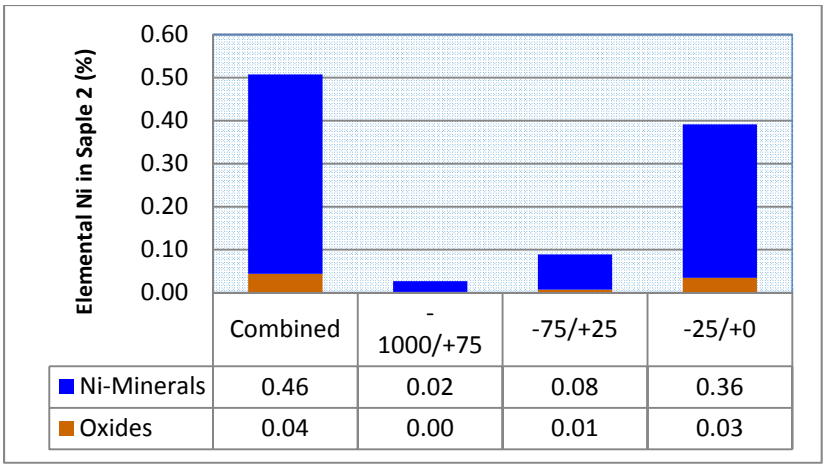


Figure 4: Nickel (Ni) Deportment in Mass% and Mass % in Fraction in Sample 2

3. Scanning Electron Microscopy-Energy Dispersive X-ray Spectrometry (SEM-EDX)

SEM-EDS analysis was performed on individual target grains or agglomerations of minerals, using a Quanta 650 SEM equipped with Two (2) Bruker® Energy Dispersive Spectrometers. X-Ray acquisition was performed using 15.0 kV of beam energy at a rate of 400 kcps and an electron energy range of 10-20 keV. The SEM-EDS aspect of the methodology was aimed to investigate the deportment of Ni in several mineral phases The suspected phases scanned for % elemental composition included:

1. **Ni-Other**: which includes iron oxides with low Mg&Si (also with relative low variable Ni [2-3%]),
2. **Ni-Other-BSE-Spec**: which includes iron oxides with low variable Ni [3-4%],
3. **Trevorite_S**: which includes trevorite with low Mg&Cr and abundant Ni [>10%],

4. **Ni-Sulphides**: which are associated with Fe-sulfides and magnetite, containing high Ni [>30%],
5. **Ni-Other-NiG10**: which includes iron oxides with low Mg&Cr (also with relative high Ni [>9%]).

Figures 8 to 12 exhibit Ni-bearing grains encountered in the samples. Several target spot EDX reading were taken to achieve median or average Ni% values associated with those phases (**Table D**). EDX analysis demonstrates that considerable Ni concentrate in Ni-Fe Oxide and Ni-Sulphides, minor amounts of Ni occurs in low-Ni serpentine and mixed silicates. The SEM-EDX is able to detect elements at as low as 0.01% occurrence at a target spot.

Table D. EDX analysis of Average Ni% Occurring in various Ni-minerals of Samples

Sample	Ni-Other (Fe-oxides with low Mg&Si)	Ni-Other-BSE-Spec (Fe-oxides)	Trevoite	Ni-Sulphides	Ni-Other-NiG10 (Fe-oxides wit low Mg&Cr)
1	3.05	3.78	-	-	-
2	-	-	10.95	33.71	9.41

Conclusions and Recommendations

The QEMSCAN investigation of the mining sample mineralogy was performed in conjunction with SEM-EDX to verify mineral and nickel composition. In fact, this method of cross-referencing QEMSCAN is the recommended methodology for accurately and precisely analyzing mining samples for mineralogy. The following set of observations and conclusions were reached through the QEMSCAN and SEM-EDX investigation of the Pavey Ark Minerals mining samples. Please refer to the QEMSCAN Excel report for tabulated data, results, and images.

- Both samples have very similar mineralogy and grain size distribution with: major oxides (93.65% and 93.95%, respectively), minor amounts of Ni-minerals (4.46% and 4.50%), plus trace volumes of carbonates (1.12% and 0.65%), silicates (0.49% and 0.54%), and pyrite (0.29% and 0.32%). Oxides are dominated by magnetite, limonite and goethite, plus trace hematite. Ni-minerals consist mainly of low-Ni iron oxides with low magnesium and silicon, plus minor portion of high-Ni trevoite and Ni-magnetite and Ni-Sulphides.

- Liberation-Association analysis demonstrates that the samples are almost identical.

- Nickel deportment analysis reveals that Ni concentrates in low-Ni Fe-oxide, and Fe-Ox/hydro (limonite-goethite). Sample 1 contains 0.43% Ni, while the Ni abundance of the sample 2 is slightly higher up to 0.50%. Differentiate Ni contents between two samples may result from different mineral composition. Compared with chemical analysis (1.21% and 0.75% of Ni, respectively), Ni% in QEMSCAN data is relative lower. Differentiated Ni abundance between QEM and chemical analysis might be derived from the nature of Ni-bearing minerals: considerable Ni-minerals might be too extremely fine (<3μm) to be acquired during the QEM scanning.

- SEM-EDX elemental analysis of relatively abundant suspected Ni-bearing mineral and Fe-Ox (limonite-goethite) phases, shows significant detectable and variable % Ni between phases and between samples. SEM-EDS spectra show a significant difference in Ni% occurrence in the suspected phases especially the Fe-Ox/Hydrox., trevoite and Ni-Sulphides.

QEMSCAN solely gives reasonable mineralogy data and includes many trace and accessory minerals. The method of cross-referencing QEMSCAN with other methods (XRD, XRF) is the recommended methodology for accurately and precisely analyzing mining samples for mineralogy.

Please call at your convenience should you have any questions regarding the above.

QEMSCAN Sample Prepared by: Rhodnell Alphonsus Batuhan

QEMSCAN Analysis and Report Prepared By: _____

Peter Hu (P.Geo.)

PERMIT TO PRACTICE
AGAT LABORATORIES LTD.
Signature Philip D Haig
Date March 11, 2016
PERMIT NUMBER: P 3989
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Reviewed By: _____

Phil Haig (P.Geol., Manager)

Note: unless otherwise requested, all parts and test samples

Shall be disposed of sixty (60) days from the date of the report

APPENDIX

QEMSCAN Additional Data and BSE Images

Table 1. Operational Statistics of QEMSCAN Analysis

Sample	Fraction (µm)	Total Scanned Fields:	Spacing (µm):	Total Finally Accepted Particles	Intercept Number:	Intercept Length (µm):	Total Acquired X-rays Points:
1	**-1000/+75**	221	2.93	4248	117,585	3,708,372	1,368,184
	-75/+25	105	2.93	15133	153,625	2,892,159	1,065,132
	-25/+0	12	2.20	20767	48,136	248,039	118,019
	Total	338		40,148	319,346	6,848,570	2,551,335
2	**-1000/+75**	221	2.93	4907	125,972	4,267,961	1,567,598
	-75/+25	108	2.93	15066	161,997	3,184,802	1,164,076
	-25/+0	14	2.20	21445	49,773	263,221	124,377
	Total	343		41,418	337,742	7,715,984	2,856,051

Table 2. Calculated Weight Percentage of Fractions

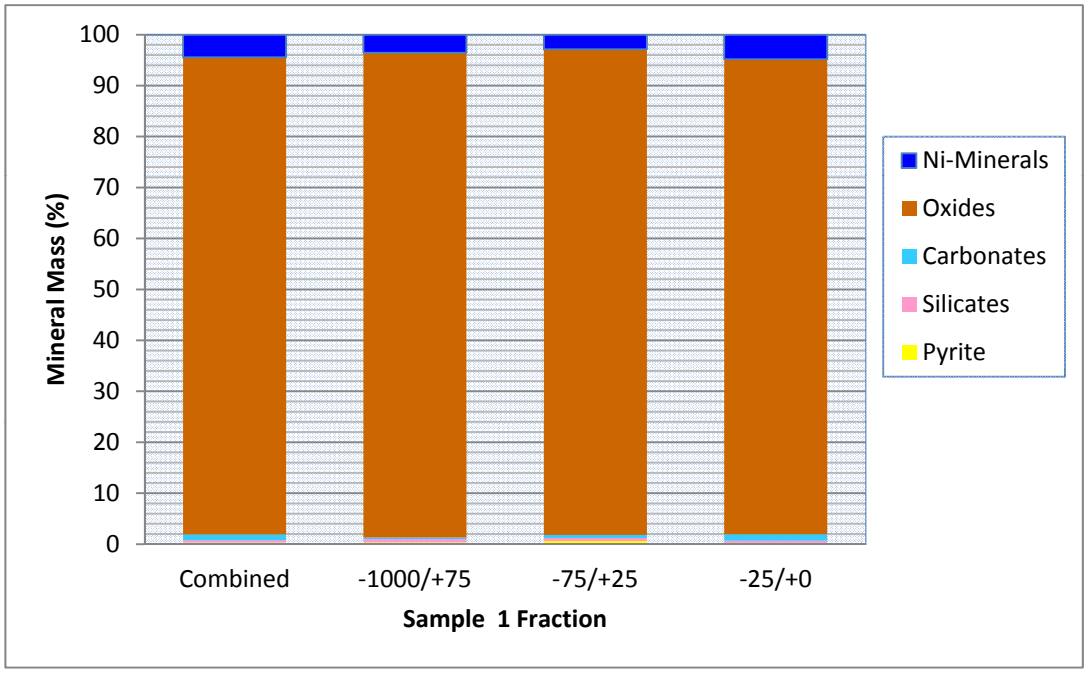
Sample	Fraction (µm)	Weight %
1	**-1000/+75**	4.5
	-75/+25	15.6
	-25/+0	79.9
	Total	100
2	**-1000/+75**	5.7
	-75/+25	18.8
	-25/+0	75.5
	Total	100

Table 3. Bulk Mineral Analyses Based on Basic Mineral Groups

Sample	Id	1							2						
Fraction	**Name**	**Combined**	**-1000/+75**		**-75/+25**		**-25/+0**		**Combined**	**-1000/+75**		**-75/+25**		**-25/+0**	
	Mass Size Dist. (%)	100.0	4.5		15.6		79.9		100.0	5.7		18.8		75.5	
	Particle Size	8.98	48.98		8.24		7.74		9.96	50.74		29.47		7.94	
		Combined	**+75**		**-75/+25**		**-25**		**Combined**	**+75**		**-75/+25**		**-25**	
		Sample	**Sample**	**Fraction**	**Sample**	**Fraction**	**Sample**	**Fraction**	**Sample**	**Sample**	**Fraction**	**Sample**	**Fraction**	**Sample**	**Fraction**
Mineral Mass (%)	Pyrite	0.29	0.01	0.32	0.09	0.61	0.18	0.22	0.32	0.03	0.48	0.09	0.48	0.20	0.27
	Silicates	0.49	0.03	0.66	0.09	0.59	0.36	0.46	0.54	0.03	0.58	0.10	0.51	0.41	0.54
	Carbonates	1.12	0.01	0.31	0.09	0.60	1.01	1.27	0.69	0.02	0.29	0.07	0.40	0.60	0.80
	Oxides	93.65	4.28	95.15	14.87	95.33	74.50	93.24	93.95	5.43	95.25	17.88	95.12	70.63	93.55
	Ni-Minerals	4.46	0.16	3.56	0.45	2.88	3.85	4.82	4.50	0.19	3.40	0.65	3.48	3.65	4.83

Table 3A. Bulk Mineral Analyses Based on Detailed Minerals

Sample	Id	1							2						
Fraction	**Name**	**Combined**	**-1000/+75**		**-75/+25**		**-25/+0**		**Combined**	**-1000/+75**		**-75/+25**		**-25/+0**	
	Mass Size Dist. (%)	100.0	4.5		15.6		79.9		100.0	5.7		18.8		75.5	
	Particle Size	8.98	48.98		8.24		7.74		9.96	50.74		29.47		7.94	
		Combined	**+75**		**-75/+25**		**-25**		**Combined**	**+75**		**-75/+25**		**-25**	
		Sample	**Sample**	**Fraction**	**Sample**	**Fraction**	**Sample**	**Fraction**	**Sample**	**Sample**	**Fraction**	**Sample**	**Fraction**	**Sample**	**Fraction**
Mineral Mass (%)	Pyrite	0.29	0.01	0.32	0.09	0.61	0.18	0.22	0.32	0.03	0.48	0.09	0.48	0.20	0.27
	Fe.Ni-sulphide trap	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.01	0.00	0.00
	Silicates	0.43	0.02	0.48	0.07	0.48	0.33	0.41	0.47	0.03	0.45	0.08	0.43	0.37	0.49
	Serpentine	0.06	0.01	0.17	0.02	0.11	0.03	0.04	0.06	0.01	0.13	0.02	0.08	0.04	0.05
	Carbonates	1.12	0.01	0.31	0.09	0.60	1.01	1.27	0.69	0.02	0.29	0.07	0.40	0.60	0.80
	Hematite	0.18	0.05	1.08	0.08	0.53	0.05	0.07	0.42	0.09	1.64	0.21	1.14	0.11	0.14
	Goethite	24.71	1.04	23.17	5.41	34.66	18.26	22.86	19.66	1.23	21.53	3.99	21.24	14.44	19.13
	Limonite	37.91	0.63	13.99	4.47	28.64	32.81	41.07	25.51	0.82	14.32	3.09	16.44	21.60	28.62
	Magnetite	30.25	2.56	56.87	4.91	31.45	22.79	28.52	47.50	3.27	57.39	10.50	55.87	33.73	44.67
	Ni-Other	3.03	0.04	0.78	0.20	1.27	2.80	3.50	2.26	0.05	0.91	0.19	1.02	2.01	2.67
	Ni-Other BSE Spec	1.41	0.12	2.77	0.25	1.59	1.04	1.30	1.71	0.12	2.08	0.38	2.04	1.21	1.60
	Trevorite_S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.01	0.12	0.03	0.15	0.16	0.21
	Ni-Goethite	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.07	0.01	0.08	0.07	0.10
	Ni-Sulphides	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.06	0.01	0.05	0.01	0.02
	Fe(Ni)_Sulphate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Ni-Other_NiG10	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.21	0.01	0.14	0.03	0.14	0.17	0.23
	Others	0.59	0.00	0.04	0.01	0.05	0.58	0.72	0.85	0.02	0.37	0.08	0.44	0.75	0.99



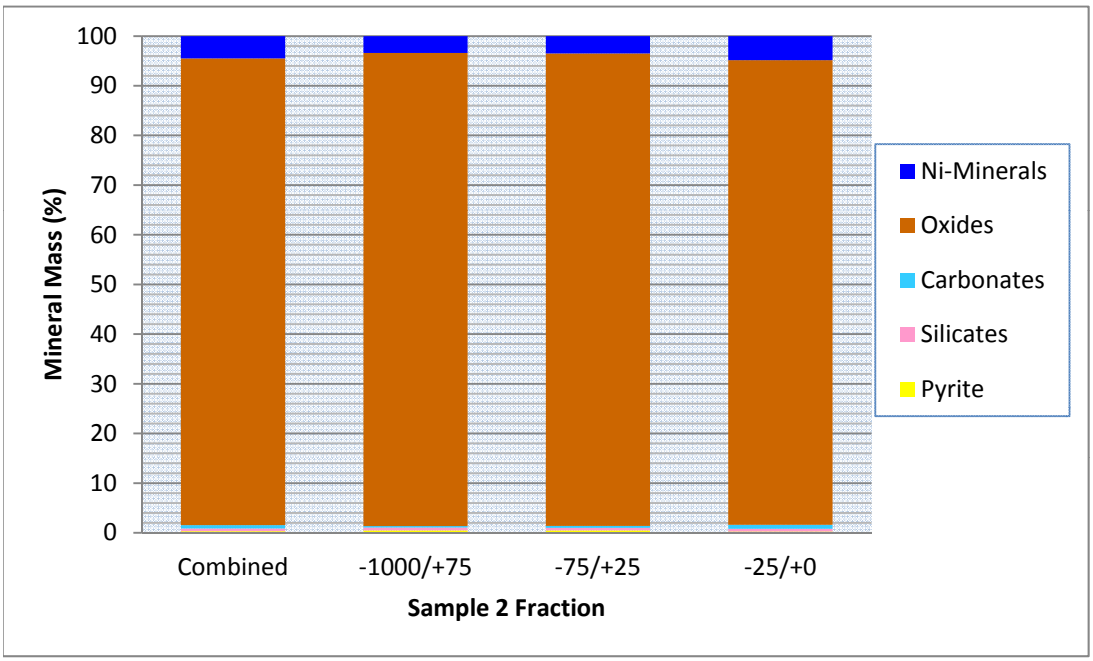


Figure 5. Bulk mineral composition of two samples.

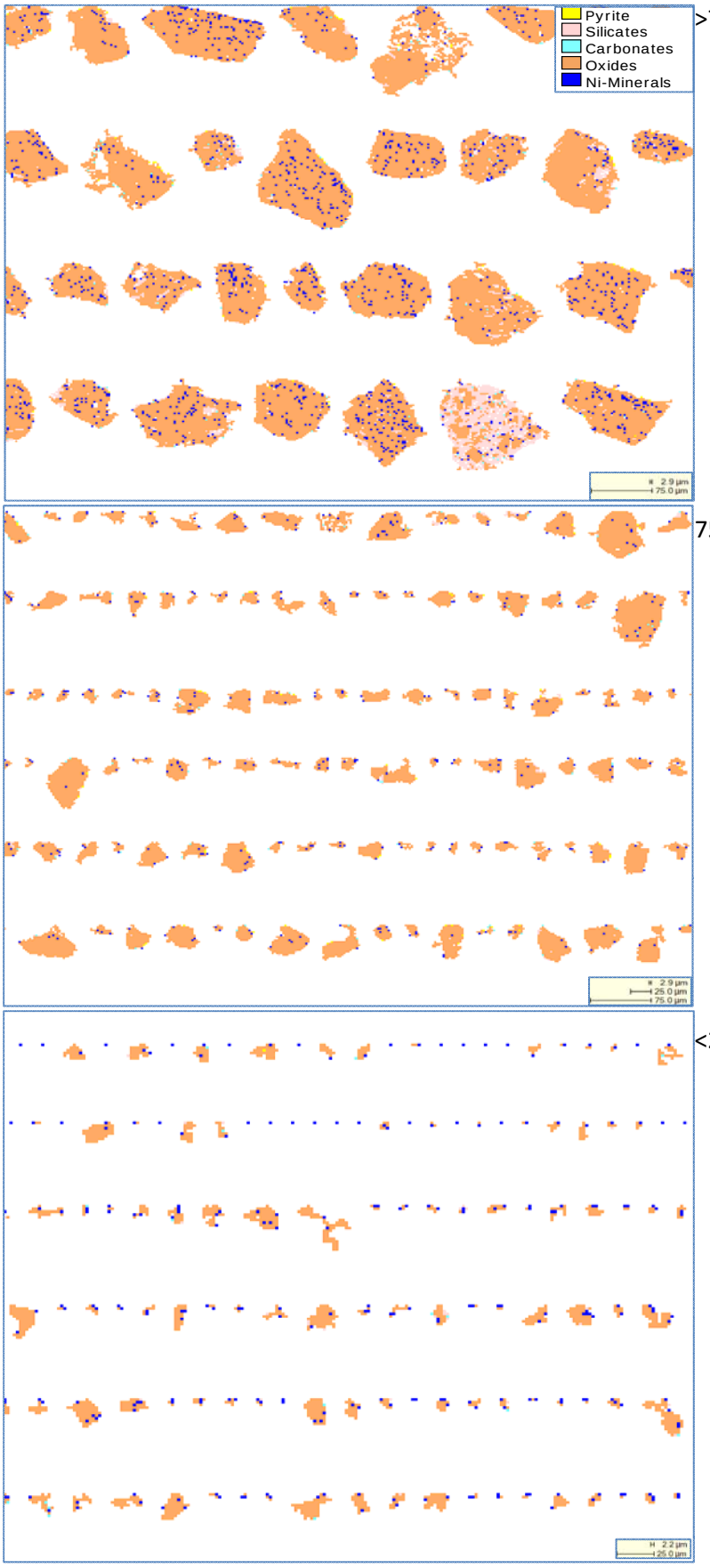


Figure 6. Prticle views of sample 1

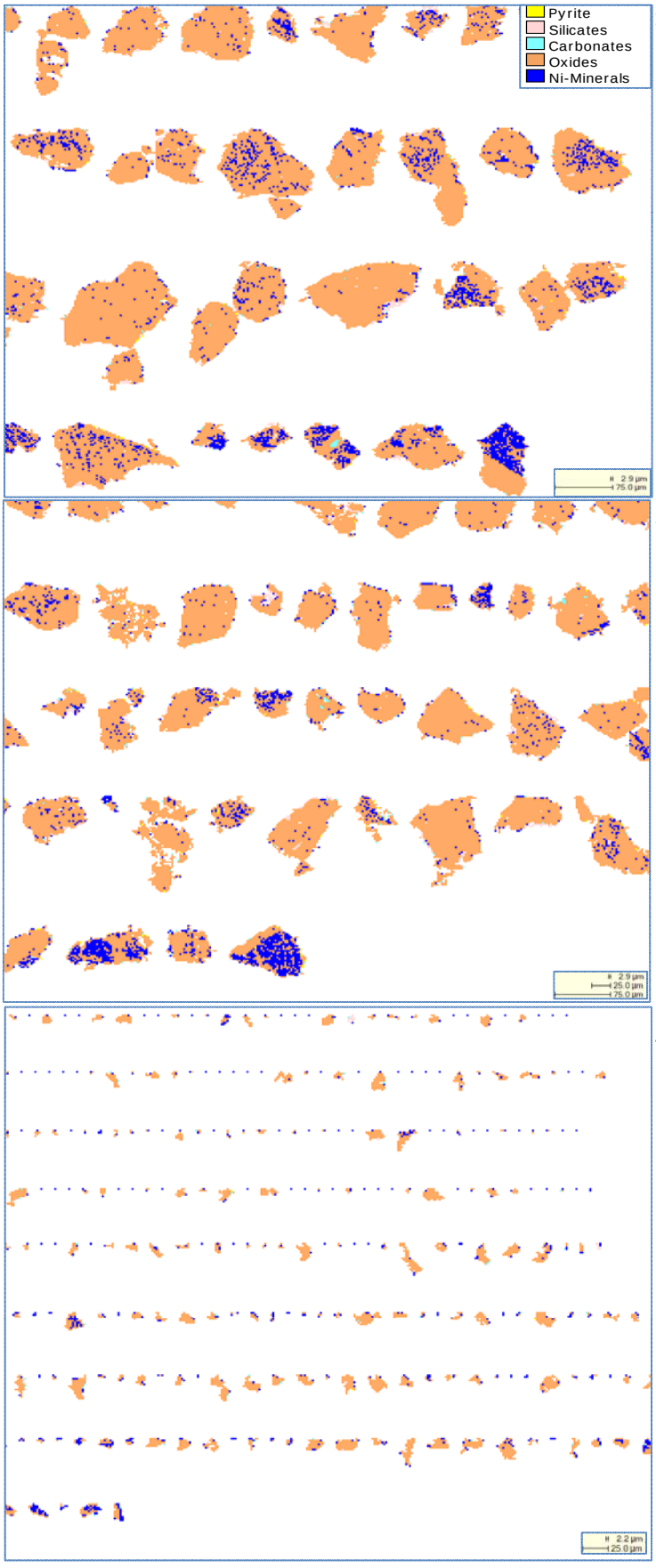
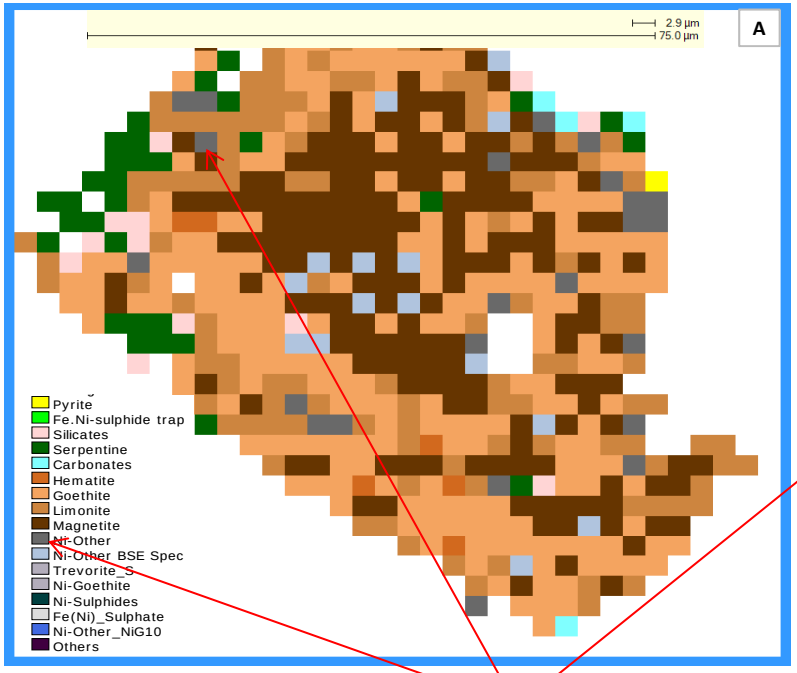
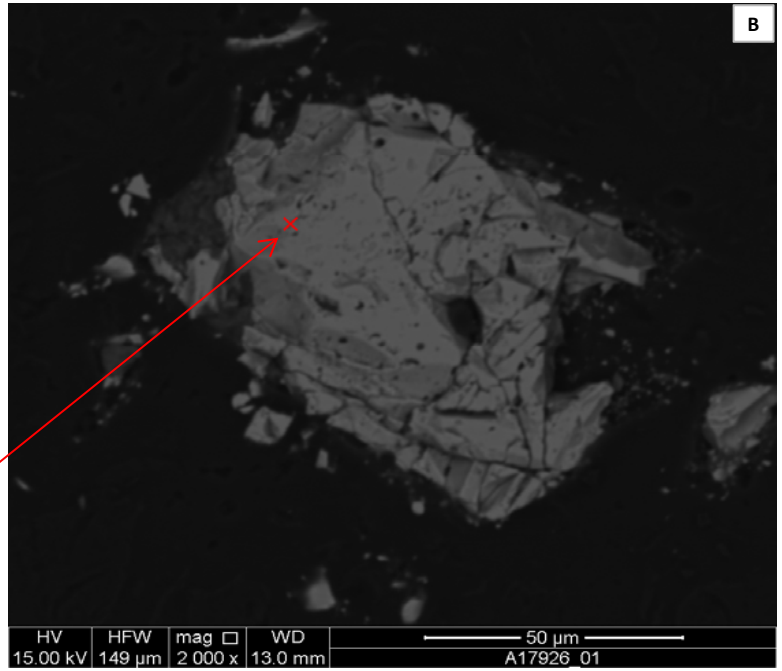
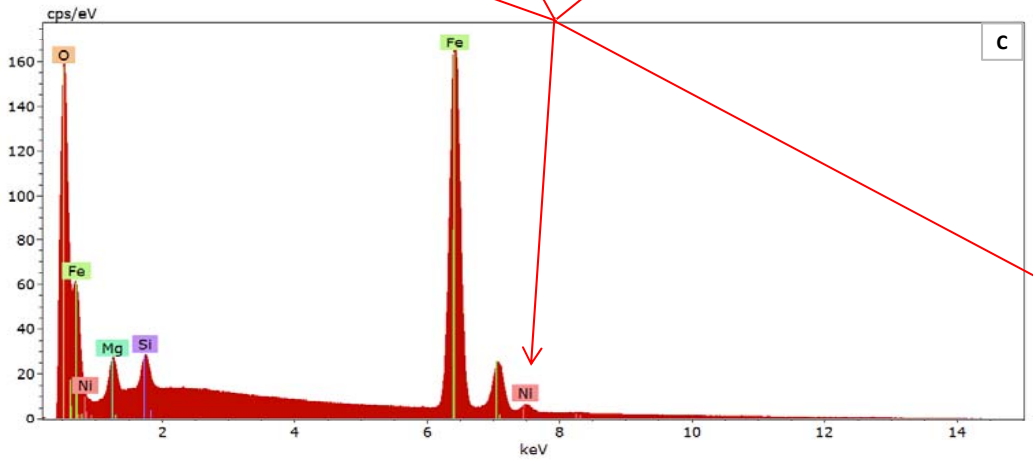


Figure 7. Prticle views of sample 2

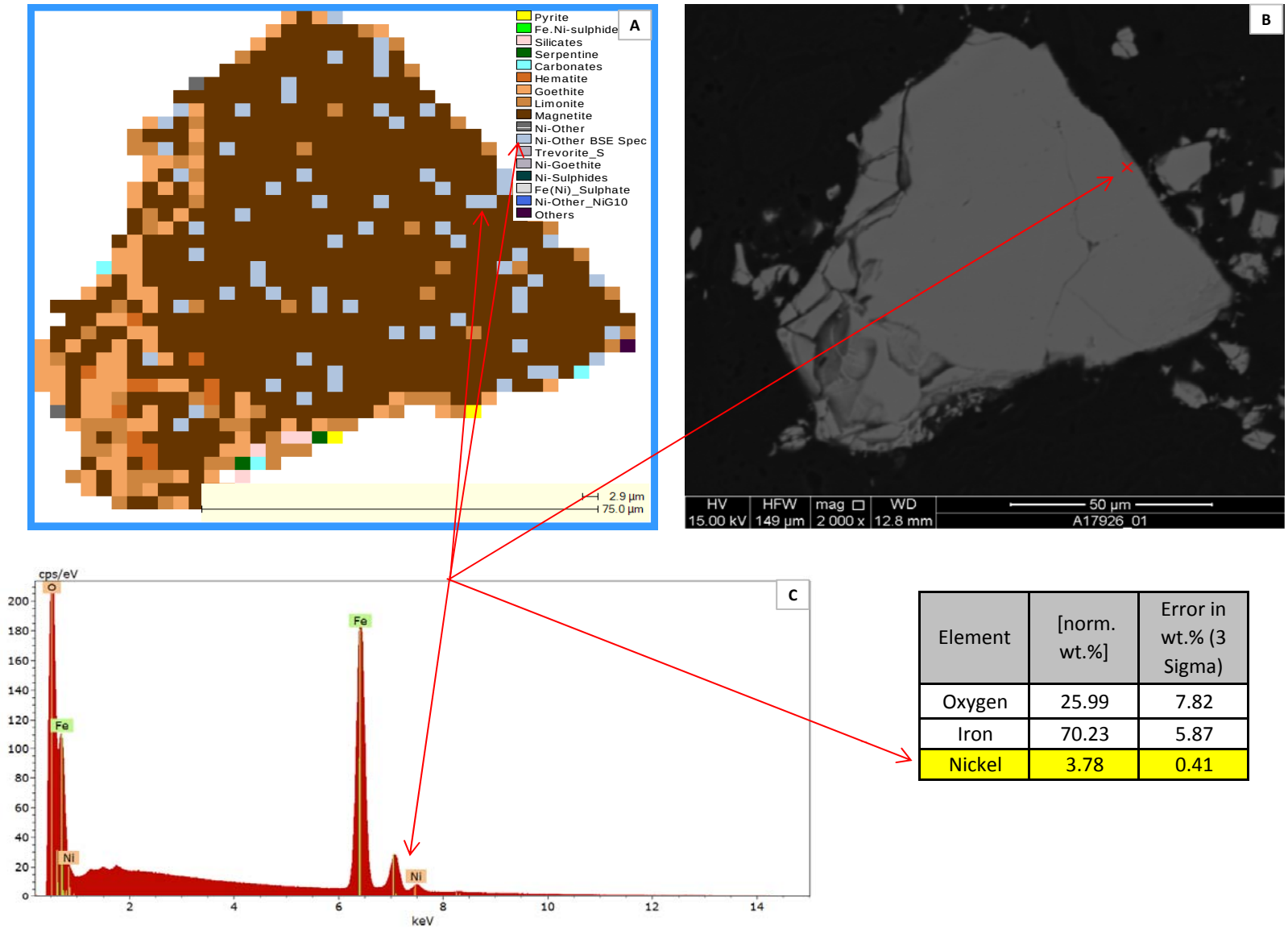






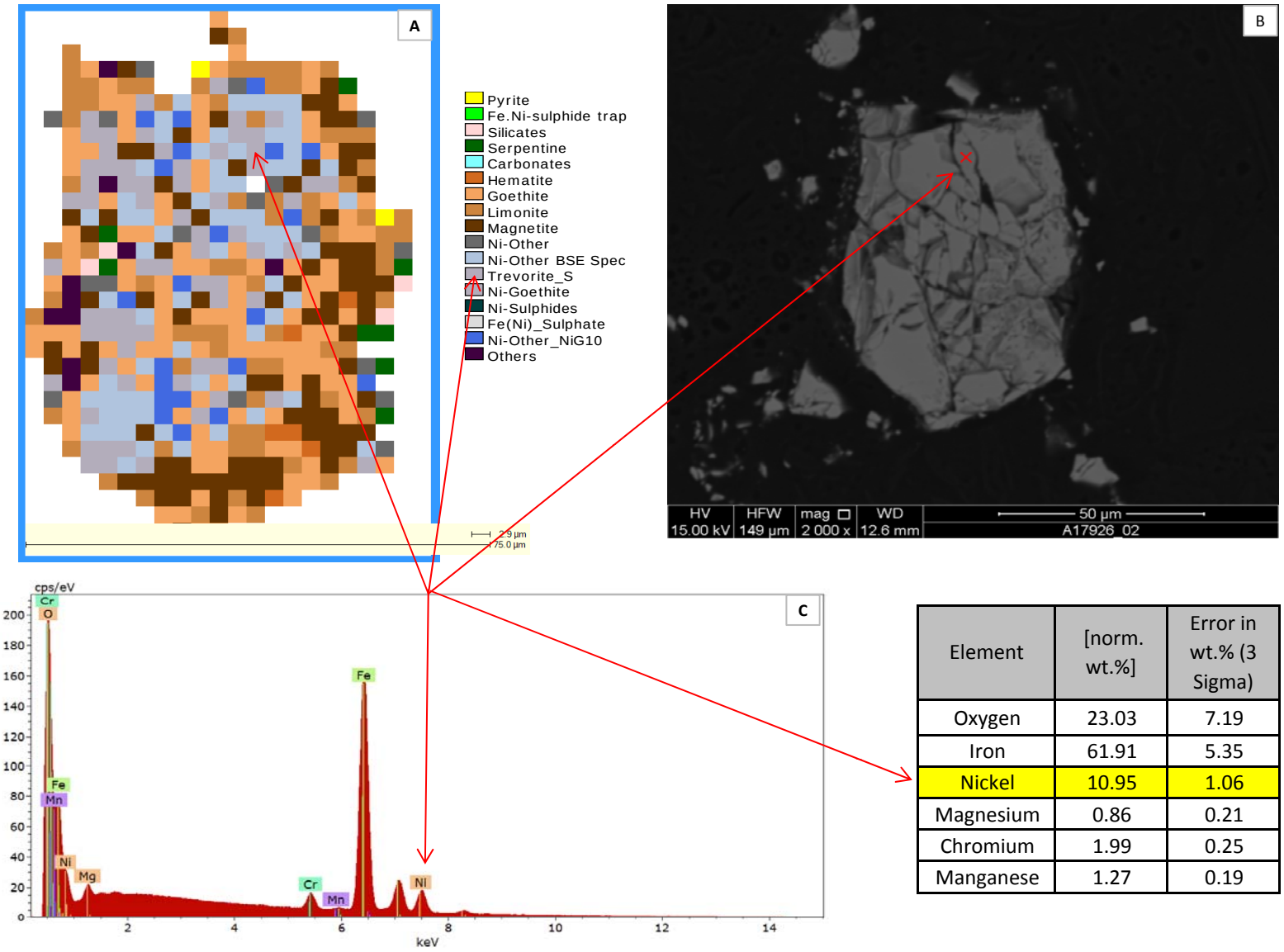
Element	[norm. wt.%]	Error in wt.% (3 Sigma)
Oxygen	20.90	6.46
Magnesium	1.59	0.32
Silicon	0.94	0.19
Iron	73.53	6.24
Nickel	3.05	0.35

Figure 8. "Ni-Other" shows relatively low nickel abundance (2%-3%) associated with goethite and limonite.
A: QEM particle view of a low-Ni Fe-oxide grain; B: BSE image of the same grain, magnification of 2000X; C: EDX spectrum of red cross in B



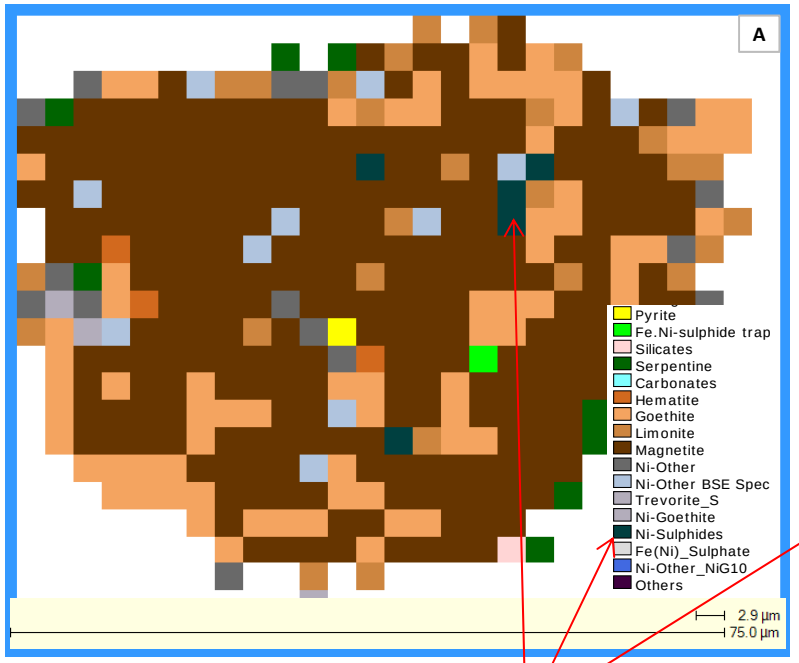
Element	[norm. wt.%]	Error in wt.% (3 Sigma)
Oxygen	25.99	7.82
Iron	70.23	5.87
Nickel	3.78	0.41

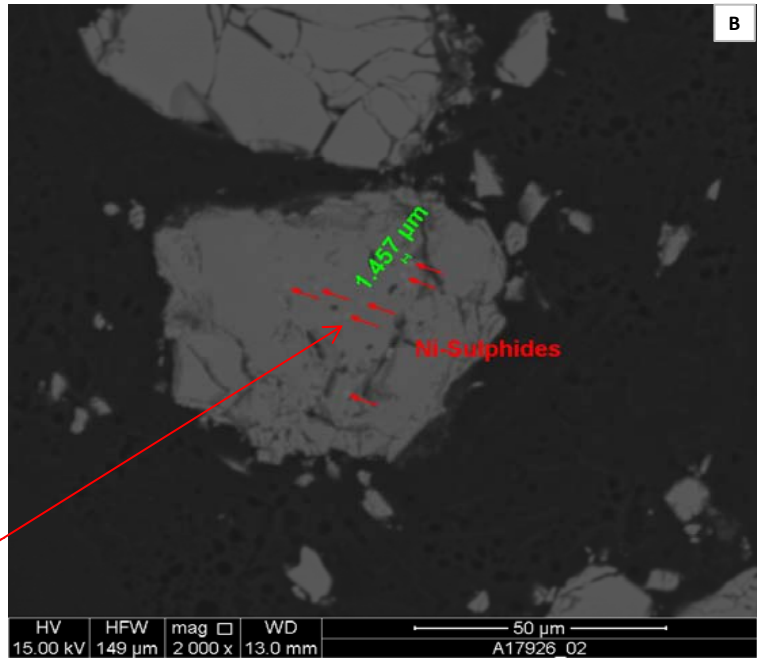
Figure 9. "Ni-Other-BSE-Spec" shows nickel abundance (3% - 4%) associated with magnetite.
A: QEM particle view of a low-Ni Fe-oxide grain; B: BSE image of the same grain, magnification of 2000X; C: EDX spectrum of red cross in B

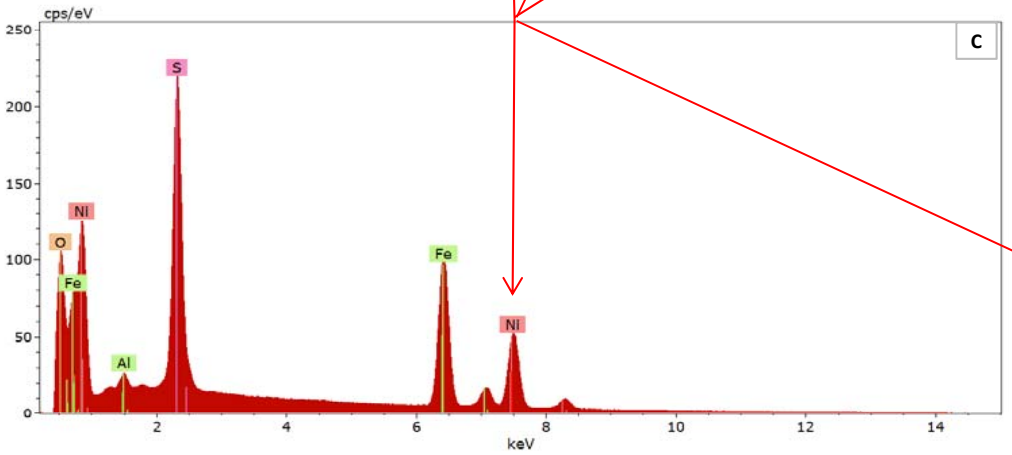


Element	[norm. wt.%]	Error in wt.% (3 Sigma)
Oxygen	23.03	7.19
Iron	61.91	5.35
Nickel	10.95	1.06
Magnesium	0.86	0.21
Chromium	1.99	0.25
Manganese	1.27	0.19

Figure 10. Relative high nickel abundance occurs in "Trevorite_S" found in sample 2.
A: QEM particle view of a trevoite grain; B: BSE image of the same grain, magnification of 2000X; C: EDX spectrum of red cross in B

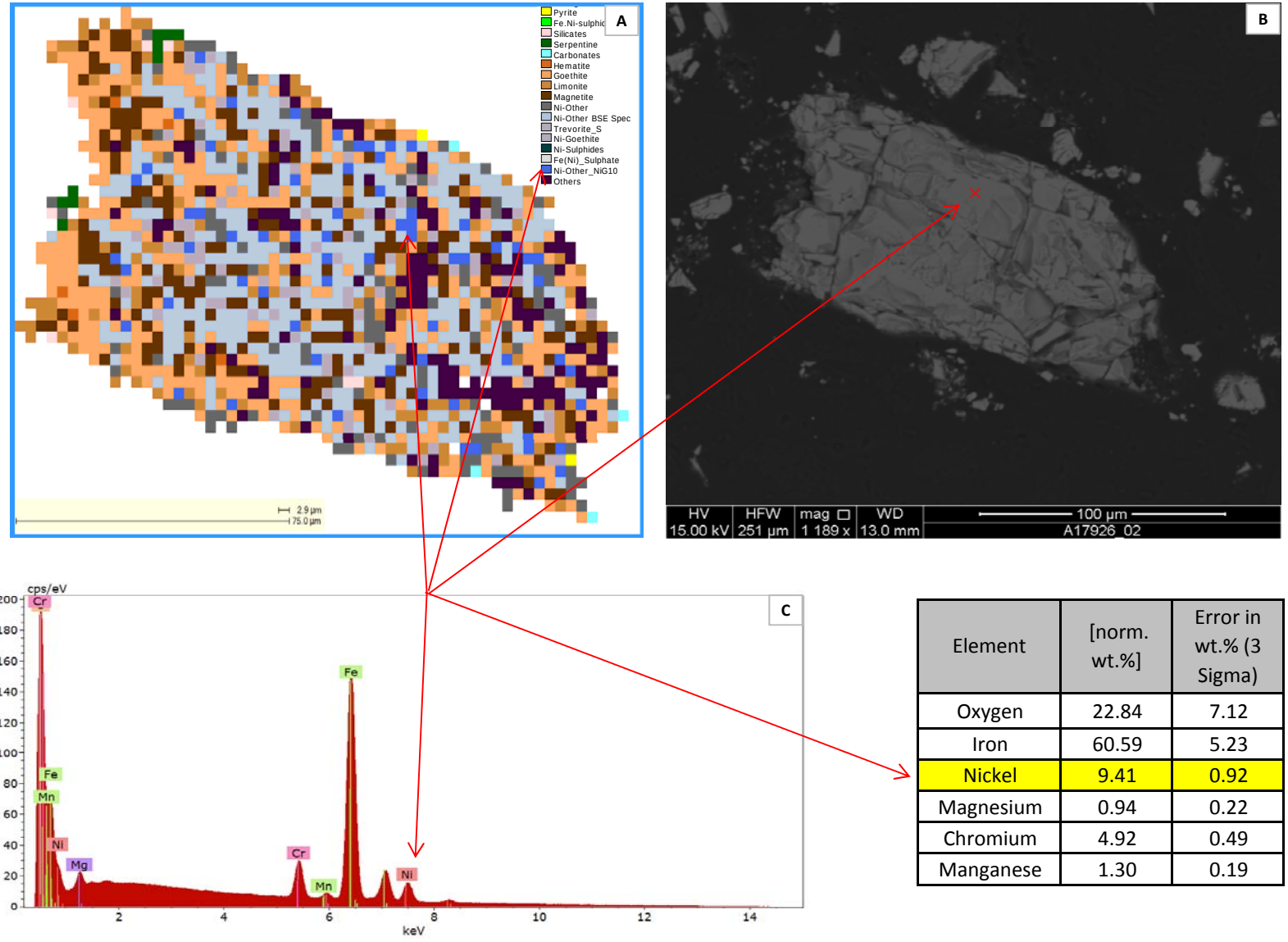






Element	[norm. wt.%]	Error in wt.% (3 Sigma)
Oxygen	15.03	4.46
Iron	36.75	2.97
Sulfur	13.91	1.40
Nickel	33.71	2.85
Aluminium	0.61	0.15

Figure 11. The highest nickel abundance (>30%) occurs in "Ni-Sulphides" in sample 2.
A: QEM particle view of a Ni-Sulphide grain; B: BSE image of the same grain, magnification of 2000X; C: EDX spectrum of red arrows in B



Element	[norm. wt.%]	Error in wt.% (3 Sigma)
Oxygen	22.84	7.12
Iron	60.59	5.23
Nickel	9.41	0.92
Magnesium	0.94	0.22
Chromium	4.92	0.49
Manganese	1.30	0.19

Figure 12. Another group of high nickel abundance minerals of "Ni-Other-NiG10" occur in sample 2.
A: QEM particle view of a high-Ni Fe-oxide grain; B: BSE image of the same grain, magnification of 1189X; C: EDX spectrum of red cross in B

Appendix 1 Analytical Report – AGAT Laboratories

See attachment

Appendix 2 Expenditures

Item	Unit cost	Units	HST	Total
AGAT Laboratories				
QEMScan Analysis and Report			$224.51	$1,951.51
Geologist – R. Sutcliffe				
Management and Reporting March 15, 2016	$650/day	1	84.50	734.50
Grand Total				**$2,686.01**