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Ontario Geological Survey
Open File Report 6328

Report of Activities, 2016 Resident Geologist Program

Kirkland Lake Regional Resident Geologist Report: Kirkland Lake and Sudbury Districts

2017

Ontario

ONTARIO GEOLOGICAL SURVEY

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Resident Geologist Program

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Kirkland Lake and Sudbury Districts

by

P.J. Chadwick, D.L. Guindon, D.G. Farrow, A.S. Péloquin, J. Suma–Momoh,
C.M. Daniels, A. Wilson, L.A. Bardeggia, F. Belley–Biswas and N. Sabiri.

2017

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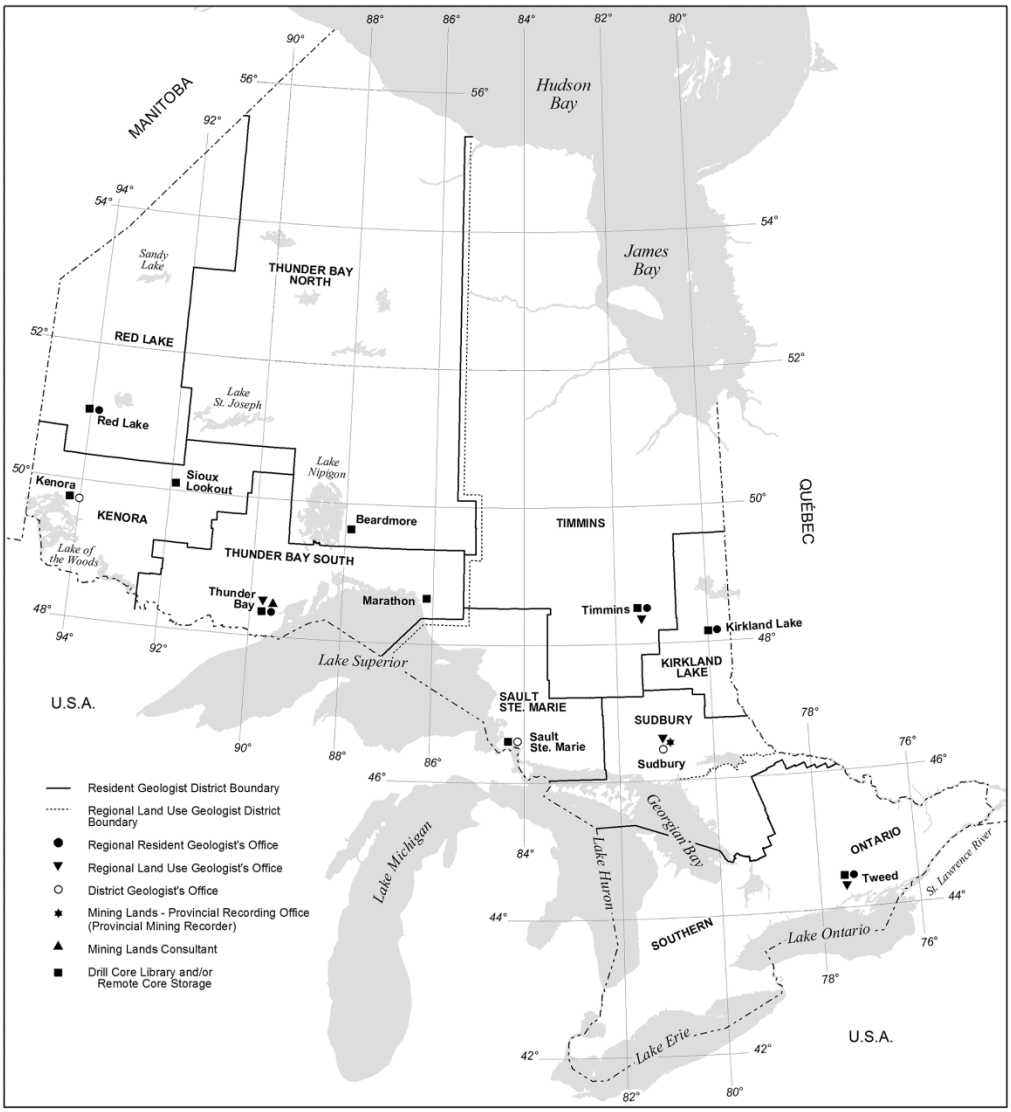

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ONTARIO GEOLOGICAL SURVEY

RESIDENT GEOLOGIST PROGRAM

REPORT OF ACTIVITIES—2016

KIRKLAND LAKE
REGIONAL RESIDENT GEOLOGIST REPORT

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INTRODUCTION

The level of exploration activities in the Kirkland Lake Resident Geologist District (Figure 1) remained relatively low compared to the boom years of 2011-2012, when the gold price spiked at near US$1900 per ounce. The year 2016 closed with a gold price of just below US$1150 per ounce and generally depressed commodity prices and decreased investor interest has made it challenging for the junior exploration sector to raise funds. However, there is a general feeling of optimism amongst local miners and explorers, with a sense that the down-cycle has bottomed out, and more diamond drills seem to be turning in recent months with the more established junior explorers and producers. It is also encouraging to note an increase in property acquisitions in recent months—particularly in the Cobalt silver camp—which may in part be due to the high global demand for cobalt metal to support the growing battery research and manufacturing industry. Another significant development within the district was the acquisition of St Andrew Goldfields Ltd. by Kirkland Lake Gold Inc. in January 2016 (www.klgold.com) and the merger with Newmarket Gold Inc. in November, 2016, to become Kirkland Lake Gold Ltd.

Cumulative gold production (excluding re-treated tailings) to the end of 2016 in the district, stands at 44 060 930 ounces (Table 1). There has been no silver or base metal production reported for the year.

Within the district, gold was produced from Alamos Gold Inc.'s Young–Davidson Mine, Primero Mining Corp.'s Black Fox Mine and Kirkland Lake Gold Ltd.'s Macassa, Holt, Holloway and Taylor mines. In a news release issued on December 12, 2016, Kirkland Lake Gold announced that it would transition the Holloway Mine (part of the Holt Mine Complex) to care and maintenance because of limited economic viability. Orefinders Resources Inc. also commenced the processing of stockpiles at the historic Mirado Mine. The total production of gold in 2016 (excluding gold recovered from stockpiles at Mirado) was 535 505 ounces or 16 656 067 g, an increase of 3% from the same period in 2015. Overall, there were 61 active exploration projects (including 4 advanced exploration projects) in the Kirkland Lake Resident Geologist District, similar to last year's 60 projects.

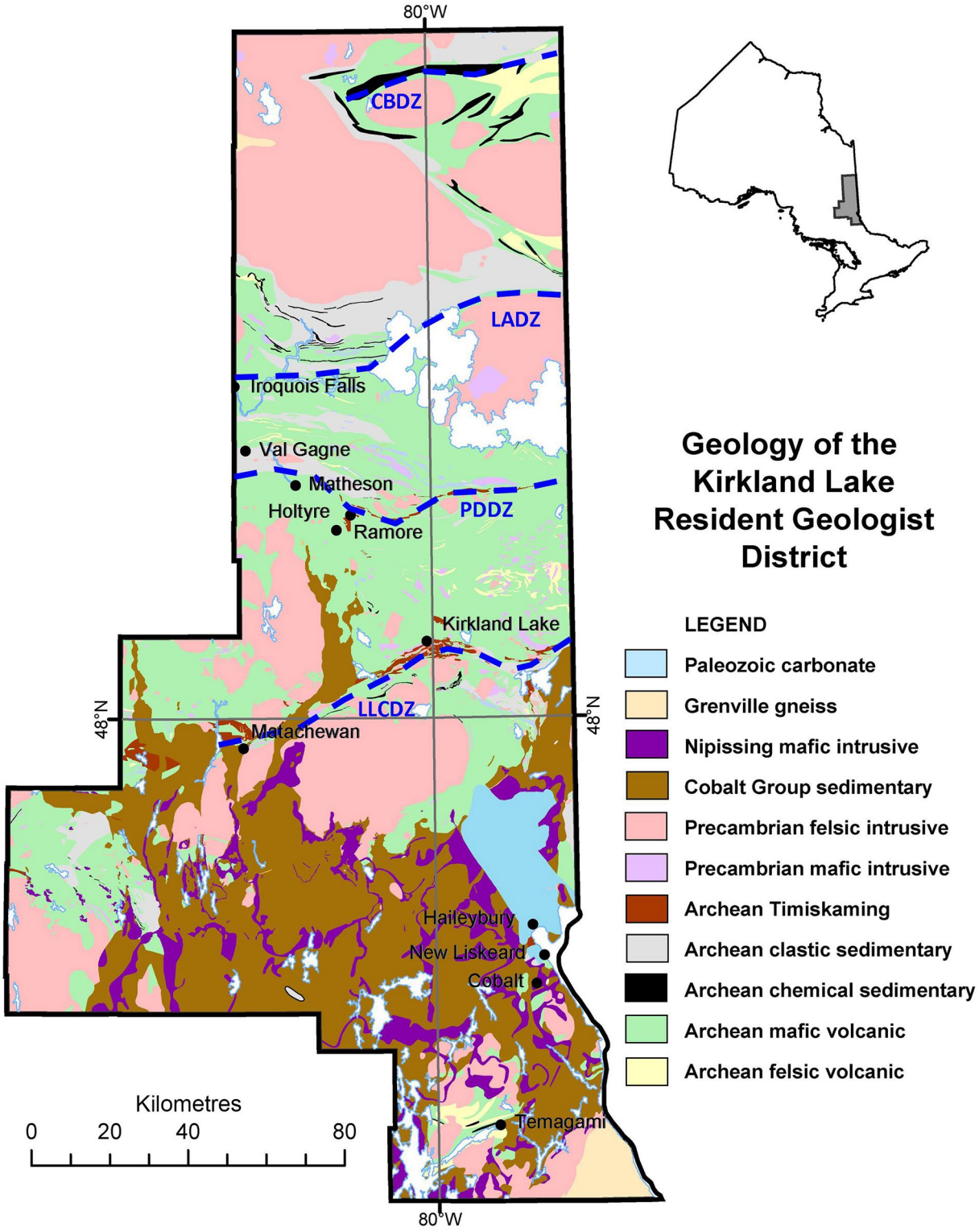

Figure 1. Kirkland Lake District with simplified bedrock geology showing major deformation zones in blue dashed lines: CBDZ, Casa Berardi Deformation Zone; PDDZ, Porcupine–Destor Deformation Zone; LLCDZ, Larder Lake–Cadillac Deformation Zone; and LADZ, Lake Abitibi Deformation Zone. Geology *from* Ayer and Chartrand 2011.

Table 1. Cumulative gold production in the Kirkland Lake Resident Geologist District to the end of 2016.

Mine	Township	Tons Milled	Production (ounces Au)	Grade (ounce/ ton)	Years of Production
Aljo	Beatty	2333	42	0.018	1940
American Eagle	Munro	60	40	0.667	1911
Argyll	Beatty	12 455	851	0.068	1918
Armistice	McGarry	8282	1035	0.125	1995, 97 (bulk samples)
Ashley	Bannockburn	157 076	50 123	0.319	1932-36
Barber Larder	McGarry	30 118	3072	0.102	1988
Barry Hollinger	Pacaud	267 741	77 000	0.288	1918, 25-36, 44-46
Bidgood	Lebel	586 367	160 184	0.273	1934-51
Black Fox (Glimmer)*	**Hislop**	**6 888 692**	**836 312**	**0.121**	**1997-2001, 2009-**
Blue Quartz	Beatty	500	81	0.162	1923, 26, 28, 34
Bourkes	Benoit	1298	277	0.213	1918, 36-38
Buffonta	Garrison	117 013	12 139	0.104	1981, 91-92
Canadian Arrow	Hislop	303 449	19 140	0.063	1974-76, 80-83
Canamax (Matheson Project)	Holloway	38 675	5391	0.139	1988
Cathroy Larder (Mirado)	McElroy	89 719	10 231	0.114	1941-44, 47, 57, 87
Centre Hill	Munro	327 007	422	0.001	1967-70
Cheminis	McVittie	179 013	17 530	0.098	1991-96
Chesterville	McGarry	3 260 439	358 880	0.110	1930-52
Croesus	Munro	5333	14 859	2.786	1915-18, 23, 31-36
Eastmaque (tailings)	Teck	1 051 744	28 740	0.027	1988-91
Ethel Copper	James	17 477	115	0.007	1962-67
Garrcon	Garrison	81 057	3518	0.046	2014, 15 (preproduction)
Gateford (Swastika)	Teck	103 684	30 068	0.290	1910-47***
Golden Summit	Maisonville	737	57	0.077	1936-37, 45
Gold Hill	Catharine	4616	660	0.143	1927-28
Gold Pyramid	Guibord	175	36	0.206	1911
Goldpost	Hislop	9403	2913	0.310	1989
Hislop Mine (Hislop East)	Hislop	2 082 219	128 635	0.062	1990-91, 93-95, 99-2000, 07, 10-14
Holloway Mine*	**Holloway**	**6 717 699**	**1 026 916**	**0.153**	**1993, 95 (preproduction), 96-06, 11-**
Holloway-Holt	Holloway	601 778	89 703	0.149	2007-2010
Holt*	**Holloway**	**10 609 045**	**1 592 682**	**0.150**	**1988-2004, 11-**
Hudson-Rand	Teck	6496	483	0.074	1922
Kerr	McGarry	40 336 512	10 457 441	0.259	1911, 38-96
Kirkland Lake	Teck	3 140 283	1 172 955	0.374	1916-60
Kirkland Lake Gold* - (Macassa)	**Teck**	**3 232 086**	**1 170 718**	**0.362**	**2002-**
Kirkland Town site	Teck	4230	1921	0.454	1958-59
Laguerre	McVittie	40 514	7568	0.187	1937-39
Lake Shore	Teck	17 208 323	8 602 791	0.500	1918-65, 82-87, 97-98
Macassa	Teck	7 877 532	3 525 389	0.448	1933-99
Macassa (Tailings)	Teck	3 240 890	173 659	0.054	1987-99, 02
Matachewan Consolidated	Powell	3 631 908	385 503	0.106	1934-54, 80-82
McBean	Gauthier	557 621	45 900	0.082	1984-86
Miller Independence	Pacaud	31	59	1.903	1918

Mine	Township	Tons Milled	Production (ounces Au)	Grade (ounce/ ton)	Years of Production
Moffat-Hall	Lebel	16 388	4780	0.292	1934-35
Morris Kirkland	Lebel	127 253	16 999	0.134	1936-38, 40-42
New Telluride	Skead	104	62	0.596	1931-32
Newfield	Garrison	55 000	9680	0.176	1996 (bulk sample)
Omega	McVittie	1 615 081	214 098	0.133	1913, 26-28, 36-47
Queenston	Gauthier	1054	177	0.168	1941
Ronda	MacMurchy	24 592	2727	0.111	1939
Ross	Hislop	6 714 482	995 832	0.148	1936-89
Ryan Lake**	Powell	188 790	1352	0.007	1948-57, 62-64
Stairs	Midlothian	15 835	3573	0.226	1965-66
Sylvanite	Teck	5 049 536	1 674 808	0.332	1927-61
Taylor*	**Taylor**	**334 015**	**66 188**	**0.198**	**2007, 13, 14, (preproduction), 15-**
Teck Hughes	Teck	9 565 302	3 709 007	0.388	1917-68
Toburn	Teck	1 186 316	570 659	0.481	1912-53***
Tyranite	Tyrrell	223 810	31 352	0.140	1939-42
Upper Beaver	Gauthier	580 562	140 709	0.242	1913-72***
Upper Canada	Gauthier	4 648 984	1 398 291	0.301	1938-71
White-Guyatt	Munro	50	10	0.200	1911
Wright Hargreaves	Teck	9 934 327	4 821 296	0.485	1921-65
Young Davidson	Powell	6 218 272	585 690	0.094	1934-57
Young-Davidson*	**Powell**	**13 345 491**	**663 987**	**0.050**	**2012-**
Total including tailings		**172 676 874**	**44 927 316**	**0.260**	
Total excluding tailings		**155 038 749**	**44 060 930**	**0.284**	

*Note: * Current producer, ** Base metal producer, *** Intermittent production*

In 2016, 182 assessment files were incorporated into the Kirkland Lake Assessment File system. These reports, approved for assessment credits, represent C$25 542 657 in exploration expenditures, compared to C$4 719 357 (for 100 reports filed) reported for the previous year.

Eight (8) publications were added to the Kirkland Lake Resident Geologist District library in 2016 and entered into the publications database. No diamond-drill core was received for the drill core library during the same reporting period.

MINING ACTIVITY

Once again, gold dominated mine production in the Kirkland Lake District in 2016 from a total of 6 mines. The Tracey Lake barite mine is the district's sole industrial mineral producer. The locations of these mines are provided on the map in Figure 2. Table 2 sumarizes 2016 production from these 7 mines, their cumulative gold production figures from startup to the end 2016, their most recent publicly disclosed mineral reserve statements (www.alamosgold.com, www.klgold.com, www.primeromining.com).

Alamos Gold Inc.

Alamos Gold Inc. (Alamos) is a Canada-based, mid-tier, international gold mining company that resulted from a merger of Alamos Gold Inc. and AuRico Metals Inc. on July 2, 2015. The Young–Davidson Mine (*see* Figure 2) is Alamos' Canadian gold producer. Other operating mines are the El Chanate and Mulatos mines in Mexico.

Table 2. Mine production and reserves in the Kirkland Lake Resident Geologist District in 2016.

Mine (period in production)	Total Production (Start-up to end of 2016)		Production (2016)		Reserves at end of 2015 (*2014)	
	Tonnage @ Grade	Total Commodity	Tonnage @ Grade	Total Commodity	Tonnage (Short Tons)	Grade
Alamos Gold – Young–Davidson (2012-present)	13 345 491 tons @ 0.050 ounce per ton gold	663 987 ounces gold	2 842 903 tons @ 0.060 ounce per ton gold	170 000 ounces of gold	(underground) Prv: 15 743 000 t Prb: 33 078 000 t Mea: 4 683 000 t Ind: 4 086 000 t Inf: 3 883 000 t (surface) Prv: 1 538 000 t Mea: 546 700 t Ind: 1 369 000 t Inf: 34 000 t	 2.73 g/t 2.68 g/t 3.47 g/t 3.43 g/t 2.76 g/t 0.82 g/t 1.13 g/t 1.28 g/t 0.99 g/t
FredMar				900 t of barite	NA	NA
Kirkland Lake Gold – Macassa (2002-present)	3 237 697 tons @ 0.362 ounce per ton gold	1 170 718 ounces gold	437 213 tons @ 0.401 ounce per ton gold	175 167 ounces of gold	*Prv: 891 000 t *Prb: 1 703 000 t *Mea: 1 116 000 t *Ind: 2 524 000 t *Inf: 1 842 000 t	15.86 g/t 21.16 g/t 13.83 g/t 19.02 g/t 20.05 g/t
[1]Kirkland Lake Gold – Holloway (1996-2006; 2011-present)	6 719 589 tons @ 0.153 ounce per ton gold	1 026 916 ounces gold	223 917 tons @ 0.126 ounce per ton gold	28 135 ounces of gold	*Prb: 257 000 t *Mea: 342 000 t *Ind: 531 000 t *Inf: 2 733 000 t	5.35 g/t 4.71 g/t 4.54 g/t 4.88 g/t
[1]Kirkland Lake Gold – Holt (1988-2004; 2011-present)	10 607 658 tons @ 0.150 ounce per ton gold	1 592 682 ounces gold	448 614 tons @ 0.124 ounce per ton gold	57 086 ounces of gold	*Prv: 1 601 000 t *Prb: 2 661 000 t *Mea: 4 081 000 t *Ind: 4 256 000 t *Inf: 8 671 000 t	4.26 g/t 5.05 g/t 3.97 g/t 3.90 g/t 4.67 g/t
Kirkland Lake Gold – Taylor (2007-2016)	337 631 tons @ 0.196 ounce per ton gold	66 222 ounces gold	219 615 tons @ 0.194 ounce per ton gold	42 639 ounces of gold	*Prb : 853 000 t *Ind : 2 561 000 t *Inf : 2 151 000 t	6.27 g/t 4.76 g/t 4.10 g/t
Primero Mining – Black Fox (1997-2001; 2009-present)	6 888 692 tons @ 0.121 ounce per ton gold	836 312 ounces gold	1 010 648 tons @ 0.062 ounce per ton gold	62 171 ounces of gold	(stockpile) Mea: 1 213 000 t (underground) Prv: 1 213 000 t Prb: 1 102 000 t Ind: 2 315 000 t	 1.1 g/t 1.1 g/t 6.2 g/t 7.3 g/t

Note: [1]2007-2010 production for Holloway and Holt mines combined and not included.

All tonnages reported in this table have been converted to US (short) tons, to preserve continuity with earlier reports.

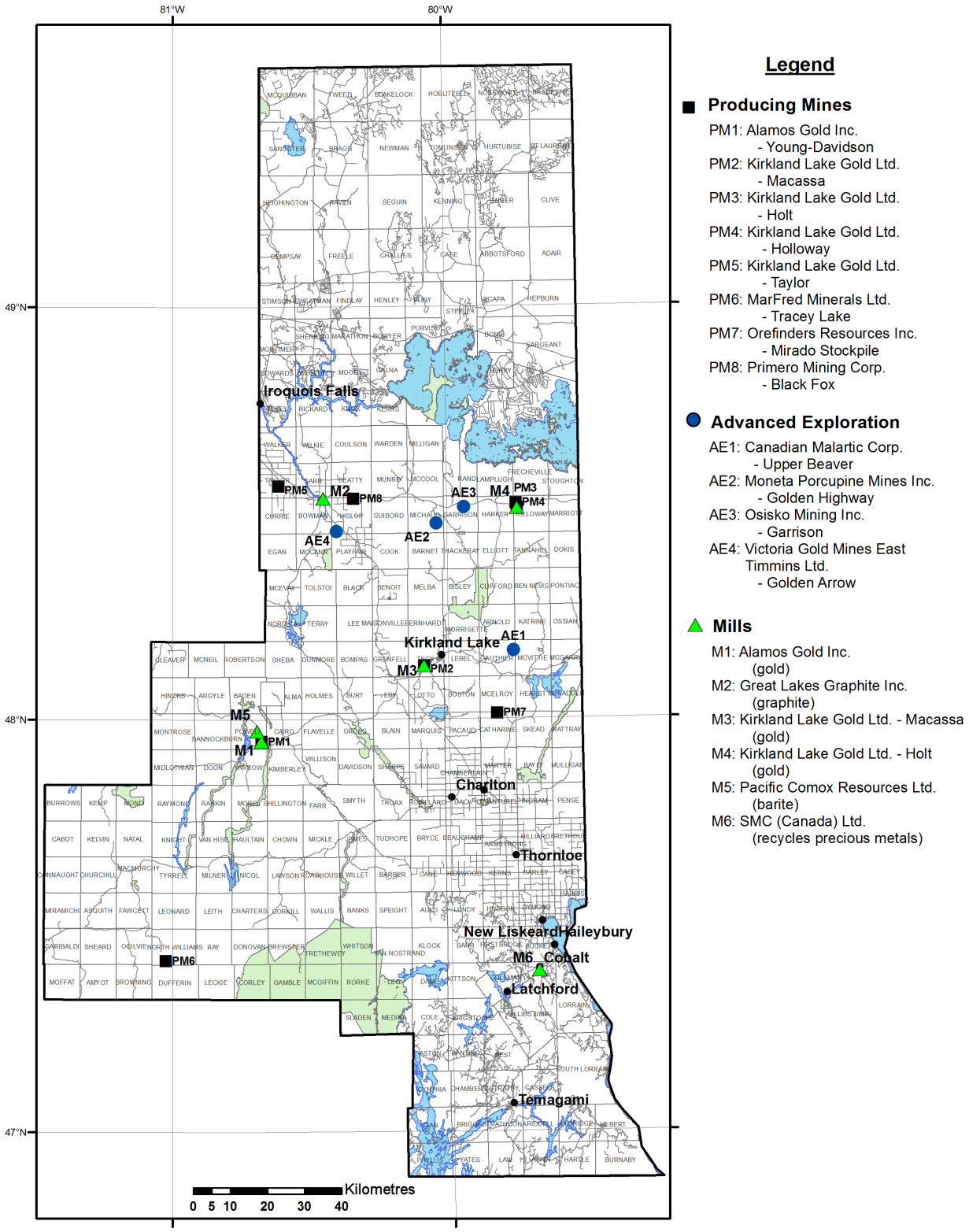

Figure 2. Kirkland Lake Resident Geologist District with locations of producing mines, mills and advanced exploration projects. Note: Those companies flagged as Advanced Exploration projects, have been carried over from 2015, and remain active.

YOUNG–DAVIDSON MINE

The Young–Davidson Mine is an underground mining operation located near the town of Matachewan, approximately 60 km west of Kirkland Lake, within the southwestern part of the Abitibi greenstone belt. The property consists of contiguous mineral leases and claims totaling 11 000 acres, and is situated on the site of 2 past-producing mines that produced about one million ounces from 1934-1957. The Young–Davidson open pit mine achieved commercial production on September 1, 2012, and on October 31, 2013, the company declared commercial production at the Young–Davidson underground mine following the commissioning of the shaft hoisting system. Open pit mining ceased in June 2014 upon depletion of the reserve; however, stockpiled open pit ore will supplement mill feed until underground production rates have ramped up to design levels of 8000 tonnes per day. Production rates for 2016 averaged at 6000 tonnes per day, with an anticipated increase to 6500–7500 tonnes per day forecast for 2017 (Alamos Gold Inc., news release, January 6, 2017).

In the 'Matachewan gold camp' the Young–Davidson property straddles the unconformable contact between the rocks of the Archean Abitibi greenstone belt to the north and the overlying Proterozoic Southern Province rocks to the south. Gold that is being extracted at the mine is hosted within the older Abitibi rocks, which consists of a complex and diverse array of metavolcanic, metasedimentary, and plutonic rocks typically metamorphosed to greenschist facies grade, but locally attaining amphibolite facies grade. Metavolcanic rocks range in composition from rhyolitic to komatiitic and commonly occur as mafic to felsic volcanic cycles. Metasedimentary rocks consist of both chemical and clastic varieties and occur as both intravolcanic sequences and as uncomformably overlying sequences. A wide spectrum of mafic to felsic, pretectonic, syntectonic and posttectonic intrusive rocks are present. All lithologies are cut by late, generally northeast-trending proterozoic diabase dikes. Specifically, gold mineralization at Young–Davidson is associated with a syenite intrusive rock (a quartz granite). Within this syenite, the gold mineralization is associated with a stockwork of quartz veinlets and narrow quartz veins, rarely greater than a few centimetres thick that are within a broader halo of disseminated pyrite and potassic alteration. Historic mining demonstrated the continuity of mineralization from surface to a depth of approximately 500 m. Mineralization is known to extend beyond 1500 m below surface (orebody open at depth); however, current drilling below this level will not be initiated until suitable underground drill platforms become available.

In 2016 the Young–Davidson Mine produced 170 000 ounces of gold, a 6% increase compared to 2015 production (www.alamosgold.com).

Kirkland Lake Gold Ltd.

Kirkland Lake Gold Inc. owns 5 of the 7 historic mines that produced a total of approximately 25 million ounces of gold from the Kirkland Lake Main Break (Guindon et al. 2015). The Macassa Mine (*see* Figure 2) is the only one currently in production. In November 2015, Kirkland Lake Gold entered into a purchase/merger agreement with St Andrew Goldfields Ltd. This agreement was ratified by shareholders of both companies in January, 2016 (Kirkland Lake Gold Inc., news release, January 26, 2016), resulting in the additional production capacity of the Holt, Holloway and Taylor mines. In November, 2016, the company merged with Newmarket Gold to become Kirkland Lake Gold Ltd. Parts of the following descriptions are taken from the company Web site (Kirkland Lake Gold Ltd., www.klgold.com, under assets | operations-and-projects | Canada [accessed April 3, 2017]).

MACASSA MINE COMPLEX

'04 and Main Breaks

The following description is taken from the company Web site (Kirkland Lake Gold Ltd., www.klgold.com, under assets | operations-and-projects | Canada [accessed April 3, 2017]).

> The Kirkland Lake Main Break system has produced over a span of 86 years, 24 million troy ounces of gold, representing some 15% of total Canadian gold production as of 1999. Mining took place along a strike length of 21 000 feet and to a depth of 8 100 feet. Some of the greatest gold mines in Canada were located along the Main Break including the Sylvanite, Wright Hargreaves, Lakeshore, Teck Hughes, Kirkland Minerals and Macassa. The average historic grade of this production is 0.48 ounces of gold per ton.
>
> The most important structural controls in the Kirkland Lake Camp (until the discovery of the South Mine Complex) are the major east-west breaks and the branching fault systems associated with them. The breaks represent re-activated fault systems with ore shoots having been formed synchronously with early displacement with the most recent movement having displaced the ore. Ore shoots may occur both on the hanging and footwall side of the Break planes.
>
> The Main Break has been traced east as far as the Toburn Mine and west onto the Macassa Mine as far as Macassa #2 shaft. The Main Break is interpreted to be a post ore structure, 1 to 20 feet wide marked by a zone of mylonitized and sometimes brecciated wall rock, chlorite schist and mud or gouge. It is a thrust or reverse fault with an estimated displacement of 1500 feet on the overlying sediments. The strike of the Main Break averages N 65°E and dips 80° to the south, gradually flattening in dip to 50° degrees at depth.
>
> In 1955 a new major break was discovered on the Macassa property termed the '04 Break. Located 400 feet north of the Main Break, the '04 Break has been the most important ore-related structure at Macassa since the 1980s. The Main and '04 Breaks are connected through a series of linking structures in the vicinity of Macassa #2 shaft which include the S and R Breaks. The ′04 Break is the host for most of the ore at Macassa, is a thrust or reverse fault with at N 65°E strike and a 72° south dip. Ore is located along this and subordinate splays as quartz veins. Gold is usually found with minor pyrite and sometimes associated with molybdenite and/or tellurides.

South Mine Complex

> It was not until 1999 that Kinross Gold Corp. planned an aggressive exploration program testing potential mineralization south of the '04 Break at the Macassa Mine. An initial drill hole returned 0.78 ounces of gold per ton over 12 feet of core, 600 feet south of the '04 Break. The intersection was comprised pyrite-rich mineralizationdistinctly different from the quartz veining associated with the '04 Break. Shortly thereafter Kinross terminated operations at Macassa and follow-up drilling was never completed.
>
> After purchasing the Macassa Mine property, along with 4 contiguous former producers (Kirkland Minerals, Teck Hughes, Lakeshore and Wright Hargreaves) in 2001, Kirkland Lake Gold began dewatering the underground workings at the Macassa Mine. Once the -4700 foot level was dewatered in 2003, an exploration program was initiated to not only follow up on the Kinross drill hole, but also to test further south, within the technical limits of large electric hydraulic drills.
>
> In November of 2003, diamond drilling intersected multiple mineralized zones up to 1600 feet south of the '04 Break indicating the presence of significant gold mineralization well south of the '04 Break. The furthest south of these zones became the Lower D Zone, which is now accepted as the first zone discovered comprising the South Mine Complex (SMC).
>
> The SMC represents an entirely new mineralized system in the Kirkland Lake mining camp. It is characterized by generally shallowly dipping (25° to 50°) structurally controlled zones of finely

> disseminated pyrite, visible gold and tellurides. This is in contrast to the steeply dipping (70° to 80°) quartz vein hosted gold of the Main and '04 Break. The new zones being developed in the SMC are hosted primarily by moderately southeast to south-southwest dipping dark grey to grey brown alkaline tuff, and by several phases of porphyritic intrusives, the most common of which is syenite porphyry. The SMC also exhibits a higher grade than what has been historically mined in the Kirkland Lake camp. It has been intersected as deep as the -6500 foot elevation and as high as the -4700 foot elevation over a strike length in excess of 2000 feet. Gold mineralization in the SMC area occurs in a complex interconnected network of narrow, east to northeast trending shallow south dipping shear zones and auriferous alteration. It consists of wide, gold-bearing alteration and mineralization halos, in contrast to the narrow quartz vein systems associated with the Main and '04 Breaks.

Parts of these descriptions were taken from the company Web site (Kirkland Lake Gold Ltd., www.klgold.com, under assets | operations-and-projects | Canada [accessed April 3, 2017]).

The Macassa Mine Complex produced a total of 175 167 ounces of gold during 2016 from 396 633 tonnes milled, at an average grade of 14.10 g/t gold (Kirkland Lake Gold Ltd., news release, January 9, 2017).

HOLT MINE

In 2006, St Andrew Goldfields Ltd. (SAS) acquired the rights to the Holt Mine and Mill and in 2007 amalgamated with Holloway Mining Ltd. to control the Holt and Holloway properties. Gold mineralization at the Holt Mine, formerly the Holt–McDermott Mine, was discovered in 1922. However, it was not until 1988 when American Barrick Resources Corp. began production at the mine. In 2004, the mine was shut down after producing 1.32 million ounces of gold from 7.48 million tons of ore grading an average of 5.9 g/t gold. SAS reopened the mine in 2011 and was subsequently acquired by Kirkland Lake Gold Ltd. in January 2016 (op. cit.).

> At the Holt Mine, mineralized zones that have been historically mined are hosted by the McDermott shear zone, a 10 m to 50 m wide south-southeast dipping carbonate-sericite-chlorite ± albite altered ductile shear zone, which is hosted by otherwise massive and generally low strain mafic volcanic rocks. The McDermott shear zone has been traced laterally for approximately 10 km along strike, joining the Destor–Porcupine corridor to the northeast.

Parts of these descriptions were taken from the company Web site (Kirkland Lake Gold Ltd., www.klgold.com, under assets | operations-and-projects | Canada [accessed April 3, 2017]).

The Holt Mine produced 57 086 ounces of gold from 416 048 tonnes grading an average of 4.52 g/t gold in 2016 (Kirkland Lake Gold Ltd., news release, January 9, 2017).

HOLLOWAY MINE

Surface and limited underground exploration was carried out on the Holloway–Harker property in the late 1930s and again in the 1980s by Teddy Bear Valley Mines Ltd. and in adjacent claims in the 1980s by Noranda Exploration Company Ltd. Gold mineralization, in what was to become known as the Lightning Zone, was identified on either side of the property boundary by the respective companies. The Holloway Joint Venture was formed in 1992 to develop the deposit and full production was achieved in 1996. The property was acquired by SAS in 2006, and re-acquired by Kirkland Lake Gold Ltd. in January 2016.

Mineralization in the Holloway Mine's Lightning, Blacktop and the Middle zones, is controlled by the east-west trending Porcupine–Destor Fault Zone (PDFZ). Structurally juxtaposed Blake River assemblage mafic metavolcanic rocks, Porcupine and Timiskaming assemblages (clastic metasedimentary rocks and

ultramafic rocks of an older Abitibi Upper Kidd–Munro assemblage) are penetratively deformed and altered. A late carbonate-quartz-albite-pyrite alteration assemblage is associated with gold mineralization.

The Holloway Mine produced 28 135 ounces of gold from 203 130 tonnes grading 4.86 g/t gold in 2016 (Kirkland Lake Gold Ltd., news release, January 9, 2017). As a result of limited economic viability, the Holloway Mine was transitioned to care and maintenance at the end of 2016 (Kirkland Lake Gold Ltd., news release, December 12, 2016).

Parts of these descriptions were taken from the company Web site (Kirkland Lake Gold Ltd., www.klgold.com, under assets | operations-and-projects | Canada [accessed April 3, 2017]).

TAYLOR MINE

> Rock lithology on the Taylor property can be generalized from south to north; as mafic volcanic rocks, which are relatively undeformed and unaltered; ultramafic and mafic volcanic rocks, which vary from weakly to strongly deformed, altered and contain felsic to intermediate porphyritic intrusions of varying shapes and sizes; and then metasedimentary rocks, which are interpreted to represent the footwall of the Porcupine–Destor Fault Zone (PDFZ) on the Taylor property.
>
> Gold mineralization at Taylor can be found in the hanging wall of the PDFZ. Three mineralized zones have been identified over a strike length of 2 km. From east to west these are; the Shaft Zone, with gold mineralization associated with felsic intrusive rocks; the West Porphyry Zone (WPZ), a system of stacked lenses, with the gold mineralization associated with felsic intrusive and altered mafic-ultramafic rocks (Green Quartz Carbonate); and the Shoot Zone, with gold mineralization hosted by argillaceous metasedimentary rocks within a package of green quartz carbonate. Gold commonly occurs as relatively coarse-sized free gold in quartz, but also occurs as fine particles, which may be intimately associated with sulphides (particularly pyrite and locally, arsenopyrite) both in quartz-carbonate veins or in surrounding altered host rocks.

Parts of these descriptions were taken from the company Web site (Kirkland Lake Gold Ltd., www.klgold.com, under assets | operations-and-projects | Canada [accessed April 3, 2017]).

During 2016, 42 639 ounces of gold from 199 231 tonnes grading an average of 6.90 g/t (Kirkland Lake Gold Ltd., news release, January 9, 2017).

Orefinders Resources Inc.

Orefinders Resources Inc. is a Canadian based junior gold exploration company with properties in Kirkland Lake and Red Lake districts of northeastern and northwestern Ontario, respectively. The company's flagship gold project; the Mirado Mine Project, is situated on the Mirado property which lies south of Kirkland Lake and the Larder Lake–Cadillac fault in the Abitibi greenstone belt.

MIRADO MINE (MIRADO PROPERTY)

The property is underlain by supracrustal rocks of the Archean Tisdale assemblage (Ayer et al. 2005) and small dikes of syenite porphyry, diorite and lamprophyre, and is transected by 2 main faults, the Catherine and Mirado. Three distinctive gold mineralization styles have been described at different parts on the property (Oliver 2014).

The Mirado North and Central zones are interpreted as concordant, gold-rich VMS mineralization style. Anomalous gold, silver and zinc occur in 6 concordant mineralized horizons within a 300 m stratigraphic corridor that strike up to 400 m. An alteration envelope extends beyond mineralization resulting in a potentially useful exploration vector (Oliver 2014).

At Mirado South, the Main Zone and Bank, gold mineralization is associated with stringer/stockwork pyrite that transects intermediate to felsic metavolcanic rocks and strike approximately north-northeast (Oliver 2014).

Stockpiles of unprocessed ore produced from the historic Mirado Mine remain on the original patented mining claims of the Mirado property. A closure plan was prepared in 2015 for the processing of these stockpiles, estimated at 2939 ounces of gold grading on average 4.41 g/t gold, and a definitive milling contract was signed with IAMGold Corp. to process the stockpiled material at its Westwood facility in Bousquet Township, southwestern Quebec (Orefinders Resources Inc., news release, July 14, 2016). Production at the Mirado Stockpile Project commenced in September 2016, and completed the crushing and trucking of approximately 26 000 tonnes of resource material to the Westwood facility in October (Orefinders Resources Inc., news release, November 7, 2016).

Primero Mining Corp.

Primero Mining Corp. (PMC) operates the underground Black Fox Mine (*see* Figure 2) in addition the San Dimas Mine in Mexico. Ore is crushed at the Black Fox Mine Complex and trucked 30 km west to the Black Fox Mill for further processing.

BLACK FOX MINE

Brisson (2014) describes the geology of the Black Fox Mine area as a variably sheared, faulted, carbonatized and mineralized sequence of komatiitic ultramafic metavolcanic rocks belonging to the Lower Tisdale Group, which strikes southeast across the property, along the southeast strike of the Porcupine–Destor Deformation Zone (PDDZ). This structure and the surrounding stratigraphy dip to the southwest at approximately 45°. These altered and deformed komatiites are generally bleached to a light grey-buff colour with ankerite-talc and ankerite-quartz- sericite-fuchsite assemblages. This alteration package is underlain to the north by a thin, fine- grained, green greywacke-type metasedimentary unit, a thick sequence of massive to pillowed tholeiitic mafic metavolcanics, and lastly by the regionally extensive package of argillites and wackes of the Porcupine Group metasediments which underlie the northeastern portion of the property.

To the south and forming the hanging wall of the main ankerite zone are green, relatively undeformed, very fine-grained and pillowed tholeiitic mafic metavolcanics with lesser intercalations of black komatiitic ultramafic flows displaying chlorite-serpentine, chlorite and talc-chlorite alteration.

Numerous syenitic and feldspar±quartz porphyry sills and dikes of various ages occur primarily within the main ankerite alteration zone. They are massive to brecciated, silicified and pyritic with occasional sericite and hematite alteration and a more common black chlorite alteration at the contacts. The porphyry sills and dikes vary in colour: pink, grey, whitish, yellow, pale green and reddish. Fragments of these dikes frequently occur within the more strongly deformed green carbonate zones. Very narrow, massive, dark green to buff-green mafic dikes and sills commonly occur within the main ankerite zone. They are generally weakly altered and probably postdate much of the alteration and deformation. Diabase dikes are the youngest rocks in the area, occupying very late north-striking crustal fractures.

Gold mineralization at the Black Fox Mine occurs in several different geological environments within the main ankerite alteration zone, which has a strike length of over 1000 m and a variable true width ranging from 20 m to over 100 m. This mineralized envelope occurs primarily within komatiitic ultramafic and lesser mafic metavolcanic rocks within the outer boundaries of the PDDZ. The auriferous zones have several modes of occurrence, from concordant zones that follow lithological contacts and have been

subsequently deformed, to slightly discordant zones associated with syenitic sills and quartz veins or stockworks.

In 2016 the Black Fox Mine produced 62 171 ounces of gold, a 4% increase compared to 2015 production (Primero Mining Corp., news release, January 18, 2017).

Exploration efforts early in 2016 were focussed on the Froome Zone, located 800 m west of the Black Fox deposit, in addition to the new "Froome-like" mineralization located 750 m southeast of Froome, and approximately 300 m from Black Fox Mine (Primero Mining Corp., news release, February 29, 2016). Furthermore, near-mine exploration drilling succeeded in identifying additional gold mineralization west of the Black Fox Deep Central Zone (Primero Mining Corp., news release, September 19, 2016).

INDUSTRIAL MINERALS

MarFred Minerals Ltd. – Tracey Lake

MarFred Minerals Ltd. purchased the Tracey Lake barite mine (*see* Figure 2), in North Williams Township, from Extender Minerals of Ontario in 2012. During 2015, approximately 900 tons of ore was produced and processed at the Pacific Comox Resources Ltd. in Powell Township (P. Rosko, personal communication, January 10, 2017).

MINERAL DEPOSITS NOT BEING MINED

Table 3 summarizes the mineral deposits that have either historic or NI 43-101 compliant reserves and resources, for a variety of commodities, that are not currently being mined.

Table 3. Mineral deposits not being mined in the Kirkland Lake Resident Geologist District in 2016.

Abbreviations

AF ..... Assessment Files
AR ..... Annual Report
CAMH ..... *Canadian and American Mines Handbook*
CMH ..... *Canadian Mines Handbook*
GR ..... Geological Report
MD&A ..... Management Discussion & Analysis
MDC ..... Mineral Deposit Circular [No.15–] [*formerly* Mineral Resources Circular, No.1-14]
MDIR ..... Mineral Deposit Inventory record
MLS ..... Mining Lands, Sudbury
MR ..... Mining Recorder
NM ..... *The Northern Miner*
OFR ..... Open File Report
PC ..... Personal communication
PR ..... Press Release

Deposit Name (Township)	Commodity MDI No.	Tonnage-Grade Estimates and/or Dimensions	Ownership References	Reserve References*	Status
180 East (Lebel)	Au 32D04SW00336	Historic indicated resource 327 000 t @ 4.1 g/t Au	Agnico Eagle Mines Limited (50%) - Yamana Gold Inc. (50%) (CMH 2015-2016, p.27-29)	Queenston Mining Inc., website, February 4, 2013	Active
95-2 (Lundy)	Diamond 31M12SW00017	Inferred Mineral Resource of 20.2 million t @ 11.3 carats/100 t	Ashton Mining of Canada Inc. (20%) and North Arrow Minerals Inc. (80%) (Claim 1202724 Abstract, December 17, 2015)	NI 43-101 Technical report for Stornoway November 28, 2012	Inactive
Adams Mine (Boston, Lebel)	Fe 32D04SW00013	Historic resource of 19 398 300 t @ about 26% iron	N/A	N/A	Inactive

Deposit Name (Township)	Commodity MDI No.	Tonnage-Grade Estimates and/or Dimensions	Ownership References	Reserve References*	Status
Amalgamated Kirkland (Teck)	Au 42A01NE00184	Indicated Mineral Resource : 1 145 000 t @ 4.70 g/t Au Inferred Mineral Resource : 1 530 000 t @ 4.21 g/t Au	Agnico Eagle Mines Limited (50%) - Yamana Gold Inc. (50%) (CMH 2015-2016, p.27-29)	Queenston Mining Inc., PR September 9, 2011	Active
Barber Larder (McGarry)	Au 32D04SE00043	Historic resource: 60 000 tons of 0.16 oz per ton Au	Kerr Mines Inc. (CMH 2015-2016, p.245-246)	CMH 1990-1991, p.416-417	Inactive
Bear Lake (McGarry)	Au 32D04SE00077	Inferred Mineral Resource : 3 750 000 t @ 5.67 g/t Au	Kerr Mines Inc. (CMH 2015-2016, p.245-246)	CMH 2015-2016, p.245-246	Inactive
Bidgood (Lebel)	Au 32D04SW00073	Indicated Mineral Resource - pit: 1 447 000 t @ 2.47 g/t Au Indicated Mineral Resource – U/G: 43 000 t @ 7.05 g/t Au Inferred Mineral Resource - pit: 246 000 t @ 2.88 g/t Au Inferred Mineral Resource – U/G: 136 000 t @ 7.52	Agnico Eagle Mines Limited (50%) - Yamana Gold Inc. (50%) (CMH 2015-2016, p.27-29)	Queenston Mining Inc., PR October 17, 2011	Active
Big Agaunico (Bucke)	Co 31M05NE00018	Historic: Indicated Resources of 100 000 tons @ 0.5% Co		CMH 1982-1983, p.320	Inactive
Blue Quartz (Beatty)	Au 42A09SW00130	Historic (1962) 128 000 tons of 0.86 oz per ton Au	McLaren Resources Inc. (50%)-Orla Mining Ltd. (50%)(CMH 2015-2016, p.276)	Red Mile Minerals Corp. NI 43-101 report, September 21, 2010	Inactive
Buffonta (Garrison)	Au 32D05NW00009	Historic resource: 400 000 tons of 0.15 oz per ton Au	Oban Mining Corporation., PR December 22, 2015	CMH 1997-1998, p.221	Inactive
Canamax (Holloway)	Au 32D12SE00008	Probable Mineral Reserve: 774 000 t @ 6.27 g/t Au Indicated Mineral Resource: 240 000 t @ 5.09 g/t Au Inferred Mineral Resource: 170 000 t @ 4.26 g/t Au	Kirkland Lake Gold Inc. (PR January 26, 2016)	St Andrew Goldfields Ltd., PR February 12, 2015	Active
Cheminis (McVittie)	Au 32D04SE00019	Indicated Mineral Resource: 335 000 t @ 4.07 g/t Au Inferred Mineral Resource: 1 391 000 t @ 5.22 g/t Au	Kerr Mines Inc. (CMH 2015-2016, p.245-246)	CMH 2015-2016, p.245-246	Inactive
Clenor (Strathy)	Au, Ag 31M04SW00088	Historic resource: 24 000 tons of 0.21 oz per ton Au, 1.8 oz per ton Ag	Gwen Resources Ltd. (CMH 1997-98, p.220)	GR 163	Inactive
Commodore (Lebel)	Au 32D04SW00039	Historic resource: 738 000 tons of 0.07 oz per ton Au inferred with a higher grade zone of 307 000 tons of 0.11 oz Au per ton inferred	Agnico Eagle Mines Limited (50%) - Yamana Gold Inc. (50%) (CMH 2015-2016, p.27-29)	AF KL-4447	Inactive
Creek Zone (Hislop)	Au 42A08NW00142	Indicated Resource 483 500 t @ 6.61 g/t Au Inferred Resource 367 700 t @ 5.90 g/t Au	Stroud Resources Ltd. (CMH 2015-2016, p.412)	CMH 2015-2016, p.412	Inactive
Diadem (Strathcona)	Cu, Ni 31M04SW00077	Historic resource: 450 000 tons of 0.5% Cu, 0.1% Ni to 400 feet	Northstar Gold Corp. (CLAIMaps III, January 29, 2016)	MDIR N 0045	Inactive
Duggan Zone (Knight)	Au 41P11NE000023	Historic resource: 1 114 000 tons of 0.07 oz per ton Au	Creso Exploration Inc.	George Cross Newsletter Ltd., No 39, February 25, 1997	Inactive
Eastmaque (Teck)	Au 42A01NE00043	Historic resource: 2 132 500 tons of tailings of 0.035 oz per ton Au	NA	CMH 1991-1992, p.142	Inactive

Deposit Name (Township)	Commodity MDI No.	Tonnage-Grade Estimates and/or Dimensions	Ownership References	Reserve References*	Status
Fenn-Gib (Guibord)	Au 42A08SE00121	Indicated Mineral Resource – pit: 40.8 million t @ 0.99 g/t Au Inferred Mineral Resource – pit: 23.3 million t @ 0.90 g/t Au Inferred Mineral Resource – out of pit: 1.2 million t @ 1.90 g/t Au	Lake Shore Gold Corp. (CMH 2015-2016, p.253-254)	Lake Shore Gold Corp., PR November 17, 2011	Inactive
Fort Knox (Fawcett)	Cu, Ni 41P11SE00074	Indicated Resource: 1 020 000 t @ 0.71% Ni, 0.36% Cu , 0.02% Co Inferred Resource: 1 490 000 t @ 0.67% Ni, 0.36% Cu, 0.03% Co	Wellgreen Platinum Ltd. (CMH 2012-2013, p.458)	CMH 2012-2013, p.458	Inactive
Garrcon (Garrison)	Au 32D12SW00004	Measured Mineral Resource: 15 100 000 t @ 1.07 g/t Au Indicated Mineral Resource: 14 100 000 t @ 1.16 g/t Au Inferred Mineral Resource (pit): 1 700 000 t @ 0.72 g/t Au Inferred Mineral Resource (U/G): 5 100 000 t @ 3.49 g/t Au	Oban Mining Corporation., PR December 22, 2015	Northern Gold Mining Inc. PR May 2, 2014	Active
Grey Fox (Hislop)	Au 000000001430 000000001431 000000001616	Measured & Indicated Mineral Resource: 4 700 000 t @ 4.4 g/t Au Inferred Mineral Resource: 1 300 000 t @ 4.2 g/t Au	Primero Mining Corp. (CMH 2015-2016, p.350)	CMH 2015-2016, p.350	Active
Gold Pike (Hislop)	Au 42A09SW00033	Historic Resource above 300 foot level in No.2 shaft area: 200 000 tons @ 0.09 ounce per ton Au	Oban Mining Corporation., PR December 22, 2015	Alban Exploration, press release, April 27, 1988	Inactive
Golden Harker (Harker, Holloway)	Au 32D05NW00159	Historic resource (1988) 241 436 tons of 0.178 oz per ton Au	Jubilee Gold Exploration Ltd. (CMH 2015-2016, p.241-242)	CMH 2010-2011, p.329	Inactive
Golden Highway (Michaud)	Au 42A08NE00030 42A08NE00038 42A08NE00158 42A08NE00175 42A08NE00036	Indicated Mineral Resource (pit) : 30 000 000 t @ 1.01 g/t Au Inferred Mineral Resource (pit) : 71 627 000 t @ 0.86 g/t Au Indicated Mineral Resource (out of pit): 1 080 000 t @ 3.29 g/t Au Inferred Mineral Resource (out of pit): 11 684 000 t @ 3.28 g/t Au	Moneta Porcupine Mines Inc. (CMH 2015-2016, p.291)	Moneta Porcupine Mines Inc., PR October 25, 2012	Active
Gowganda Silver (Haultain)	Ag 41P10NE00009	Indicated Mineral Resource: 1 937 520 t @ 47.5 g/t Ag	Lake Shore Gold Corp. (CMH 2015-2016, p.253-254)	CMH 2015-2016, p.253-254	Inactive
Hare Lake (Tyrrell)	Au 41P11NE00024	Historic resource: 600 000 t @ 6 g/t Au	Lake Shore Gold Corp. (CMH 2016-2016, p.253-254)	Goldeye Explorations Ltd., PR November 5, 2002	Inactive
Hislop (Hislop)	Au 42A08NW00154	Probable Mineral Reserve: 280 000 t @ 5.16 g/t Au Indicated Mineral Resource: 983 000 t @ 4.01 g/t Au Inferred Mineral Resource: 690 000 t @4.16 g/t Au	Kirkland Lake Gold Inc. (PR January 26, 2016)	St Andrew Goldfields Ltd., PR February 12, 2015	Active
Hydro Creek Big Dome (Tyrrell)	Au 41P11NE00024 New	Indicated Mineral Resource: 1 290 000 t @ 1.28 g/t Au Inferred Mineral Resource: 22 010 000 t @ 1.04 g/t Au	Lake Shore Gold Corp. (CMH 2016-2016, p.253-254)	Temex Resources Corp., PR January 15, 2014	Inactive
Iris (Harker)	Au, W 32D05NW00021	Historic resource: 769 756 tons of 0.07 oz per ton Au	The Alberta Gold Corporation (55%) – Perrex Resources Inc. (45%) (CMH 1995-96, p.289)	AF KL-3170	Inactive

Deposit Name (Township)	Commodity MDI No.	Tonnage-Grade Estimates and/or Dimensions	Ownership References	Reserve References*	Status
Jonpol (Garrison)	Au 32D12SW00044	Indicated Mineral Resource: 253 100 t @ 7.77 g/t Au Inferred Mineral Resource: 1 555 800 t @ 4.93 g/t	Oban Mining Corporation., PR December 22, 2015	Northern Gold Mining Inc. PR June 5, 2012	Inactive
Juby (Tyrrell)	Au 41P10SW00013	Indicated Mineral Resource 25 300 000 t @ 1.28 g/t Au Inferred Mineral Resource 74 200 000 t @ 0.91 g/t Au	Lake Shore Gold Corp. (CMH 2016-2016, p.253-254)	Temex Resorces Corp. PR April 29, 2013	Inactive
Kanichee (Strathy)	Cu, Ni, Au, Ag, PGE 31M04SW00022	Historic drill proven + indicated resource 2 062 505 tons of 0.412% Cu, 0.257% Ni	Temagami Gold Inc. (CLAIMaps III, January 6, 2016)	Northern Platinum Ltd, CMH 1989-1990, P.346	Active
Kerr-Addison (McGarry)	Au 32D04SE00011	Proven + Probable Reserves 771 000 tons @ 0.110 oz per ton Au (84 500 oz Au) Possible Reserves 1 299 000 tons @ 0.124 oz per ton Au (161 800 oz Au) Additional Mineral Inventory 3 051 000 tons @ 0.150 oz per ton Au 457 600 oz Au	Gold Candle Ltd.	Armistice Resources Corp., December 23, 2010	Inactive
Kerrs (Kerrs)	Au MDI000000001443	Inferred Mineral Resource: 7 041 460 t @ 1.71 g/t Au	Canoe Mining Ventures Corp. (CMH 2015-2016, p.106-107)	CMH 2015-2016, p.106-107	Inactive
Kokoko (Chambers, Cynthia)	Fe 31M04SW00096	Historic unclassified: 93 700 000 tons @ 25% Fe	J.M. Kleinboeck & D.D. Laronde (CLAIMaps III, January 6, 2016)	AF CO-0866	Inactive
Leckie (Strathy)	Au 31M04SW00090	Historic probable ore 348 240 tons @ 0.20 ounce per ton Au Historic possible 57 237 tons @ 0.17 ounce per ton Au	Stroud Resources Ltd. (CMH 2015-2016, p.412)	CMH 2000-2001, p.372	Inactive
Ludgate (Michaud, Guibord, Garrison)	Au 42A08NE00159	Indicated Mineral Resource: 522 000 t @ 4.06 g/t Au Inferred Mineral Resource: 1 396 000 t @ 3.60 g/t Au	Kirkland Lake Gold Inc. (PR January 26, 2016)	St Andrew Goldfields Ltd., PR February 12, 2015	Active
Martin-Bird (Hearst)	Au 32D04SE00143	Historic resource: 558 000 tons of 0.114 oz per ton Au	Barrick Gold Corporation (CMH 2007-2008, p.87-91)	AF KL-3752	Inactive
Matona (Tyrrell)	Au 41P11NE00014	Historic: 27 000 t @ 13.2 g/t Au	Creso Exploration Inc.	AF	Inactive
McBean-Anoki (Gauthier)	Au 32D04SW00060 32D04SW00069	Measured + indicated Mineral Resource 1 436 000 t @ 4.69 g/t Au Inferred Mineral Resource 1 558 000 t @ 4.73 g/t Au	Agnico Eagle Mines Limited (50%) - Yamana Gold Inc. (50%) (CMH 2015-2016, p.27-29)	Queenston Mining Inc., PR December 16, 2009	Inactive
McGarry (McGarry)	Au 32D04SE00013	Indicated Mineral Resource: 492 000 tons @ 0.23 ounce/ton Au Inferred Mineral Resources: 172 000 tons @ 0.17 ounce/ton Au	Kerr Mines Inc. (75%) – Jubilee Gold Inc. (25%) (CMH 2015-2016, p.245-246)	Armistice Resources Corp., NI 43-101, September 2011	Inactive
Mikwam (Noseworthy)	Au 32E05NE00004	Inferred Mineral Resource 1 810 000 t @ 2.34 g/t Au	ALX Uranium Corp. (CMH 2015-2016, p. 41-42)	CMH 2015-2016, p. 41-42	Inactive
Minto (Tyrrell)	Au 41P10NW00006	Historic resource: 225 000 tons of 0.20 oz per ton Au to 750 feet	Creso Exploration Inc.	AF	Inactive

Deposit Name (Township)	Commodity MDI No.	Tonnage-Grade Estimates and/or Dimensions	Ownership References	Reserve References*	Status
Mirado (Catharine)	Au 32D04SW00004	Inferred Mineral Resource (pit) 9 927 000 t at 1.18 g/t Au (UG) 669 000 t @ 2.90 g/t Au (N Pile) 23 000 t @ 4.71 g/t Au (Cen. Pile) 4 000 t @ 5.38 g/t Au (S Pile) 5 000 t @ 2.74 g/t Au	Orefinder Resources Inc. (CMH 2015-2016,p.324)	Orefinder Resources Inc.. PR December 9. 2013	Active
Omega (McVittie)	Au 32D04SE00017	Indicated Mineral Resource (<130masl): 4 920 000 t @ 1.39 g/t Au Indicated Mineral Resource (>130masl): 3 000 t @ 3.19 g/t Au Inferred Mineral Resource (<130masl): 3 350 000 t @ 1.80 g/t Au Inferred Mineral Resources (>130masl) : 1 340 000 t @ 4.00 g/t Au	Mistango River Resources Inc. (CMH 2015-2016, p.289-290)	Mistango River Resources Inc., PR July 10, 2013	Inactive
Potter (Munro)	Cu, Zn, Ag, Au, Co 42A09SE00015	Indicated Mineral Resource: 3 028 767 t @ 1.45% Cu, 1.19% Zn, 389.7 ppm Co, 11.1 ppm Ag, 127.5 ppb Au Inferred Mineral Resources: 2 071 101 t @ 1.08% Cu, 1.05% Zn, 301.4 ppm Co, 8.7 ppm Ag, 81.7 ppb Au	Millstream Mines Ltd. (CMH 2015-2016, p.285)	CMH 2012-2013, p.436	Inactive
Ramp Property (Beatty, Carr, Coulson, Wilkie)	Au 42A09SW00133	Historic resource: 813 414 tons of 0.235 ounce per ton Au	Globex Mining Enterprises Inc. (Globex Mining Enterprises Inc., website, January 6, 2016)	Globex Mining Enterprises Inc. website 2002	Inactive
Ross (Hislop)	Au 42A08NW00005	Historic resource: 1 055 000 tons of 0.125 oz per ton Au	Eastway International Inc.	CMH 1989-1990, p.188	Active
Ryan Lake (Powell)	Cu, Mo 41P15NE00015	Indicated Mineral Resource: 5 969 917 t @ 0.34% Cu, 0.039% Mo, 0.09 g/t Au and 5.0 g/t Ag	Pacific Comox Resources Ltd. (CMH 2015-2016, p.330)	CMH 2012-2013, p.505	Inactive
Sherman Mine (Chambers, Strathcona, Strathy)	Fe 31M04SW00025	5 years open pit reserves at time of mine closure. Underground resources unknown.	N/A	Northern Daily News, March 7, 1989	Inactive
Stairs (Midlothian)	Au 41P14NE00011	Historic: to 500 foot level Proven: 45 200 tons @ 0.88 ounce per ton Au Probable: 95 700 tons @ 0.25 ounce per ton Au	Teck Resources Limited (CLAIMaps III, February 1, 2016)	MDC 18, p158-159	Inactive
Teck Hughes (Teck)	Au 42A01NE00020	Measured + Indicated Resource 3 347 000 tons @ 0.32 ounce/t Au Inferred Resources 58 900 tons @ 0.35 ounce/t Au	Kirkland Lake Gold Inc. (CMH 2015-2016, p.249-250)	CMH 2003-2004, p.270	Inactive
Temagami Copper (Phyllis)	Cu, Ni 41I16NE00004	Historic: 770 000 tons of 1.04% Cu, 0.46% Ni	Teck Resources Limited (CLAIMaps III, January 6, 2016)	AF	Inactive
Tillex (Currie, Bownman)	Cu 42A10SE00055	Historic: 1 338 000 t @ 1.56% Cu	Metals Creek Resources Corp. (Metals Creek Resouces website, January 6, 2016)	Metals Creek Resouces website, January 6, 2016	Inactive
Tyranite (Tyrrell, Knight)	Au 41P11NE00013	Historic resource: 567 000 tons of 0.18 oz per ton Au	Creso Exploration Inc.	NM 06/93	Active
Upper Beaver (Gauthier)	Au, Cu 32D04SW00068	Indicated Mineral Resource: 6 870 000 t @ 0.37% Cu 6.62 g/t Au Inferred Mineral Resources: 4 570 000 t @ 0.36% Cu, 4.85 g/t Au	Agnico Eagle Mines Limited (50%) - Yamana Gold Inc. (50%) (CMH 2015-2016, p.27-29)	Queenston Mining Inc., PR September 26, 2012	Active

Deposit Name (Township)	Commodity MDI No.	Tonnage-Grade Estimates and/or Dimensions	Ownership References	Reserve References*	Status
Upper Canada (Gauthier)	Au 32D04SW00057	Indicated Mineral Resource – Pit: 1 721 000 t @ 2.04 g/t Au Inferred Mineral Resource – Pit: 1 308 000 t @ 1.95 g/t Au Indicated Mineral Resource – U/G: 243 000 t @ 4.73 g/t Au Inferred Mineral Resource – U/G: 4 075 000 t @ 5.38 g/t Au	Agnico Eagle Mines Limited (50%) - Yamana Gold Inc. (50%) (CMH 2015-2016, p.27-29)	CMH 2010-2011, p.484	Active
Victoria Creek (Gauthier)	Au 32D04NW00043	1 342 000 t @ 5.12 g/t Au	Agnico Eagle Mines Limited (50%) - Yamana Gold Inc. (50%) (CMH 2015-2016, p.27-29)	Queenston Mining Inc. website, January 27, 2012	Inactive
Vimy Gold Mine (Hislop	Au 42A08NW00105	Historic unclassified: 18 144 t @ 7.2 g/t Au		NMI 42A/08 AU2	

ADVANCED EXPLORATION ACTIVITY

Canadian Malartic Corp. (CMC) - Kirkland Lake Properties

Canadian Malartic Corporation (CMC) is jointly owned by Agnico Eagle (50%) and Yamana Gold (50%). CMC holds a largely contiguous 240 km^2 property package in the Kirkland Lake Gold Camp that straddles the gold associated with the Larder Lake Cadillac Deformation Zone, LLCDZ, for nearly 30 km from Kirkland Lake to east of Dobie. Key assets are located within the Gauthier Township, where the Company has NI 43-101 mineral resources on 5 properties: Upper Beaver, McBean-Anoki, Bidgood, Upper Canada and Amalgamated Kirkland. (www.canadianmalartic.com).

In 2016, the company completed geophysical surveys (resistivity/induced potential) on the Amalgamated Kirkland and Rand properties (Teck Township) in addition to linecutting on the Pawnee property (Lebel Township). Activity on the Upper Beaver property (Gauthier Township) included additional field mapping and a complete data analysis, which identified near-surface targets that are ready to drill-test in early 2017.

Moneta Porcupine Mines Inc. – Golden Highway Property

Moneta's 100% owned Golden Highway property covers 100 km^2 east of Matheson in Michaud Township. Mafic to ultramafic metavolcanic rocks with metasedimentary interlayers underlie the property. The Porcupine–Destor Deformation Zone (PDDZ) crosses the property from southwest to northeast and cuts the metavolcanic and metasedimentary rocks. The Golden Highway property hosts a NI 43-101 resource estimate (October 2012) of 1 091 200 ounces indicated (31.1 Mt at 1.09 g/t Au) plus 3 203 800 ounces inferred (83.3 Mt at 1.20 g/t Au) in 2 distinctive geological settings: the Northern Corridor consisting of metavolcanic rocks and local felsic porphyries, and the Southern Corridor defined by Timiskaming metasedimentary rocks and iron formation (www.monetaporcupine.com/s/Resources-and-Reserves.asp).

The Northern Corridor includes Moneta's Windjammer–North Area (included in NI 43-101 resource estimate), Landing Zone, Twin Creeks Zone and Last Chance Zone all have distinct similarities to the Timmins Gold Camp and the potential to host high-grade lode-gold quartz and quartz-carbonate vein deposits hosted in metavolcanic rocks. The Southern Corridor hosts most of the gold mineralization discovered to date and it follows most of the known gold resources. This corridor crosses Michaud Township and continues northeasterly into Garrison Township over a distance of 12 km and hosts the

Windjammer–South Area, Windjammer–Central Area, Windjammer–West Area, Southwest Zone, 55 Zone, Dyment3, and Western Zone gold zones.

Moneta announced a 40 000 m drill program in September, 2016 (Moneta Porcupine Mines Inc., news release, September 29, 2016), with 2 diamond drill rigs mobilized in that same month, and a third to follow early in 2017. Drilling will focus on targets in close proximity to the existing NI 43-101 gold resources (www.monetaporcupine.com).

Osisko Mining Inc. – Garrison Property

In June 2016 Oban Mining Corp. changed its name to Osisko Mining Inc. (Oban Mining Corp., news release, June 24, 2016). The Garrison property (Garrison Township), which includes the Garrcon, Jonpol and 903 zones, is located on the same claim group totalling 766 hecatares, and straddles the Porcupine–Destor Deformation Zone and the Munro Fault—its interpreted southerly splay. It is underlain by mafic and ultramafic metavolcanic rocks of the Kidd–Munro assemblage, clastic metasedimentary rocks of the Timiskaming assemblage, and Timiskaming-aged syenitic intrusive rocks. Osisko reports:

> The bulk tonnage Garrcon deposit is hosted in fine-grained Timiskaming type metasediments. The zone measures 300 m wide, extends for 1800 m along strike, and has been drilled to depths of 650 m. The zone is situated along the footwall of the Destor–Porcupine fault. Gold mineralization occurs as a broad zone of quartz vein stockworks and breccias within the metasediments.

The Jonpol deposit, consists of 4 high-grade gold mineralized zones (JP, JD, RP and East) situated on the Munro fault, a west striking splay off the north side of the Destor–Porcupine Deformation Zone. It is a shear zone tens of meters wide in altered mafic metavolcanic rocks. Gold mineralization at the Jonpol deposit is hosted in quartz carbonate veins, in mafic and ultramafic host rocks, and associated with zones of intense albite and/or sericite alteration, and pyrite mineralization. (www.osiskomining.com/projects/garrison).

Both the Garrcon and Jonpol deposits have resource estimates described in a technical report prepared in accordance with National Instrument 43-101. A.C.A. Howe International Limited prepared the technical Report for Northern Gold Mining Inc. (a wholly-owned subsidiary of Osisko). It is available on Osisko's website at www.osiskomining.com and on SEDAR® under Northern Gold Mining Inc.'s issuer profile at www.sedar.com.

In July 2016, Osisko Mining Inc. announced the commencement of a 20 000 m diamond drill program on the Garrison property (Osisko Mining Inc., news release, July 13, 2016). The drilling is to confirm previous work and to follow-up on potential higher grade underground zones at the bulk tonnage Garrcon deposit. Drilling will also be directed to further exploring the underground resource potential on the Jonpol deposit as well as the 903 Zone.

Victoria Gold Mines East Timmins Ltd. – Golden Arrow Property

The Golden Arrow property consists of 20 mining patents and leases and 11 mining claims covering more than 1377 hectares located just south of the town of Matheson in Hislop, McCann and Playfair townships. The company writes that:

> The Golden Arrow property is underlain by mafic flows and syenite intrusions with younger post mineral diabase dikes. Two syenitic intrusions are located on the property, the West Syenite which hosts the Golden Arrow deposit and the East Syenite which remains unexplored with the exception of a few short historical drill holes. Gold mineralization is generally hosted within the West Syenite intrusion and consists of a stockwork of quartz veinlets situated within a broader halo of pink to brick-red potassic

alteration with 2-3% disseminated pyrite. Most of the gold mineralization to date has been associated with the NE-trending Golden Arrow fault, a structure associated with the Porcupine–Destor Fault Zone. The property covers a 2 kilometre strike extent of this northeast-trending structure. (www.azx.ca/projects/goldenarrow).

Victoria Gold Mines East Timmins Ltd., a privately held company, continued to extract a bulk sample from the Golden Arrow deposit in Hislop Township. The mined rock was trucked to Kirkland Lake Gold Ltd.'s Holt Mill for processing.

EXPLORATION ACTIVITY

A summary of 57 active exploration projects, based on assessment filings, as reported in the Kirkland Lake Resident Geologist's District is listed in Table 4 and project localities shown in Figure 3. An expanded description of exploration on an additional 3 featured projects is listed below.

Table 4. Exploration activity in the Kirkland Lake District in 2016. Map numbers keyed to Figure 3.

Abbreviations

AM	Airborne magnetic survey	LiDAR	Light detection and ranging survey
ARA	Airborne radiometric survey	M	Ground magnetic survey
Beep	Beep Mat survey	MET	Metallurgical testing
BENEF	Beneficiation	Micro	Microscopic study
Bulk	Bulk sampling	MMI	Mobile Metal Ion™ soil sampling survey
DD	Diamond drilling	Pr	Prospecting
DGP	Down-hole geophysics	PW	Physical Work
EM	Ground electromagnetic survey	Ra	Radiometric Survey
Gc	Geochemical survey	RC	Reverse-circulation drill hole(s)
GEM	Ground electromagnetic survey	RE	Re-evaluation of surveys
GL	Geological survey	RES	Resistivity survey
GR	Geological report	SA	Sampling (other than bulk)
GRA	Ground radiometric survey	Seismic	Seismic survey
Grav	Gravity survey	Soil	Soil sampling
HLEM	Horizontal loop electromagnetic survey	SP	Self-potential survey
HM	Heavy mineral sampling	sTr	Stripping
IP	Induced polarization survey	VLEM	Vertical loop electromagnetic survey
KIM	Kimberlite indicator minerals	VLF-EM	Very low frequency electromagnetic survey
Lc	Line cutting	VTEM	Versatile time-domain electromagnetic survey

Map Number	Company/Individual (Occurrence Name or Property)	Township/Area	Exploration Activity
1	1074127 Ontario Ltd. (Coleman Property)	Coleman	M, VLF-EM
2	2254022 Ontario Ltd. (Old Adit Claim)	Benoit	Pr, SA
3	Allaire, G.A.	McCool	Gc, SA
4	Annett, R. (Historic McDonald Property)	MacMurchy	Pr
5	Ashley Gold Mines Ltd. (Lucky Strike Property)	McVittie	VLF-EM, M
6	Ashley Gold Mines Ltd./Skead Holdings Ltd. (MacMurchy East Property)	MacMurchy	M
7	Ashley Gold Mines Ltd./Skead Holdings Ltd. (MacMurchy West Property)	Churchill, MacMurchy	M
8	Brixton Metals Corp. (Hudson Property)	Coleman	RE, Pr
9	Canadian Gold Miner Corp./Transition Metals Corp. (Midlothian Property)	Midlothian	Pr, sTr, GL, Micro, SA
10	Canadian Malartic Corp. (Amalgamated Kirkland Property)	Teck	DD(19)(3066m), SA, IP, Pr
11	Canadian Malartic Corp. (Kirkland Lake Bassin Property)	Teck	Pr, SA
12	Canadian Malartic Corp. (Kirkland Lake North Property)	Teck	Pr, Gc, SA

Map Number	Company/Individual (Occurrence Name or Property)	Township/Area	Exploration Activity
13	Canadian Malartic Corp. (Kirkland Lake Property)	Boston, Gauthier, Lebel McVittie, Otto, Teck	Gc, SA
14	Canadian Malartic Corp. (Rand Property)	Teck	IP
15	Canadian Malartic Corp. (Skead-MacGregor Property)	Gauthier, McElroy	DD(5)(1475m), SA
16	Canadian Malartic Corp. (Upper Canada Property)	Gauthier	DD(9)(4838), SA
17	CJP Exploration Inc. (Tannahill Gold Property)	Tannahill	Ra
18	Cunningham. L. G. (Cunningham Property)	Holmes	DD(44)(11 355m), SA
19	Despres, L.J. (John Doh Property)	Eby	Pr
20	Elk Lake Mining Company Ltd. (Elk Lake Property)	James	VLF-EM, M
21	Elk Lake Mining Company Ltd. (Mapes-Johnston Property)	Mickle	VLF-EM, M
22	Explor Resources Inc. (Western PG-101 Project)	Holloway	Lc, M, VLF-EM
23	Goldstake Explorations Inc. (Clay Property)	McGarry, McVittie, Ossian	KIM
24	Gore, J.A.	South Lorrain	Pr
25	Harrington, M.S.	Carr	Lc, Pr
26	Harrington, M.S.	Skead	Beep
27	Hermeston, P.M	Tannahill	Pr, SA
28	Knightsbridge Exploration Ltd. (North Wind Property)	Connaught	M
29	Kon, A.D.	Bucke	M, Pr
30	Kon, A.D. (The Hound Chutes Road Claims)	Gillies Limit	Beep, SA, M
31	Lalonde, J.D. (Midlothian and Halliday Project)	Midlothian	Lc, M, VLF-EM
32	Marion, E.J.	Dokis	Pr
33	Marion, E.J.	Teck	Pr, PW, SA
34	Martel, T.P. (Lorrain Property)	Lorrain	BENEF, Pr, SA
35	Oban Mining Corp. (Cote Property)	Catharine	DD(8)(2409m), SA, GL, Lc, IP
36	O'Connor, T. A.	Teck	Pr, SA
37	Salo, A.J.	McGarry	Pr, SA
38	Shynkorenko, E.	Steele	Pr, SA
39	Skead Holdings Ltd.	Skead	SA
40	St Andrew Goldfields Ltd.	Guibord	DD(6)(1946m), SA
41	St Andrew Goldfields Ltd.	Taylor	DD(4)(3060m), SA
42	St Andrew Goldfields Ltd. (Caman Property)	Guibord	sTr, GL, SA
43	St Andrew Goldfields Ltd. (Foster-Harley Claim)	Harker	Pr, GL, SA
44	St Andrew Goldfields Ltd. (Holt and Holloway Properties)	Harker, Holloway	DD(34)(31760m), SA
45	Swain, S.L.	Nicol	Pr
46	Temagami Gold Inc.	Strathy	Pr, SA
47	Tiger Gold Exploration Corp. (Tiger-Harker Heritage Property)	Cllifford, Elliott	M
48	Tiger Gold Exploration Corp. (Tiger-Harker Heritage Property)	Elliott, Harker, Tannahill	M
49	Tiger Gold Exploration Corp. (Bradette Property)	Bradette	VLF-EM
50	Tiger Gold Exploration Corp. (Tiger-Harker Heritage Property)	Holloway, Marriott	M
51	Tiger Gold Exploration Corp. (Harker Heritage Property)	Marriott	M
52	Tiger Gold Exploration Corp. (Tiger-Harker Heritage Property)	Harker	M
53	Tinney, J.K.	Dokis	Pr, PW
54	Tinney, J.K.	Eby, Otto	Pr

Map Number	Company/Individual (Occurrence Name or Property)	Township/Area	Exploration Activity
55	Tri Origin Exploration Ltd.	Best	GL
56	Victoria Gold Mines East Timmins Ltd. (Golden Arrow Property)	Hislop	Pr
57	Young, T.A. (Gardner-Courageous Showing)	Knight	GL, SA
	Featured Projects		
A	Brixton Metals Corp. (Langis Property)	Casey	DD (in progress)
B	Prosper Gold Corp. (Ashley Gold Project)	Bannockburn	DD (in progress)
C	Tri Origin Exploration Ltd. (South Abitibi Property)	Brigstocke	DD (in progress)

Brixton Metals Corp. – Langis Property

The Langis Mine project is located in Casey Township, near Cobalt and 15 km north from Temiskaming Shores. Between 1908 and 1989 the Langis Mine produced over 10.4 million ounces of silver with a recovered grade of approximately 25 ounces of silver per ton and 358 340 pounds of cobalt from shallow depths (http://brixtonmetals.com/langis-mine/).

Near-surface geology is dominated by the Nipissing diabase intrusion, a sill-like feature that lies unconformably over conglomerates and related sediments of the of the Huronian-age Gowganda Formation, which is underlain by Archean (Keewatin Formation) brecciated basaltic volcanic rocks and metasediments. Whilst historic production focused mostly on the polymetallic veins within the Nipissing Diabase, Brixton Metals is testing both the gold and silver potential of the basement volcanic rocks – proximal to the overlying contact with the diabase sill and Huronian sediments.

Towards the end of 2016, Brixton Metals Corp. announced the completion of a 15 hole diamond drill program for a total of 3170 m on its Langis silver project, in addition to a 720 line-kilometers of a combined airborne (Quadra–Mag) high-resolution magnetics and very low-frequency electromagnetic survey (Brixton Metals Corp., news release, October 25, 2016). Diamond-drill hole LM-16-03 intersected 4.15 m grading 4.90 g/t gold and 397.00 g/t silver, including 0.22 m grading 74.90 g/t gold and 5236.40 g/t silver.

Prosper Gold Corp. – Ashley Gold Project

The Ashley Gold project is located in the northeastern corner of Bannockburn Township, approximately 17 km west of Alamos Gold Inc. Young–Davidson Mine along Highway 566. Prosper Gold Corp. acquired the property through an option agreement with R. W. Salo, J. E. Robert, D. M. Lefort and A. D. McLellan (Prosper Gold Corp., news release, February 29, 2016). The project is centred on the old Ashley Mine, which produced 50 099 ounces of gold from 157 636 tons of ore (0.32 ounce/ton) from the main Ashley vein between 1932 and 1937. The project lies on the western extension of the Cadillac–Larder Deformation Zone (CLDZ). Mineralization is hosted in Archean Tisdale Group basalt, with felsic and intermediate metavolcanic rocks to the north and south (http://www.prospergoldcorp.com). Prosper notes that there are several syenite bodies intruding the metavolcanic rocks that offer exploration targets similar to the setting of the nearby Young–Davidson Mine, where gold occurs in quartz stockworks and veinlets in a syenite host.

Airborne geophysical surveys were completed in August, 2016, and preliminary magnetic, resistivity and gravity results were used in drill targeting for structural definition and stratigraphic refinement. To this end, Prosper Gold Corp. announced the commencement of a 7500 m drill program at the Ashley Gold Project the following month (Prosper Gold Corp., news release, September 6, 2016).

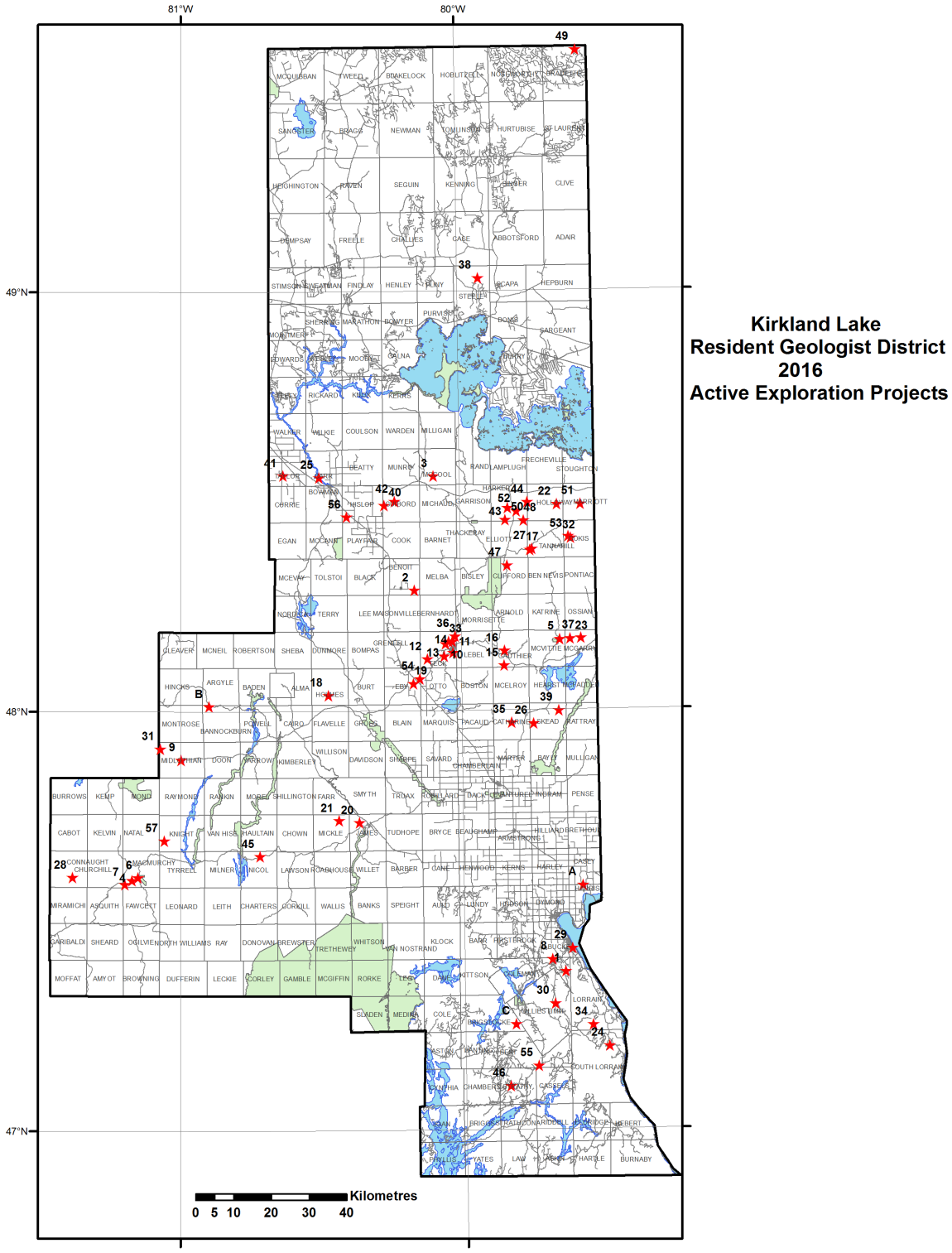

Figure 3. Active exploration projects in the Kirkland Lake Resident Geologist District in 2016; numbered red dots are keyed to Table 4.

Tri Origin Exploration Ltd. – South Abitibi Property

In 2015, Tri Origin Exploration Ltd. in alliance with Sumac Mines Ltd., a subsidiary of Sumitomo Metal Mining Co. Ltd. acquired claims in Brigstocke Township, which is situated in the Cobalt–Temagami area. Known as the South Abitibi project, the companies are targeting gold and base metals along the southern margin of the Abitibi greenstone belt of Ontario. Tri Origin is the operator of the project and Sumac is funding property acquisition and early stage exploration activities (www.triorigin.com/projects).

The South Abitibi project encompasses some 300 km^2 of Archean-age mafic to intermediate metavolcanic and intrusive rock overlain by Proterozoic-age sedimentary rocks of variable thickness. These cover rocks precluded historic prospecting along this portion of the Abitibi, also restricted by the limited the effectiveness of earlier geophysical equipment which had minimal depth penetration ability.

Early stage prospecting and geologic mapping conducted by Tri Origin Exploration Ltd., was followed by a 5000 line-kilometer versatile time domain electromagnetic (VTEM-Plus) and magnetic airborne geophysical survey in 2015 (Tri Origin Exploration Ltd., news release, October 15, 2015). A number of electromagnetic anomalies were detected. Many of the responses exhibit characteristics representative of buried sulphide mineralization in bedrock (Tri Origin Exploration Ltd., news release, March 7, 2016). A 7 hole, 3150 m diamond drilling program targeting several geophysical anomalies, was completed by year end (Tri Origin Exploration Ltd., news release, December 20, 2016). Assay results have yet to be released.

RESIDENT GEOLOGIST STAFF AND ACTIVITIES

In 2016, the Kirkland Lake's Resident Geologist office was staffed by D. Guindon, *P.Geo.,* Regional Resident Geologist (January–November), P. Chadwick, *P.Geo.,* Regional Resident Geologist (December), L. Hall, *P.Geo.*, Acting District Geologist (January–February), J. Suma–Momoh, District Geologist (March–December), and N. Sabiri, District Geological Assistant. A. Wilson, *P.Geo.,* the Mineral Deposit Inventory Geologist and C. Daniels, *P.Geo.*, the Regional Land Use Geologist, both from the Timmins office, contributed to this report in their respective sections. C. Steckle was the Summer Experience Program Student from June to August. The activities of the Kirkland Lake Regional Resident Geologist Office in 2016 are summarized in Table 5.

Table 5. Summary of activities of the Kirkland Lake Regional Resident Geologist Office in 2016.

Activity	Number
Office Visit Inquiries	899
Telephone/email Inquiries	303
Remote Inquiries*	106
Properties Visited	24
Field Trips Attended	6
Field Trips Given	6
Talks Given	3
Assessment Files and Donations Processed	184
Titles Added to Library Database	42
Drill Holes Added to Drill Core Library	0
MDI Records Updated	74
MDI Records Deleted	3
MDI Records Added	0

**Personal out-of-office (field/property visit, public meeting or conference).*

During the course of the year, Kirkland Lake Regional Office staff provided 1308 individual services (client inquiries) to 1104 clients, processed 184 assessment work reports (Table 6) and performed 24 property visits (Table 9; Figure 4). Staff attended various industry related events including the Northeastern Ontario Mines and Minerals Symposium (Sudbury), the Northwestern Ontario Mines and Minerals Symposium (Thunder Bay) and the Big Event (Timmins). Office staff also contributed display and presentation material for the Association for Mineral Exploration British Columbia Mineral Exploration Roundup (Vancouver) and the Prospectors and Developers Association of Canada Convention (Toronto). C. Steckle, the summer experience student, assisted with ongoing office projects, which included the sorting and refiling of mine shut-down plans and assistance on property visits.

A total of 42 publications were received, as listed in Table 8, and entered into the Kirkland Lake District library database.

Under the guidance of A. Wilson, the Northeastern Mineral Deposit Inventory Geologist, 74 Mineral Deposit Inventory (MDI) records were updated, 3 deleted and no new records created by Kirkland Lake office staff for the Kirkland Lake district (Table 5). Additional changes to the MDI database are reported in Table 13 (*see* "Mineral Deposit Compilation Geologist – Northeastern Ontario").

Drill Core Storage Site

The Kirkland Lake Resident Geologist District operates an indoor Drill Core Library (DCL) within the municipality of Kirkland Lake, and a Remote Drill Core Storage Site (RDCSS) west of Kirkland Lake in Burt Township.

During 2016, work at the RDCSS included vegetation control and the installation of 3 back-to-back, roofed core racks. In addition, a total of 1281 core boxes were transferred from 26 pallets and repacked into new boxes and shelved in core racks.

There was no donated core received during 2016.

PROPERTY VISITS

During 2016, a total of 24 properties were visited by Kirkland Lake District Office staff as listed in Table 9, and the locations of these properties are keyed to the property number as shown in Figure 4.

Forwood Property

The Forwood property is located in Katrine Township, north of the town of Larder Lake. To access the property, travel east from Kirkland Lake to Larder Lake along Highway 66. Turn left on Killarney Road and continue for approximately 14.2 km. From this point, use a utility terrain vehicle (UTV) and travel along the road branching west for about 7.0 km to the centre of the property.

Hogg (1964) conducted geological mapping on Katrine and Arnold townships and shows the Forwood property in the southwest corner of Katrine Township, an area underlain by dacite, andesite, and basalt.

Forwood Mining Syndicate carried out pitting, trenching, and the sinking of a vertical shaft to a depth of 30 feet (approximately 9.1 m) in 1943. Chip samples from 5 trenches returned 0.65 to 1.80% copper across 4 to 8.5 feet (1.2 to 2.6 m). A reported 418 pounds (0.2 tonnes) of ore from trench No. 4 returned 1.77% copper, 0.0025 ounces/ton (0.08 g/t) gold, and 0.26 ounces/ton (8.13 g/t) silver. In 1954, Mogul Mining Corp. optioned the property and completed 5 diamond-drill holes totaling 2002 feet (610 m).

Results from the drilling showed the area to be underlain by fractured pillowed andesite, containing quartz and quartz-carbonate stringers. Misema Lake Mining Corp. completed 7 diamond-drill holes totaling 2017 feet (614 m) on the property in 1960 and reported 1.06% copper over 24 inches (0.6 m) in hole No. 1; and 4.4% copper over 12 inches (0.3 m) in hole No. 2. The remaining holes showed abundant quartz veining with occasional sulphide mineralization consisting of chalcopyrite, pyrite, and seams of pyrrhotite (Assessment File KL-0876).

The property was visited by J. Suma–Momoh and C. Steckle. An open cut was encountered at 594273E 5338825N (NAD83 UTM Zone 17), which measures approximately 2.5 m in diameter and approximately 2 m deep (depth to water surface). Much of the rock surfaces are covered by lichens and mosses, making it difficult to identify any relevant structural feature. One grab sample was collected from each of the west and east ends of the pit. The host rock is a dark green, aphanitic, nonmagnetic, relatively unaltered basalt, and locally contains up to 2% disseminated, fine-grained, cubic (approximately 1 mm) pyrite mineralization. Trace pyrite is also observed in quartz along fracture-fills. The 2 samples yielded less than 150 ppm of copper and zinc.

About 25 m further to the northeast from the open cut is a 20 m long by 4 m wide by 3 m deep trench, trending due north at 594296E 5338846N (NAD83 UTM Zone 17). Unlike the open pit, the trench is dry. A 3 cm wide, near-vertical, white quartz vein trending 34° is exposed on the north face of the trench (Photo 1). The quartz vein contains solution cavities, approximately 5% blebby chalcopyrite and trace pyrite mineralization. A small sample of the quartz vein returned less than 200 ppm of copper and zinc. Immediately south of the trench, downhill, is a vertical shaft (Forwood shaft, MDI32D04NE00029) with a wooden framework. The shaft is deep (at least 10 m) and contains water. Unfortunately, for safety reasons samples couldn't be collected from this site.

There is a trail approximately 10 m south of the shaft. This trail heads southeast and was followed in order to return to the UTV. Outcrops of basalt are encountered along the trail.

Photo 1. North face of trench with 3 cm wide near-parallel, pyrite-chalcopyrite-bearing quartz vein at UTM 594296E 5338846N; looking north. Magnet pen is 12.3 cm long.

Table 6. Assessment files received in the Kirkland Lake Resident Geologist District in 2016.

Abbreviations

AEM ..... Airborne electromagnetic survey
AGRAD ..... Airborne gravity gradiometric survey
AM ..... Airborne magnetic survey
Anlys ..... Analysis
ARA ..... Airborne radiometric survey
ASD ..... Assay data
Assays ..... Assays (standard metallic)
AVLF-EM ..... Airborne very low frequency E survey
Beep ..... Beep Mat survey
BENEF ..... Beneficiation
BORE ..... Boring, other than core
Bulk ..... Bulk sampling
Comp ..... Compilation
Consult ..... First Nations consultation
DD ..... Diamond drilling
DDH ..... Diamond drill hole(s)
DGP ..... Down-hole geophysics
EM ..... Ground electromagnetic survey
ENV ..... Environmental study
Gc ..... Geochemical survey
GEM ..... Ground electromagnetic survey
GL ..... Geological survey
GM ..... Ground magnetic survey
GPSG ..... Georeferencing
GR ..... Geological report
GRA ..... Ground radiometric survey
Grav ..... Gravity survey
HLEM ..... Horizontal loop electromagnetic survey
HM ..... Heavy mineral sampling
IGD ..... Interpretation of geophysical data
IM ..... Industrial mineral testing and marketing
Interp ..... Interpretation
IP ..... Induced polarization survey
Lc ..... Line cutting
LiDAR ..... Light detection and ranging survey
M ..... Ground magnetic survey
Man ..... Manual labour
MET ..... Metallurgical testing
MICRO ..... Microscopic study
MMI ..... Mobile Metal Ion™ soil sampling survey
MRE ..... Mineral resource estimate (NI 43-101)
OD ..... Overburden drilling
OvD ..... Overburden drill hole(s)
Other ..... Other study
PEA ..... Preliminary economic assessment
PEM ..... Pulse electromagnetic survey
Pet ..... Petrographic analyses
PGM ..... Platinum group metals
Pr ..... Prospecting
PStrip ..... Overburden stripping
PW ..... Physical work
Ra ..... Radiometric Survey
RC ..... Reverse-circulation drill hole(s)
RE ..... Re-evaluation of surveys
Rehab ..... Rehabilitation
REP ..... Technical report (NI 43-101)
Rpt ..... Report, unspecified work type
RES ..... Resistivity survey
SA ..... Sampling (other than bulk)
Seismic ..... Seismic survey
Soil ..... Soil sampling
SP ..... Self-potential survey
sTr ..... Stripping
TEM ..... Time domain electromagnetic survey
Tr ..... Trenching
UG ..... Underground exploration/development
VLEM ..... Vertical loop electromagnetic survey
VLF-EM ..... Very low frequency electromagnetic survey
VTEM ..... Versatile time-domain electromagnetic survey

Township/Area	Company Filing Report	Year	Work Performed	AFRO Number	Resident Geologist Office File Designation
Adair	Yorbeau Resources Inc. (Normetal Property)	2015	DD(1)(321m), SA	2.56509	KL-7115
Argyle, Bannockburn, Montrose	Salo, R. W. (Ashley Property)	2015	Pr, SA	2.56324, 2.56390	KL-7130, KL-7131
Arnold	CJP Exploration Inc. (A1 Property)	2014	Beep, Ra	2.56515, 2.56516, 2.56517	KL-7132, KL-7133, KL-7134
Arnold	Gold Diamet Resources Ltd. (A1 Property)	2013-2014	M	2.54695	KL-7175
Beatty	Primero Mining Corp. (Black Fox North Property)	2015	Gc, GL, Pr, SA, RS	2.56195	KL-7090
Benoit	Lance, H. Eden	2015	Pr, SA	2.56119	KL-7089
Benoit	Northern Gold Mining Inc. (Wolf Lake Property)	2015	GL, SA	2.56423	KL-7105
Benoit	2254022 Ontario Ltd. (Old Adit Claim)	2015-2016	Pr, SA	2.56997	KL-7188

Township/Area	Company Filing Report	Year	Work Performed	AFRO Number	Resident Geologist Office File Designation
Best	Tri Origin Exploration Ltd.	2016	GL	2.56976	CO-3916
Boston, Gauthier, Lebel McVittie, Otto, Teck	Canadian Malartic Corporation (Kirkland Lake Property)	2013-2016	Gc, DD(9)(4838m), DD(93)(43358m), SA	2.55815, 2.56757, 2.56010	KL-7063, KL-7075, KL-7086
Bowman, McCann	Good Mining Exploration Inc. Bow-Mac Project (CanREE & Golden Target Prospects)	2014	DD(28)(3087m), SA, PW, Pr, VLF	2.56219	KL-7091
Bradette	Tiger Gold Exploration Corporation (Bradette Property)	2016	M, VLF-EM	2.56805, 2.56995	KL-7163, KL-7187
Bucke	Kon, A.D.	2016	M, Pr	2.56930	CO-3914
Burrows	Transition Metals Corp. (Jumping Moose Property)	2015	RE, SA	2.56341	CO-3900
Cairo	Golden Valley Mines Ltd. (Matachewan Property)	2015	Pr	2.56323	KL-7098
Carr	Harrington, M.S.	2015-2016	Lc, Pr	2.57062, 2.57166	KL-7203, KL-7207
Catharine, Marter, Pacaud	Oban Mining Corporation (Cote Property)	2015-2016	Lc, IP, DD(8)(2409m), SA, GL, rTr	2.56788, 2.57100, 2.56487	KL-7167, KL-7204, KL-7112
Catharine, McElroy	Rapski, J. P. (Catharine Property)	2015	M, VLF	2.56319	KL-7097
Catharine, Pacaud	Northstar Gold Corp. (Miller Gold Project)	2014	IP	2.56585	KL-7118
Churchill, MacMurchy	Ashley Gold mines Limited/ Skead Holdings Ltd. (MacMurchy West Property)	2016	M	2.56894	CO-3911
Cleaver	Warford, V. W.A. (Warford Property)	2015	GL, SA	2.56295	KL-7094
Clifford	Tiger Gold Exploration Corporation (Tiger- Harker Heritage-Area 1)	2015-2016	Pr, Ra, Beep, M	2.56604, 2.56473, 2.56500, 2.56684	KL-7137, KL-7135, KL-7136, KL-7070
Clifford, Elliott	Tiger Gold Exploration Corporation (Tiger- Harker Heritage- Area 2, 3, 4, 5)	2015-2016	M, Pr, Beep, Ra	2.56823, 2.56655, 2.56607, 2.56544, 2.56599, 2.56562, 2.56563, 2.56606, 2.56601, 2.56561	KL-7080, KL-7160, KL-7138, KL-7173, KL-7078, KL-7142, KL-7139, KL-7140, KL-7069, KL-7141
Coleman	Brixton Metals Corporation (Hudson Property)	2016	RE, Pr	2.56787	CO-3904
Coleman	1074127 Ontario Ltd. (Coleman Property)	2016	M, VLF-EM	2.56969	CO-3915
Connaught	Beecham, A.W. (Mataris Lake Showing Area)	2015	Gc, SA	2.56502	CO-3902
Connaught	Knightsbridge Exploration Ltd. (North Wind Property)	2016	M	2.56895	CO-3913
Cook, Garrison, Guibord, Holloway, Marriott, Thackeray	St Andrew Goldfields Ltd. (St Andrew Goldfields Properties)	2013-2015	Gc, SA	2.56257	KL-7093

Township/Area	Company Filing Report	Year	Work Performed	AFRO Number	Resident Geologist Office File Designation
Dokis	Marion, E.J.	2015-2016	Pr	2.56810, 2.57172	KL-7122, KL-7210
Dokis	Tinney, J. K.	2015-2016	Pr, PW	2.56299, 2.56858	KL-7095, KL-7124
Donovan	Ashley Gold Mines Limited (Thompson Silver Property)	2015	Pr	2.56300	CO-3910
Donovan	Ashley Gold Mines Limited (Donovan Property)	2016	M	2.57155	CO-3924
Eby	Despres, L.J. (John Doh Property)	2015-2016	Pr	2.56875	KL-7125
Eby	Marion, E.J. The 1	2015	SA	2.56212	KL-7061
Eby, Otto	Tinney, J.K.	2015-2016	Pr	2.56940	KL-7182
Elliott	Tiger Gold Exploration Corporation (Tiger-Harker Heritage-Area 6)	2015-2016	Ra, Beep, Pr, M	2.56499, 2.56581, 2.56645, 2.56728	KL-7143, KL-7144, KL-7161, KL-7162
Elliott	Tiger Gold Exploration Corporation (Tiger-Harker Heritage-Area 7)	2015	Ra, Beep, Pr, M	2.56536, 2.56582, 2.56646, 2.56725	KL-7145, KL-7146, KL-7147, KL-7148
Elliott, Harker, Holloway, Tannahill	Tiger Gold Exploration Corporation (Tiger-Harker Heritage- Area 8)	2015-2016	M, Beep, Ra, Pr	2.56724, 2.56583, 2.56495, 2.56653	KL-7071, KL-7068, KL-7149, KL-7150
Flavelle	Rapski, J. P. (Lucky Irish Property)	2014-2015	DD(9)(1187m), SA	2.56316	KL-7096
Gauthier, McElroy	Canadian Malartic Corporation (Skead-MacGregor Property)	2015-2016	DD(5)(1475m), SA	2.56658	KL-7084
Gillies Limit	Kon, A.D. (The Hound Chutes Road Claims)	2015-2016	Beep, SA, M	2.56704, 2.56485	CO-3896, CO-3901
Guibord	St Andrew Goldfields Ltd.	2014-2016	DD(6)(1946m), SA	2.56685	KL-7126
Guibord	Anderson, A. (HWY 572 Property)	2015	SA	2.56409	KL-7104
Guibord	St Andrew Goldfields Ltd. (Caman Property)	2014-2016	sTr, GL, SA	2.57019	KL-7199
Harker	Tiger Gold Exploration Corporation (Tiger -Harker Heritage- Area 9, 10)	2015-2016	Beep, M, Ra, Pr, M	2.56579, 2.56580, 2.56826, 2.56566, 2.56498, 2.56650, 2.56727	KL-7066, KL-7067, KL-7082, KL-7151, KL-7152, KL-7153, KL-7154
Harker	St Andrew Goldfields Ltd. (Foster-Harley Claim)	2015-2016	Pr, GL, SA	2.56616	KL-7120
Harker, Elliott	Tiger Gold Exploration Corporation (Tiger-Harker Heritage- Area 13)	2016	M, Ra, Beep, Pr	2.56824, 2.56546, 2.56565, 2.56656	KL-7081, KL-7159, KL-7077, KL-7079
Harker, Holloway	St Andrew Goldfields Ltd. (Holt and Holloway Properties)	2014-2016	DDH(34)(31760m), SA	2.56925	KL-7181
Haultain, Nicol	Castle Silver Mines Inc./ Mines d'Argent Castle (Castle Silver Property)	2013-2015	Pr, sTr, PW, Gc, SA	2.56259	CO-3897

Township/Area	Company Filing Report	Year	Work Performed	AFRO Number	Resident Geologist Office File Designation
Hislop	St Andrew Goldfields Ltd. (Hislop Property)	2015	M	2.56377	KL-7101
Hislop	St Andrew Goldfields LTD	2014-2015	DD(35)(10486m), SA	2.56481	KL-7109
Hislop	Victoria Gold Mines(East Timmins) Limited (Golden Arrow Property)	2014-2016	Pr, DD(18)(2609m), SA	2.56970, 2.56993	KL-7183, KL-7185
Holloway	Explor Resources Inc. (Western PG-101 Project)	2016	Lc, M, VLF-EM	2.56732	KL-7178
Holloway, Marriott	Tiger Gold Exploration Corporation (Tiger-Harker Heritage- Area11)	2015-2016	Ra, Beep, M	2.56474, 2.56496, 2.56545, 2.57113	KL-7065, KL-7155, KL-7156, KL-7205
Holloway, Tannahill	Brandy Brook Mines Limited (Tannahill Property)	2015	M, VLF-EM	2.56362, 2.56387	KL-7100, KL-7102
Holmes	Cunningham. L. G. (Cunningham Property)	2011-2016	DD(44)(11 355m), SA	2.56744	KL-7128
Holmes	Mclean, A.C. (McLean Property)	2011-2013	DD(9)(2331m)	2.54032	KL-7168
James	Elk Lake Mining Company Limited (Elk Lake Property)	2016	VLF-EM, M	2.56669, 2.56605	CO-3892, CO-3893
Katrine	Dellelce, P. M (Misema Property)	2015	Pr, SA	2.56597	KL-7121
Knight	Young, T.A. (Gardner-Courageous Showing)	2016	GL, SA	2.57064	CO-3920
Leith	Ashley Gold Mines Limited (Hudson Bay Property)	2015	Beep, Ra	2.56424, 2.56354	CO-3890, CO-3907
Leonard, Tyrrell	Wilcox, W.S. (Goganda West Claims)	2014-2015	sTr, SA	2.56522	CO-3912
Lorrain	Martel, T.P. (Lorrain Property)	2014-2016	BENEF, Pr, SA	2.56664	CO-3891
Lorrain	CJP Exploration Inc. (Cabo Property)	2015	Beep	2.56568	CO-3908
MacMurchy	Annett, R. (Historic McDonald Property)	2016	Pr	2.56890	CO-3919
MacMurchy	Ashley Gold Mines Limited/ Skead Holdings Ltd. (MacMurchy East Property)	2016	M	2.56864	CO-3894
Marriott	Tiger Gold Exploration Corporation (Tiger-Harker Heritage- Area12)	2015-2016	Ra, Beep, M	2.56472, 2.56567, 2.56733	KL-7064, KL-7157, KL-7158
Marriott	Tiger Gold Exploration Corporation (Harker-Heritage Property Area14)	2016	M	2.57154	KL-7206
McCool	Lalonde, D.J.	2015	Pr, SA	2.56459, 2.56460, 2.56461	KL-7106, KL-7107, KL-71078

Township/Area	Company Filing Report	Year	Work Performed	AFRO Number	Resident Geologist Office File Designation
McCool	Lalonde, D. J.	2015	Pr, SA	2.56484, 2.56491, 2.56507, 2.56508, 2.56523, 2.56471, 2.56482, 2.56470	KL-7110, KL-7111, KL-7113, KL-7114, KL-7164, KL-7170, KL-7171, KL-7195
McCool	Allaire, G.A.	2016	Gc, SA	2.56971	KL-7197
McGarry	Salo, A.J.	2015-2016	Pr, SA	2.56643	KL-7177
McGarry, McVittie, Ossian	Goldstake Explorations Inc. (Clay Property)	2015-2016	KIM	2.57026	KL-7200
McVittie	Ashley Gold Mines Limited (Lucky Strike Property-Lemieux Area)	2016	M, VLF-EM	2.56821, 2.56822, 2.56994	KL-7083, KL-7129, KL-7186
McVittie	DRC Explorations (Monocle Lake Property)	2015	M, VLF-EM	2.56406	KL-7103
Michaud	Moneta Porcupine Mines Inc. (Golden Highway Project)	2015	DD(48)(21 307m), SA	2.56510	KL-7117
Michaud	O'Connor, T.A.	2016	Pr, SA	2.57229	KL-7211
Mickle	Elk Lake Mining Company Limited (Mapes-Johnston Property)	2016	M, VLF-EM	2.56840, 2.56996	CO-3895, CO-3918
Midlothian	Kiska Metals Corp. (Midlothian Project)	2015	Pr, Gc, SA	2.56330	KL-7099
Midlothian	Lalonde, J.D. (Midlothian and Halliday Project)	2015-2016	PW, Pr, Lc, M, VLF-EM	2.56974, 2.57007	KL-7172,KL-7189
Midlothian	Canadian Gold Miner Corp./Transition Metals Corp. (Midlothian Property)	2015-2916	Pr, sTr, GL, Micro, SA	2.56989	KL-7198
Munro, Warden	2333382 Ontario Inc. (Warden Dunite Property)	2015	Pr, Gc, SA	2.56617	KL-7092
Munro, Warden	Jubilee Gold Exploration Ltd. (Munro North Property)	2015	Gc	2.56587	KL-7174
Nicol	Swain, S.L.	2014-2015	SA	2.56201	CO-3887
Nicol	Transition Metals Corp. (Orphan Claim-Haultain Project)	2015	Pr, GL, SA	2.56393	CO-3889
Nicol	Swain, S.L.	2016	Pr	2.57111	CO-3921
Skead	Harrington, M.S.	2016	Beep	2.56848	KL-7179
Skead	Skead Holdings Ltd.	2011-2016	SA	2.57142	KL-7208
South Lorrain	Gore, J.A.	2016	Pr	2.57117	CO-3923
Steele	Shynkorenko, E.	2016	Pr, SA	2.56876	KL-7180

Township/Area	Company Filing Report	Year	Work Performed	AFRO Number	Resident Geologist Office File Designation
Strathy	Temagami Gold Inc. (Arsenic Lake Grid/Muck pile Sampling)	2015-2016	Pr, SA, M	2.56331, 2.56361, 2.56718	CO-3899, CO-3888, CO-3903
Tannahill	Brandy Brook Mines Limited (Tannahill Property)	2014-2015	rTr, SA, GL	2.56442, 2.56986	KL-7085, KL-7196
Tannahill	CJP Exploration Inc. (Tannahill Gold Property)	2016	Ra	2.56576	KL-7116
Tannahill	Hermeston, P.M	2015-2016	Pr, SA	2.56602	KL-7176
Taylor	St Andrew Goldfields Ltd.	2014-2016	DD(4)(3060m), SA	2.56589	KL-7119
Teck	Marion, E.J.	2015-2016	Pr, PW, SA	2.56860, 2.57114	KL-7123, KL-7209
Teck	O'Connor, T. A.	2015-2016	Pr, SA	2.56688	KL-7127
Teck	O'Connor, T.A.	2016	Pr, SA	2.57241	KL-7212
Teck	Kirkland Lake Gold Inc.	2014-2015	DD(13)(18,436ft), SA	2.56458	KL-7062
Teck	Canadian Malartic Corporation (Amalgamated Kirkland Property)	2015-2016	IP, DD(19)(3066m), SA	2.56798, 2.56756	KL-7072, KL-7074
Teck	Canadian Malartic Corporation (Goldbanks Property)	2011-2016	IP, DD(21)(6160m), SA	2.56799, 2.56709	KL-7073, KL-7088
Teck	Canadian Malartic Corporation (Rand Property)	2016	IP	2.56812	KL-7076
Teck	Canadian Malartic Corporation (Federal Mine Property)	2016	Pr, SA	2.56841, 2.57052, 2.57053	KL-7087, KL-7201, KL-7202
Teck	Canadian Malartic Corporation (Kirkland Lake North/Kirkland Lake Bassin Properties)	2011-2015	Pr, Gc, SA	2.56796, 2.56797, 2.56842	KL-7166, KL-7169, KL-7184
Van Hise	Nemcsok, M.S.(Alpine Silver Mine Project 2015)	2015	Pr, GL	2.56429	CO-3898
Van Nostrand, Whitson	Ashley Gold Mines Limited (Anvil Property)	2015-2016	M, VLF-EM	2.56277, 2.56296, 2.57112	CO-3905, CO-3906, CO-3922

Table 7. Claims recorded and assessment work filed in the Kirkland Lake Resident Geologist District in 2016.

Year	Cancelled (Claim Units)	Recorded (Claim Units)	Active (Claim Units)	Total ($)
2016	2925	7493	30 713	25 542 657
2015	6458	3556	25 666	4 719 357
2014	7449	2501	28 602	14 331 530
2013	N/A	N/A	N/A	25 531 304
2012	8131	5970	36 601	27 037 497
2011	N/A	N/A	N/A	27 780 764
2010	10 497	7538	38 306	19 246 271
2009	8736	5126	39 636	27 939 265
2008	N/A	N/A	N/A	16 782 293
2007	N/A	N/A	N/A	15 606 666
2006	8213	10 131	42 185	17 389 166
2005	12 989	5830	40 500	8 575 417

N.B., Claim data for years 2009, 2010, 2012 and 2014 to 2016 are for the Larder Lake Mining Division. Assessment work for 2013 and 2014 does not include the amount approved for claim georeferencing.

Table 8. Publications received by the Kirkland Lake Resident Geologist office in 2016.

Title	Author	Type and Year of Publication (office collection code)
Reports of Activities, 2015 RGP Kirkland Lake Regional Resident Geologist Report: Kirkland Lake and Sudbury Districts 2016	Guindon, D.L et al.	Ontario Geological Survey OFR 6318, 106 p. (106318)
Reports of Activities, 2015 RGP Red Lake Regional Resident Geologist Report: Red Lake and Kenora Districts 2016	Lichtblau, A.F. et al.	Ontario Geological Survey, OFR 6314, 130p. (106314)
A Library of Standards for Rock Names, Rock Modifiers and Terms Related to Structure, Alteration, Mineralization and Minerals for Precambrian Rocks. 2016	Muir, T.L., Buse, S., Trowell, N.F. and Duget, M.	Ontario Geological Survey, OFR 6289 (106289)
Komatiites reveal a hydrous Archaean deep-mantle reservoir. 2016	Sobolev, A., Asafov, E.V., Gurenko, A.A., Arndt, N.T., Batanova, V.G., Portnyagin, M.V., Garbe-Schonberg, D. and Krasheninnikov, S.	Nature, Vol. 531, P.628-636. (15320)
Map 82826 Airborne Magnetic and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Shaded colour image of the second vertical derivative, Smooth Rock Falls area, OGS, Map 82826, scale: 1:50 000 (482826)
Map 82 813 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma ray spectrometer surveys. Colour-filled contours of the residual magnetic field, Smooth Rock Falls area, OGS, Map 82 813, scale: 1:50 000 (482813)
Map 82 812 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma ray spectrometer Surveys. Colour-filled contours of the residual magnetic field, Smooth Rock Falls Area, OGS, Map 82 812, scale: 1:50 000 (482812)
Map 82 810 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma ray spectrometer surveys. Colour-filled contours of the residual magnetic field, Smooth Rock Falls area, OGS, Map 82 810, scale: 1:50 000 (482810)

Title	Author	Type and Year of Publication (office collection code)
Map 82 809 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma ray spectrometer surveys. Colour-filled contours of the residual magnetic field, Smooth Rock Falls area, OGS, Map 82 809, scale: 1:50 000 (482809)
Map 82 808 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma ray spectrometer surveys. Colour-filled contours of the residual magnetic field, Smooth Rock Falls area, OGS, Map 82 808, scale: 1:50 000 (482808)
Map 82837 Airborne Magnetic and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Ternary radio-element image, Smooth Rock Falls area, OGS, Map 82837, scale: 1:50 000 (482837)
Map 82 817 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma ray spectrometer surveys. Shaded colour image of the second derivative of the residual magnetic field & K coefficient, Smooth Rock Falls area, OGS, Map 82 817, scale: 1:50 000 (482817)
Map 82833 Airborne Magnetic and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Ternary radioelement image, Smooth Rock Falls area, OGS, Map 82833, scale: 1:50 000 (482833)
Map 82 818 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma ray spectrometer surveys. Shaded colour image of the second derivative of the residual magnetic field & K coefficient, Smooth Rock Falls area, OGS, Map 82 818, scale: 1: 50 000 (482818)
Map 82825 Airborne Magnetic and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Shaded colour image of the second vertical derivative, Smooth Rock Falls area, OGS, Map 82825, scale: 1:50 000 (482825)
Map 82822 Airborne Magnetic and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Shaded colour image of the second vertical derivative, Smooth Rock Falls area, OGS, Map 82822, scale: 1:50 000 (482822)
Map 82815 Airborne Magnetic and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Colour-filled contours of the residual magnetic field, Smooth Rock Falls area, OGS, Map 82815, scale: 1:50 000 (482815)
Map 82814 Airborne Magnetic and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Colour-filled contours of the residual magnetic field, Smooth Rock Falls area, OGS, Map 82814, scale: 1:50 000 (482814)
Map 82811 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Colour-filled contours of the residual magnetic field, Smooth Rock Falls area, OGS, Map 82811, scale: 1:50 000 (482811)
Map 82836 Airborne Magnetic and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Ternary radioelement image, Smooth Rock Falls area, OGS, Map 82836, scale: 1:50 000 (482836)
Map 82 830 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Ternary radioelement image, Smooth Rock Falls area, OGS, Map 82 830, scale: 1:50 000 (482830)
Map 82 806 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Colour-filled contours of the residual magnetic field, Smooth Rock Falls area, OGS, Map 82 806, scale: 1: 50 000 (482806)

Title	Author	Type and Year of Publication (office collection code)
Map 82 805 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Colour-filled contours of the residual magnetic field, Smooth Rock Falls area, OGS, Map 82 805, scale: 1:50 000 (482805)
Map 82 835 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Ternary radioelement image, Smooth Rock Falls Area, OGS, Map 82 835, scale: 1:50 000 (482835)
Map 82 834 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma- ray spectrometer surveys. Ternary radioelement image, Smooth Rock Falls area, OGS, Map 82 834, scale: 1:50 000 (482834)
Map 82 816 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Shaded colour image of the second derivative of the residual magnetic field & K coefficient, Smooth Rock Falls area, OGS, Map 82 816, scale: 1:50 000 (482816)
Map 82 831 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Ternary radioelement image, Smooth Rock Falls area, OGS, Map 82 831, scale: 1:50 000 (482831)
Map 82 807 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Colour-filled contours of the residual magnetic field, Smooth Rock Falls Area, OGS, Map 82 807, scale: 1:50 000 (482807)
Map 82 829 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Ternary radioelement image, Smooth Rock Falls area, OGS, Map 82 829, scale: 1:50 000 (482829)
Map 82 828 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Ternary radio-element image, Smooth Rock Falls area, OGS, Map 82 828, scale: 1:50 000 (482828)
Map 82 827 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Ternary radioelement image, Smooth Rock Falls area, OGS, Map 82 827, scale: 1:50 000 (482827)
Map 82 824 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Shaded colour image of the second derivative of the residual magnetic field & K coefficient, Smooth Rock Falls area, OGS, Map 82 824, scale: 1:50 000 (482824)
Map 82 823 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Shaded colour image of the second derivative of the residual magnetic field & K coefficient, Smooth Rock Falls area, OGS, Map 82 823, scale: 1:50 000 (482823)
Map 82 821 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Shaded colour image of the second derivative of the residual magnetic field & K coefficient, Smooth Rock Falls area, OGS, Map 82 821, scale: 1:50 000 (482821)
Map 82 820 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Shaded colour image of the second derivative of the residual magnetic field & K coefficient, Smooth Rock Falls area, OGS, Map 82 820, scale: 1:50 000 (482820)
Map 82 819 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Shaded colour image of the second derivative of the residual magnetic field & K coefficient, Smooth Rock Falls area, OGS, Map 82 819, scale: 1:50 000 (482819)

Title	Author	Type and Year of Publication (office collection code)
Map 82 832 Airborne Magnetic, Gradiometer and Gamma-ray Spectrometer Surveys 2016	Ontario Geological Survey	Airborne magnetic gradiometer and gamma-ray spectrometer surveys. Ternary radioelement image, Smooth Rock Falls area, OGS, Map 82 832, scale: 1:50 000 (482832)
Report of Activities, 2015 RGP Thunder Bay South Regional Resident Geologist Report: Thunder Bay South District 2016	Puumala, M.A. et al.	Ontario Geological Survey, OFR 6316, 85p. (106316)
Report of Activities, 2015 RGP Timmins Regional Resident Geologist Report: Timmins and Sault Ste. Marie Districts 2016	Van Hees, E et al.	Ontario Geological Survey OFR 6317, 91 p. (106317)
Report of Activities, 2015 RGP Thunder Bay North Regional Resident Geologist Report: Thunder Bay North District 2016	White, G.D. et al.	Ontario Geological Survey, OFR 6315, 68p. (106315)
Report of Activities 2015, Resident Geologist Program, Southern Ontario Regional Resident Geologist Report: SEO, SWO Districts & Petroleum Section, 2016	Sangster P.J., LeBaron, P.S. Charbonneau, S.J Laidlaw, .D.A. Debicki, R.L., Wilson, A.C, Fortner, L.	Ontario Geological Survey, Open File Report 6319, 65p (106319)
Summary of Field Work and Other Activities 2016.	Ontario Geological Survey	Ontario Geological Survey, OFR 6323

Table 9. Property visits conducted by the Kirkland Lake Resident Geologist and staff in 2016 (keyed to Figure 4).

Number	Occurrence-Client	MDI Number	Location (Township)
1	Barbi Lake – Ashley Gold Mines Ltd.	MDI32D04NE00013	Ossian
2	Callighan	MDI32D04NE00022	Katrine
3	Candore – Goldstake Explorations Inc.	MDI32D04NE00032	Ossian
4	Cheminis Mine – Kerr Mines Inc.	MDI32D04SE00019	McVittie
5	Culhane	MDI32D04NE00019	Ossian
6	Fernland – Kerr Mines Inc.	MDI32D04SE00163	McVittie
7	Firetower – Canadian Malartic Corp.	MDI32D04NW00027	Lebel
8	Forwood – Ashley Gold Mines Ltd.	MDI32D04NE00029	Katrine
9	Gagnes – Ashley Gold Mines Ltd.	MDI000000000601	Katrine
10	Glenora – Canadian Malartic Corp.	MDI32D04SW00026	Lebel
11	Kirkland Commodore – Canadian Malartic Corp.	MDI32D04SW00039	Lebel
12	Lake Shore – Kirkland Lake Gold Inc.	MDI42A01NE00022	Teck
13	Langis Mine – Brixton Metals Corp.	MDI31M12SE00005	Casey and Harris
14	Little Silver Vein	New	Coleman
15	Lowe Katrine – Ashley Gold Mines Ltd.	MDI32D04NE00030	Katrine
16	MZ – Orefinders Resources Inc.	New	Catharine
17	Natjo	MDI32D04NE00021	Ossian
18	Nipissing 404	MDI31M05NE00072	Coleman
19	North Kirkland 1	MDI32D04NW00021	Lebel
20	North Kirkland 2	MDI32D04NW00022	Lebel
21	Norwood – Dellelce and Vallillee	MDI32D04NE00023	Katrine
22	Rivard – Ashley Gold Mines Ltd.	MDI32D04NE00018	Katrine
23	Teck Hughes – Kirkland Lake Gold Inc.	MDI42A01NE00020	Teck
24	Walsh Katrine – Ashley Gold Mines Ltd.	MDI32D04NE00024	Katrine

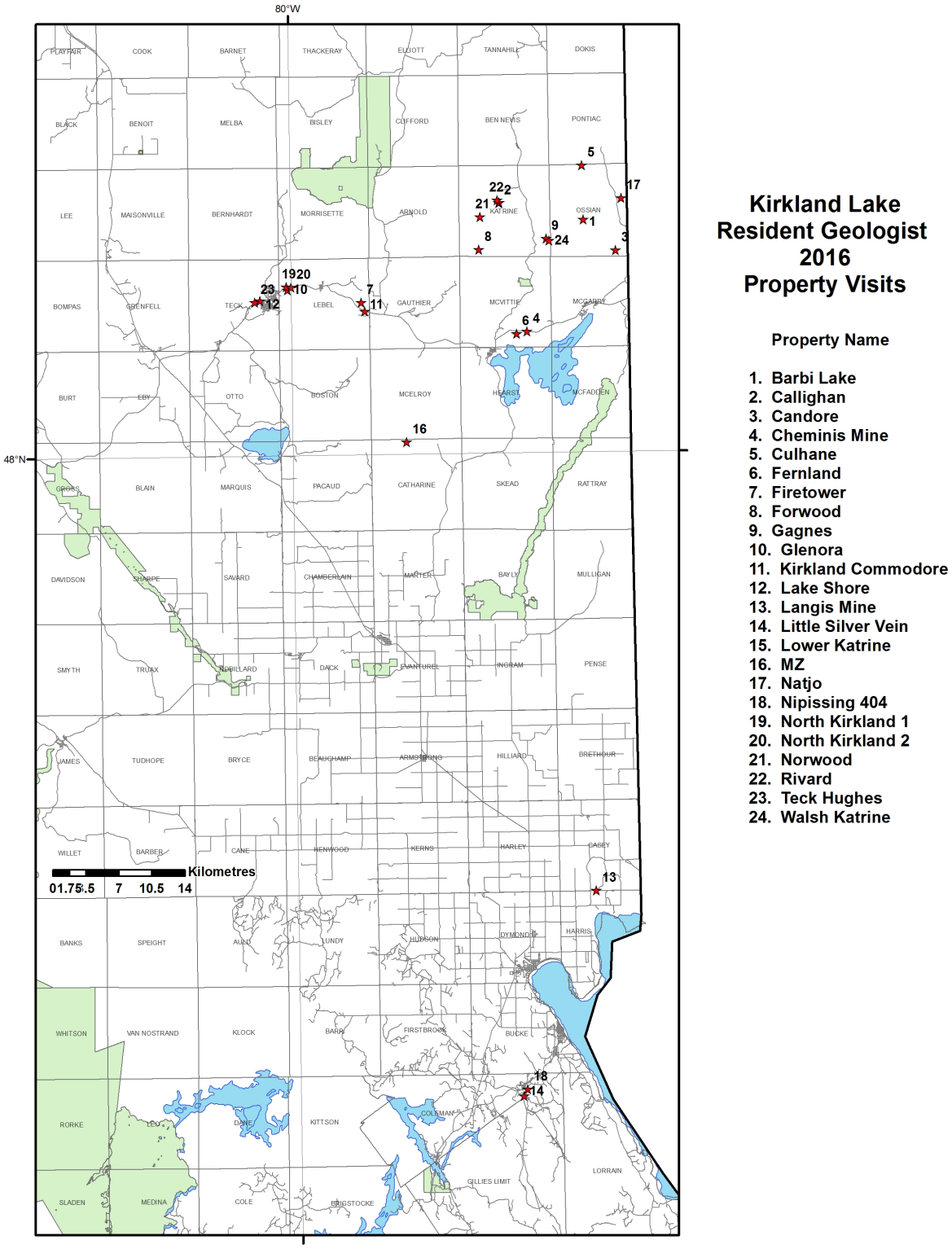

Figure 4. Property visits made by Kirkland Lake Resident Geologist Office staff in 2016; numbers associated with red stars are keyed to Table 9.

Candore Property

The Candore property is located in the southeast corner of Ossian Township. It can be accessed via Highway 66 east, and then northeast along a gravel road (Cheminis Road) from the village of Kearns. Thereafter, continue north along the Ontario–Quebec border for about 1.8 km. Take a bush road on the west side and continue between Gardner and Link Lakes which leads to the easternmost part of the property in claim number 4219190, currently registered in the name of Goldstake Explorations Ltd. Glover Lake occupies the southern half of the claim property.

Ekstrom (1985) reports that a showing was discovered at Glover Lake in 1933 and subsequently worked by Norontic Gold Mines Limited. Ekstrom (1985) further reports that work indicated the presence of quartz veins with gold at Glover Lake and in the showings to the east. Assays reported ranged from 0.05 ounce per ton gold to 0.42 ounce per ton gold. In the early 1950s, Tresdor Larder Mines Ltd. collared 2 diamond drill holes at the southwest end of Glover Lake to drill test for base metals; no mineralization was found (AFRO 2.16173). In 1967, Candore Explorations Ltd. staked the property, and in the following year conducted geological field mapping and a ground magnetometer survey. The property is underlain by a series of andesite flows that strike east. Some of the flows are coarse-grained and highly altered, whereas, others are medium- to fine-grained and massive; the latter show zones of flow breccia. Feldspar porphyry dikes intrude the andesitic flows. There is a persistent shear on the property that strikes 70° (Beaton 1968). In 1985, Firespur Explorations Ltd. carried out line cutting, trenching, and magnetometer and very low frequency-electromagnetic (VLF-EM) surveys on the property in response to a minor gold showing on the north end of Glover Lake. A similar description of the rocks as described by Beaton (1968) was reported, but included pillowed textures of rocks of mafic to intermediate composition. Sixteen (16) rock samples collected by Firespur Explorations from the trenches returned assay values less than 0.01 ounces per ton gold (0.3 g/t gold). In 1995, Falconbridge Exploration Ltd. conducted reconnaissance mapping and sampling on the property. The company described the underlying rocks as intermediate to mafic volcanic rocks which form a synclinal structure with the long dimension of Glover Lake coincident with the fold axis. The 10 samples collected by Falconbridge Exploration from the northern and southern shores of Glover Lake returned less than 200 ppm of copper and zinc.

J. Suma–Momoh and N. Sabiri visited the property on September 15, 2016, in order to locate a mineral deposit inventory entry (MDI32D04NE00032), in addition to investigate the mineral potential of the property. This MDI point representing a diamond drill hole collar could not be located, but is likely to have been positioned in a swampy tributary linking Glover Lake to the west, and Link Lake to the east. The author spotted what seemed like a small buried rock (about 20 cm in diameter) along the trail while heading east from Glover Lake. A rock chip broken from this rock was found to contain approximately 5% sulphide mineralization (pyrite occurring as fine disseminations; and chalcopyrite occurring as blebs and semi-massive). The soil around the exposed rock was removed by hand to expose actual bedrock, andesitic in composition and strongly sheared at 250°/58°N, which is consistent with the observation of Beaton (1968). The outcrop contains two 1 cm wide sulphide-bearing quartz veins, which appear to be parallel to the trend of the shear and sulphide mineralization can be observed along the vein contacts with the host rock. Another shear fabric could also be observed trending obliquely with the first at 220°/35°N (Photo 2). A grab sample from the outcrop returned anomalous values of copper (518 ppm), zinc (113 ppm) and gold (0.006 ppm).

All the other rock outcrops encountered on the property are andesitic with very similar properties, predominantly pale grey-coloured, very fine- to fine-grained and relatively unaltered, with trace to locally 1 to 2% sulphides occurring as fine pyrite disseminations or as chalcopyrite blebs (up to 2 mm wide). Sulphide mineralization can also occur along 1 mm to 4.5 cm wide quartz-healed fractures in the form of ladder veins and stockworks. A total of 3 grab samples collected from some of the outcrops returned less than 150 ppm of copper and zinc, and less than 0.0016 ppm gold. However, one out of the 3 samples gave 0.017 ppm gold.

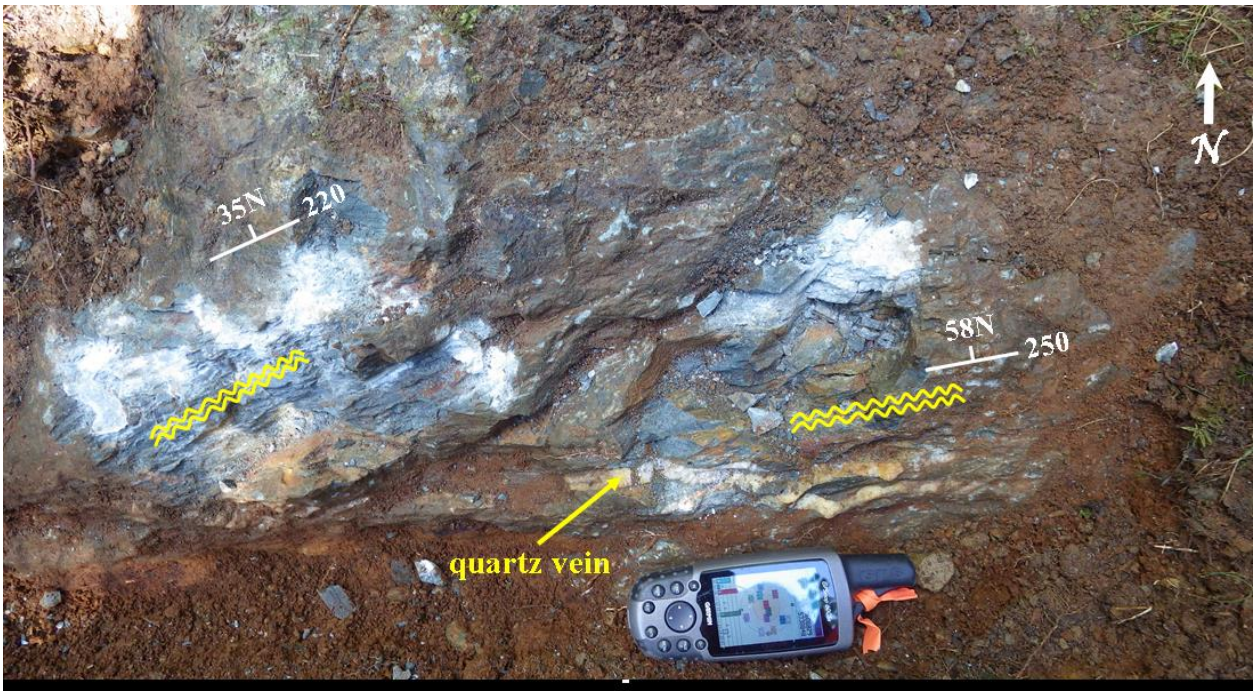

Photo 2. Overhead view of chalcopyrite-pyrite-mineralized quartz veins in andesite at 608829E 5338849N (NAD83 UTM Zone 17). Note deformation relationships. GPS is for scale.

Langis Past-Producing Silver–Cobalt–Copper–Nickel

The Langis property is located in Casey and Harris townships approximately 10.5 km northeast of the community of Temiskaming Shores. Brixton Metals Corporation purchased the Langis property from Canagco Mining Corporation in February 2016. The property consisted of 35 patented claim units and 29 staked claim units, with 46 in southern portion of Casey Township and 18 in the northern portion of Harris Township (Alexander 2013). In May 2016 Brixton announced that it purchased additional claims and staked 461 ha (about 29 claim units) bringing its land position to about 205 claim units (Brixton Metals Corporation, news release, May 25, 2016). The company acquired additional land in July and September 2016 (Brixton Metals Corporation, MD&A, filed November 25, 2016 with SEDAR®, SEDAR Home Page, 26p.). The September acquisition with Agnico Eagle Mines Limited included the Penna No. 7 shaft lands (Brixton Metals Corporation, news release, September 30, 2016).

The property hosts the following MDI points: Langis Mine – past producing mine with reserves, also known as the Casey Cobalt (MDI31M12SE00005), Penna Mine – developed prospect without reserves (MDI31M12SE00010), Dolphin–Miller Shaft – developed prospect without reserves, also known as the Harmak (MDI31M12SE00003) and the Quincy Creek – occurrence, also known as Casey Mountain (MDI31M12SE00013). The Langis Mine was the most important deposit in the area, producing 10 445 630 ounces of silver from 418 305 tons of ore during intermittent periods between 1908 and 1989 (Alexander 2013). Mining ceased in 1989 due to the low silver price, thus mineable reserves were left behind (Owsiaki, Cosec and Anderson 1989). The Dolphin–Miller produced 4625 ounces of silver between 1965 and 1968. At least 20 tons of ore was shipped from the Quincy Creek Shaft in 1908 but there is no record of production. Cobalt, nickel and copper were also recovered from the Langis Mine and cobalt from the Dolphin–Miller Shaft (Sergiades 1968).

Brixton uses the following to designate shafts for the property: Langis #1 – Langis #1 and #2, Langis #2 – Seneca Shaft, Langis #3 – Langis #3, Langis #4 – Langis #4, Langis #5 – Dolphin–Miller, Langis #6 –

Langis #6; and Langis #7 – Penna Shaft. The area between the shafts is triangular with the base about 2100 m and the height of the peak about 1000 m above the base. The base of the triangle trends about east-southeast, with the peak northeast of the base (Figure 5). The Langis #7 is the deepest of the shafts, sunk to a depth of 350 m (1182 feet) (Alexander 2013).

The history of the property is provided by Alexander (2013). Following the closure of the Langis in 1990, little work was completed. Canagco Mining Corporation purchased the property in 2011 and sold it to Brixton Mining Corporation in 2016. In 2016, Brixton completed a 3-dimensional geological model of the Langis area, airborne magnetic and electromagnetic surveys, IP and 15 diamond drill holes totaling 3170 m. (Brixton Metals Corporation, MD&A, filed November 25, 2016 with SEDAR®, see SEDAR Home Page, 26p.).

Underlying the Langis Mine area is an inlier of mainly Southern Province rocks within the eastern edge of the Timiskaming outlier. Thompson (1965) describes the inlier as basin shaped. Nipissing gabbro overlie Gowganda Formation conglomerate. The Gowganda Formation is flat lying to gently dipping and unconformably overlies older Archean rocks. It is composed of coarse and fine boulder conglomerate, wacke, slate and quartzite. In the vicinity of the Langis Mine, the Gowganda Formation is at least 136 m (447 feet) thick (Thompson 1965). More recent work by Agnico Eagle Mines Limited identified a deep linear trough within the Archean basement filled with about 325 m of Gowganda Formation rocks (Alexander 2013). Archean rocks are steeply dipping mafic to intermediate metavolcanic flows with minor cherty interflow metasedimentary rocks and tuffs. Narrow lamprophyre dikes were noted cutting the Archean rocks and are up to 6 m (20 feet) in width (Jerome 1969).

The Timiskaming outlier is controlled by the Timiskaming Structural Zone (TMZ), a northwest-trending rift system that is part of the Ottawa–Bonnechere graben. Veining in the Langis #3 shaft area is subparallel to the rift system or orthogonal to it. In addition, the recently identified trough has a northeast-trend and is suggested to be a paleo-fault scarp in the Archean basement (Owsiaki, Cosec and Anderson 1989).

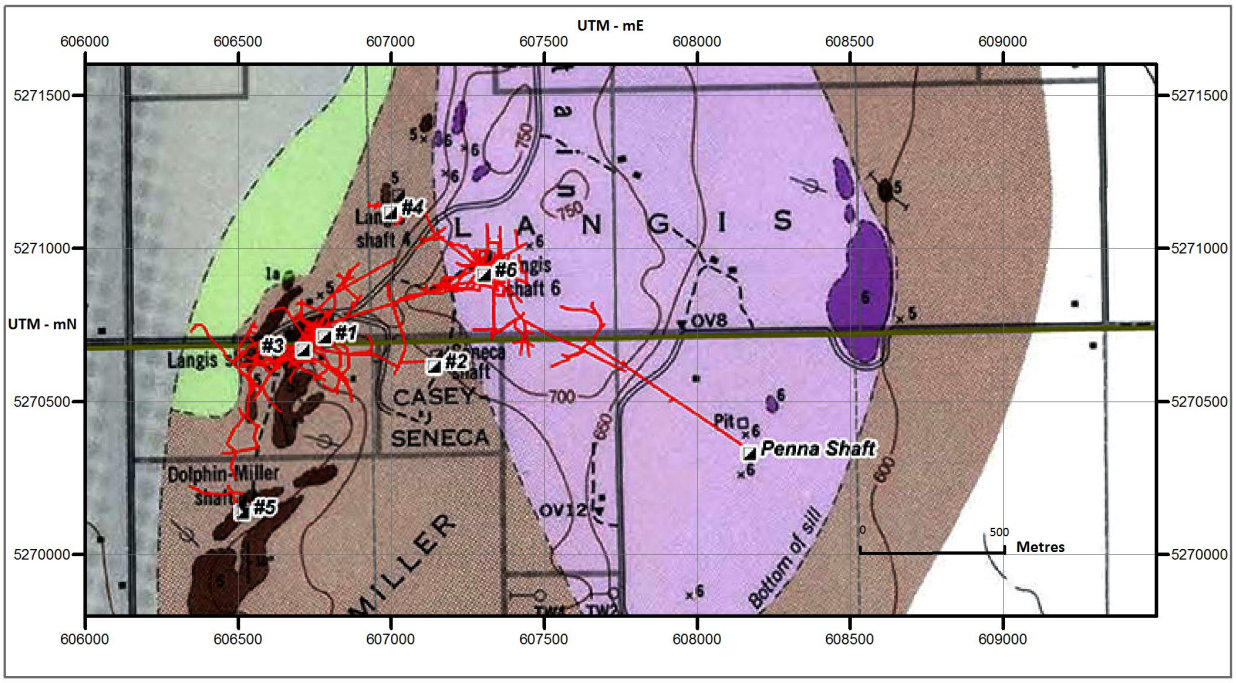

Figure 5. Langis shaft locations on Map 2066 (Thompson 1965).

The Casey fault is a reverse fault and dips between 10 and 20° to the southwest similar to the Archean–Gowganda contact. It is represented by gouge and fractured rock several feet in thickness. It displaces veins and usually the grade increases in the veins near the fault (Jerome 1969).

The Langis was essentially 2 mines, the main production from the No.3 Shaft and lesser amounts from the No.6 Shaft about 600 m (2000 feet) northeast of the No.3 Shaft. There is about 300 m (1000 feet) of unproductive area between the two. Jerome (1969) makes the following observations regarding the mineralization associated with each zone.

No.3 Shaft

- Ore was mined from veins within the Gowganda Formation rocks and Archean basement.
- Gowganda Formation rocks are mainly boulder conglomerate.
- Fault type veins are usually stronger and more productive.
- Stoping was done on one or multiple structure veins 1.25 to 2.0 m in width and better grades.
- Veins dip from 70 to 90°and are rarely productive for more than 120 m (400 feet) horizontally and vertically more than 45 m (150 feet) from the Archean–Gowganda unconformity.
- Metallic minerals are native silver and cobalt, nickel, iron arsenides and sulpharesenides.
- Nonmetallic gangue is calcite, dolomite or quartz coloured white, grey or pink.
- The main veins strike northeasterly paralleling the strike of the Archean–Gowganda contact or some northwesterly.
- Most of the ore was mined from the Gowganda Formation rocks.
- Ore mined in the Archean was associated with lamprophyre dikes.

No.6 Shaft

- Ore is mined from veins within the Gowganda Formation rocks and the Nipissing gabbro. Veins die out before entering the Archean rocks.
- Gowganda Formation are commonly quartzite and boulder conglomerate is almost absent.
- Fault type veins are usually stronger and more productive.
- Stoping was done on vein clusters where stopes were wider than 2 m and lower and grades. Silver had an uneven distribution in the veins.
- Veins dip from 70 to 90°and are rarely productive for more than 120 m (400 feet) horizontally and vertically more than 45 m (150 feet) from the Archean-Gowganda unconformity.
- Metallic minerals are native silver and cobalt, nickel, iron arsenides and sulpharesenides.
- Nonmetallic gangue is calcite, dolomite or quartz coloured white, grey or pink. Black calcite occurs in some veins.
- Two basins and a dome structure in the Archean basement with veins developed along the long axis of the basins.
- Flat faults are more prevalent.

Portions of drill core were examined near the end of the 2016 diamond drilling program. The drilling was designed to confirm previous diamond drilling intersections and test new target areas. Major rock units were examined.

Archean rocks were mainly volcanic with some being talc-chloritic suggesting komatiitic chemistry.

Diamond drill hole LM-16-03 intersected 397 g/t silver, 4.9 g/t gold over 41.5 approximately 300 m southeast of the No.6 Shaft. The intersection was close to the Archean–Gowganda unconformity and not typical of Cobalt-style mineralization. Timiskaming conglomerate, identified by the presence of jasper clasts, was intersected in this drill hole and would be considered unusual. Timiskaming series conglomerate is found in outcrops between Haileybury and New Liskeard and identified in diamond drilling in the southeastern portion of Hudson Township (Lovell and Frey 1976), the closest being about 15 km to the southeast. The unconformity, as exposed in the Cobalt area, is often irregular with a basal unit of mainly volcanic fragments just above the unconformity and overlain with conglomerate. As noted above, troughs are found in the area and thus further drilling may be required to better understand the extent, orientation and relationship of the Huronian and Timiskaming conglomerate units.

Typical Cobalt-style mineralization was identified in one hole (Photo 3). Individual ore zones tend to be small in the Cobalt mines, thus the likelihood of intersecting mineralization is small. Jerome (1969) mentions black calcite veining and comments on the difficulty of identifying it in drill core. This opens the possibility that barren black calcite veins, thus their structures, were missed in the initial core logging.

Cobalt-style silver mineralization tends to be very high grade forming relatively small metal rich zones. Detailed induced polarization (IP) should be useful in directing future diamond drilling, especially in structurally favourable areas.

Photo 3. Photo of silver-rich zone in drill core intersected by Brixton Metals.

MZ (Metherall–Zabudsky) Surface Gold Occurrences – Catharine Township

The MZ property is part of the Orefinders Resources Inc. Mirado property in Catharine and McElroy townships, about 22 km southeast of Kirkland Lake. The property is accessible by gravel roads, leading east from Hwy 112 and about 12 km east of the hamlet of Boston Creek (Reddick and Lavigne 2012). The Mirado mine shaft is located at UTM NAD83 Zone 17 587504E 5318699N (AMIS08318; MDI32D04SW00045). A surface stripping program in 2014 further exposed surface gold occurrences and was the subject of the examination. The Mirado Shaft is about 850 m to the northeast of trenches 2S, 3N and 7.

The MZ property consists of 10 claims totalling 45 claim-units to the west, south and southeast of the Mirado claims (Reddick and Lavigne 2012). A summary of the exploration history, as compiled by Reddick and Lavigne (2012) follows. Metherall and Zabudsky located undocumented overgrown pits and trenches in 2000. They obtained significant gold values from surface sampling on claims L.1146327 and L.1196951. In 2002, the pair completed mechanized overburden stripping and completed 8 EX-size diamond drill holes totalling 114 m. Hawk Precious Metals Inc. completed line cutting and a ground magnetic survey in 2002, followed by additional mechanical stripping in 2003. Later in 2003 Quantec Geophysics Inc. completed 5.7 km of IP on claim L.1146327. Four areas were stripped in 2003. A sample collected by Orefinders in the area identified as the "Main Zone", returned 3.28 g/t gold over 5.33 m. Five NQ-size diamond drill holes were completed in the northern half of L.1146327. Diamond drill hole DDHMZ2004-01 intersected 3.73 g/t gold over 1.5 m. In 2010 White Pine Resources Inc. completed 19 km of IP and diamond drilled 9 holes totalling 1934 m testing IP targets. In 2012, Orefinders Resources Inc. optioned the MZ property along with the Mirado property. Orefinders completed 14.5 km of IP (2012). In 2013, 6 areas were stripped on claim L.1146327 and 2 areas on claim L.31378. The areas on L.1146327 exposed Mirado style mineralization with values up to 86.8 g/t gold. Orefinders completed a stripping and sampling program in 2014 (Rattee 2014).

The MZ and Mirado properties are underlain by northwest-trending metavolcanic and metasedimentary rocks of the Superior Province. From southwest to northeast the units are Stoughton–Roquemaure assemblage (2723–2720 Ma), Upper Blake River assemblage (2701–2696 Ma), and Lower Tisdale assemblage (2710–2704 Ma) (Ayer et al. 2005). The Stoughton–Roquemaure (formerly the Catharine assemblage (Jackson and Fyon 1991)) is composed mainly of iron-rich, pillowed, tholeiitic metabasalts and plagioclase-porphyritic metagabbros (Powell and Jackson 1994). The Catharine fault lies about 500 m to the southwest of and approximately parallel to the contact with the Upper Blake River assemblage. The Upper Blake River assemblage (formerly the Skead assemblage (Jackson and Fyon 1991)) is composed predominantly of calc-alkalic felsic to intermediate volcaniclastic rocks (Grant 1961, Powell and Jackson 1994). The Lower Tisdale assemblage (formerly the McElroy assemblage (Jackson and Fyon 1991)) consists of mafic and ultramafic flows and minor felsic fragmental units (Abraham 1950, Powell and Jackson 1994).

The MZ and Mirado projects are almost exclusively underlain by rocks of the Upper Blake River assemblage. Initial interpretation was that the Skead assemblage was conformably overlain by the McElroy assemblage, but geochronology reported by Ayer et al. (2005) demonstrates that the Upper Blake River (Skead) assemblage is much younger than the Lower Tisdale (McElroy) assemblage. The contact is marked by an iron formation.

Stripped area 2S is centered about UTM NAD83 Zone 17 586610E 5318350N and was a southern continuation of area 2 stripped in 2013. The predominant lithology is intermediate, calc-alkalic, tuffaceous rocks. The unit as grey, fine-grained, sandy ash with moderate to high bleaching forming sericite ± carbonate ± silica. Oxidization is localized with pervasive sub- to euhedral disseminated pyrite, ranging from 2 to 7% in composition. The east side of the area contains a 1 to 2 m wide mafic dike, striking north-northeast with a 70 to 75^{o} dip to the east. The northwest portion of the area contains a

south-trending narrow lamprophyrye dike that pinches out about half way to the southern extent of the stripped area. The bleaching of the host rock is to the east of the lamprophyre dike (and its projection to the south) and areas of oxidation are only within the bleached rock. Zones of bleaching tend to be about 1 m wide and have a southern trend. Seven channels were cut on a southeastern-trend and were sampled. Four samples assayed greater than 1 g/t gold with the best being 9.15 g/t gold over 1 m (Photo 4A) (Rattee 2014).

Area 3N is centered about UTM NAD83 Zone 17 586660E 5318420N expanding the northeast from area 3. This was the largest of the stripped areas observed. The major lithology is an intermediate calc-alkalic tuff with 2 minor narrow dikes and a 10 to 20 m wide zone of lapilli tuff in the northern most portion of the area. The lapilli tuff unit hosts 2 to10% fine- to medium-grained disseminated pyrite with local concentrations as stringers and clots. The rock is highly oxidized and broken where the pyrite is concentrated. Two very narrow lamprophyre dikes are in the zone, one west-trending and the other north-trending. A south-southeast-trending fault/shear dips 60^{o} to the east and hosts a pyritized patch that returned an assay of 20.5 g/t gold. The southern tuff unit is pale greenish-grey to grey, massive sandy tuff, with local mafic fragments to 1 cm. The unit is highly oxidized with up to 7% disseminated pyrite. Assay results of samples were generally low even in the oxidized and pyritized zones (Rattee 2014).

Area 7 is centered about UTM NAD83 Zone 17 586780E 5318479N expanding the southern portion of the original area 7 to the east and west. The rock is predominantly an intermediate ash tuff, as in the other 2 stripped areas. Bleaching is present and there is pervasive 2 to 7% disseminated pyrite. A 40 cm wide shear zone trending south-southwest dips to the west is in the eastern portion of the area. This unit is a host to low grade gold mineralization. A subparallel weakly developed shear about 3 to 4 m is found to the west. A poorly exposed northwest-trending fault in the very northwest portion of the stripped area returned 30.1 g/t gold over 1.5 m (Photo 4B). The western 5 m of the stripped area contains 5 to 8% pyrite, associated minor chalcopyrite and returned higher gold assays. Locally, malachite staining is present in the tuff and along the shear faults (Rattee 2014).

Orefinders Resources Inc. considers the mineralization within the MZ zone to be stratabound. Weiershäuser and El-Rassi (2013) completed a mineral resource evaluation of the Mirado and MZ property. As part of the study, a pit optimizer was used to identify blocks of mineralization potentially amenable to open pit mining and to outline conceptual pit outlines. The stripped areas are near and on trend with the smaller western conceptual pit identified by Weiershäuser and El-Rassi (2013). The mineralization appears to be related more to the north-trending structures/fractures. The number of significant assays returned in the stripping and sampling programs justifies further exploration in order to better understand the mineralization, structural controls and continuity, especially as related to the mineralization to the east.

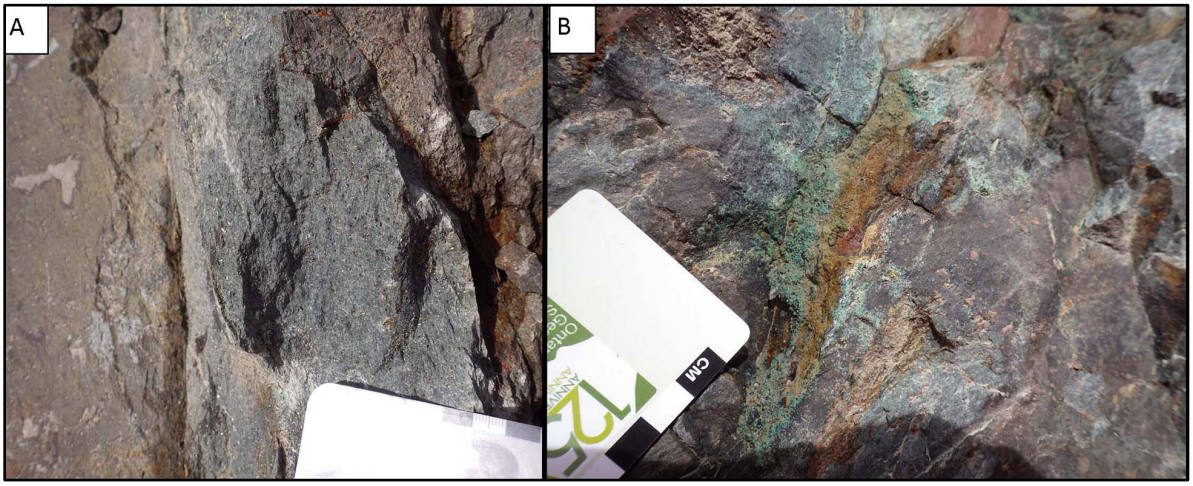

Photo 4. A) Intermediate calc-alkalic tuff with disseminated pyrite (stripped area 2S) near area that returned an assay of 9.15 g/t gold, **B)** stripped area 7 showing disseminated pyrite and malachite in a shear that assayed 30.1 g/t gold over 1.5 m.

RECOMMENDATIONS FOR EXPLORATION

Cobalt Potential in the Kirkland Lake District

Whilst demand growth for most metals stalled in recent years, cobalt demand grew strongly, spurred on by the increasing popularity of lithium-ion batteries, which also contain cobalt. The CRU Group (formerly the Commodity Research Unit) estimates that demand for cobalt will grow at an average rate of 5% per annum for the next 10 years. In October 2016, prices were up to US$13.4 per pound (Kitco News, October 10, 2016) and are expected to increase onwards in 2017 (*The Northern Miner*, October 3–9, 2016, p.4).

Cobalt was produced as a byproduct of silver extraction in the Kirkland Lake Resident Geologist District. Since 1903, the district has produced approximately 553 million ounces of silver, 24.6 million pounds (11 158 tonnes) of cobalt, 3.6 million pounds (1633 tonnes) of nickel and 2.6 million ounces of copper from its silver deposits (Guindon et al. 2016). Table 10 shows historical production of cobalt and silver (± nickel, copper) from some mines in the district.

Silver-sulpharsenide vein deposits in the Kirkland Lake district occur along the north and northeastern margins of the Cobalt Embayment (Figure 6); as a result, 5 distinct silver mining camps emerged, namely, the South Lorrain, Cobalt, Casey Township, Elk Lake and the Gowganda camps. The Cobalt Embayment

Table 10. Historical metal production of selected mines in the Cobalt Embayment (*modified from* Guindon et al. 2016).

Mine	Mining Camp	Township	Tons Milled	Ag (oz)	Co (lb)	Ni (lb)	Cu (lb)	Years of Production
Curry	S. Lorr	S. Lorr	87	49 821	7691			1916–1938
Keeley and Frontier	S. Lorr	S. Lorr	NA	19 197 413	3 310 556	27 252	10 292	1908–1965
Lorrain Lake	S. Lorr	S. Lorr	22 405	1 093 404	64 458			1924–1943
Nipissing Lorrain	S. Lorr	S. Lorr	NA	350 000	5521			1925–1929
Wettlaufer	S. Lorr	S. Lorr	6861	2 593 041	23 910			1909–1940
Cobalt Contact	Cob	Bucke	11 074	26 000	31 000			1912–1944
Cobalt Lode Silver	Cob	Coleman	263 140	4 493 542	2 545 117	610 716	459 078	1917–1956
Cobalt Town site	Cob	Coleman	913 268	37 362 032	1 852 765	163 687	90 288	1907–1939
Foster Cobalt Mining	Cob	Coleman	2818	1 159 390	457 164	21 766	24 121	1951–1956
Harrison–Hibbert and Ruby	Cob	Bucke	NA	876 500	214 600	69 458		1920–1963
Kerr Lake Mining	Cob	Coleman	235 503	28 502 037	650 094		1792	1905–1948
Nipissing	Cob	Coleman	1 066 589	32 000 000	3 636 704			1905–1951
Provincial	Cob	Gillies Limit	258	286 897	54 473	2842		1908–1940
Casey Cobalt-Silver	Cas	Cas	NA	9 373 085	356 418	141 733	88 437	1908–1966
Langis	Cas	Cas, Harris	49 542	653 882	25 474	8013	8 550	1983–1989
Lucky Godfrey Silver	E. Lake	Willet	NA	9835	592			1908–1911
Shane–Darragh	E. Lake	Mickle	NA	63 471	1214			1953–1955
Castle	Gow	Haultain	111 258	2 949 074	76 206	24 199	22 425	1979–1989
Castle–Tretheway	Gow	Haultain	254 311	6 461 021	299 847			1920–1931
Miller Lake O'Brien	Gow	Nicol	1 111 986	37 987 767	785 760	13 248	72 946	1910–1966
Millerett	Gow	Haultain	NA	611 822	5000			1910–1912
Morrison	Gow	Nicol	24 945	719 201	22 018			1930–1954
Walsh	Gow	Nicol	19 677	453 424	3555			1925–1940

Abbreviations: S. Lorr = South Lorrain, Cob = Cobalt, Cas = Casey Township, E. Lake = Elk Lake, Gow = Gowganda, NA = not available.

is a large irregular domain of Huronian-age clastic sedimentary rocks intruded by Nipissing diabase sills and crosscut by regional-scale fault systems. The vein systems occur in faults and fault-related fracture systems hosted by Huronian sedimentary rocks, Archean basement rocks and Nipissing diabase sills. The vein systems are also often extensive; however, silver-sulpharsenide mineralization is highly restricted in occurrence to within about 200 m of the upper and lower diabase contacts or deep within the sills themselves. The Huronian sequence consists of a variety of coarse- to fine-grained clastic sedimentary rocks that have been subdivided into the Lorrain and Gowganda formations. The Gowganda formation, in turn, is locally subdivided into the Firstbrook and Coleman members. In the immediate vicinity of the Cobalt, Casey and Gowganda mining camps, mainly the Firstbrook and Coleman members are preserved. The Coleman member is the most important sediment host to the silver deposits (Andrews et al. 1986).

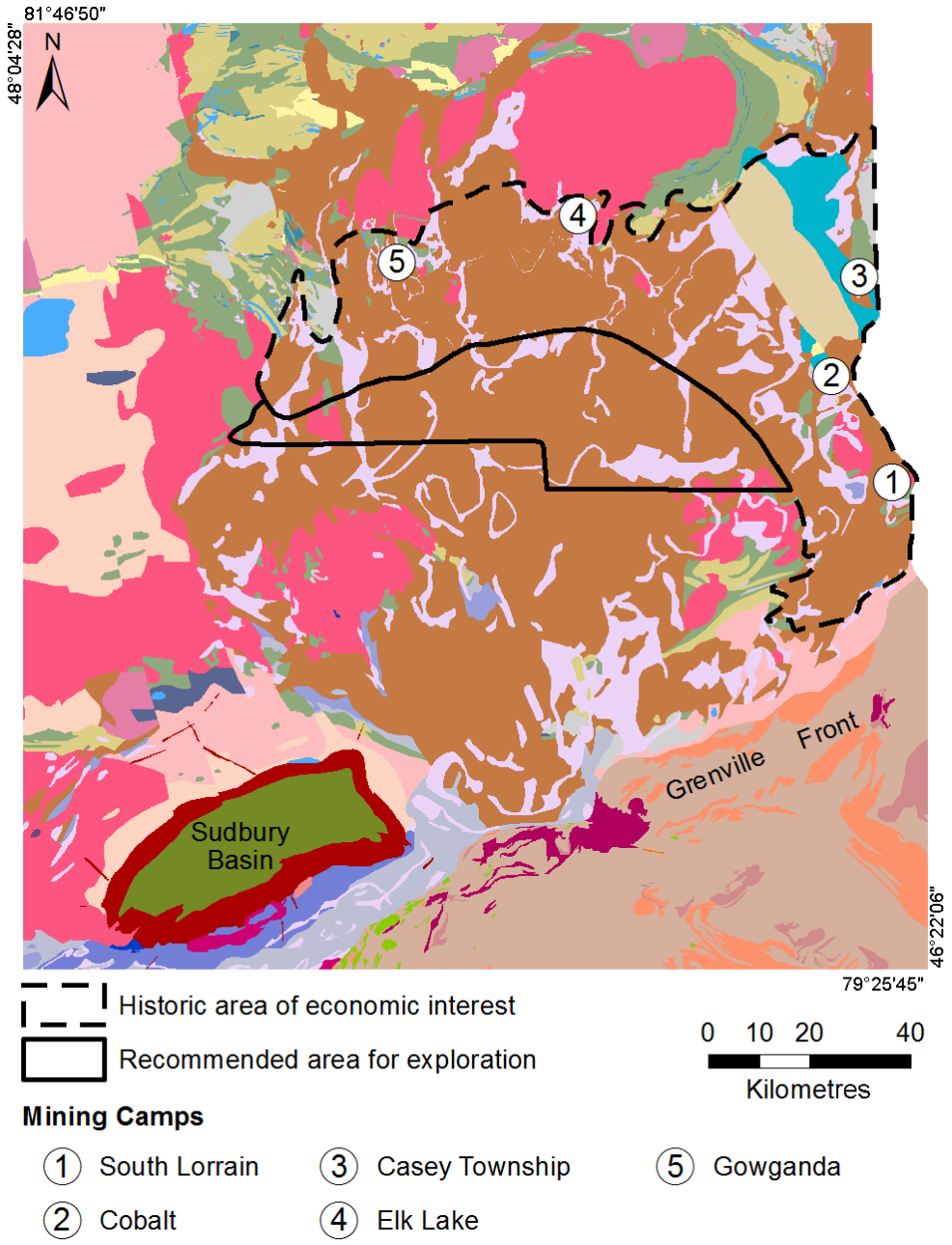

Figure 6. Geology of the Cobalt Embayment showing the general area encompassing historic mines, most occurrences of silver-cobalt mineralization, and proposed area for exploration (*modified from* Andrews et al. 1986; Ontario Geological Survey 2011).

The silver deposits are characterized by a complex ore mineralogy consisting of native silver and bismuth, copper-nickel-iron arsenides, sulpharsenides and sulphides of lead, zinc and copper (Marshall 2008; Smyk 1987; Petruk 1971). In contrast, the gangue mineralogy consists dominantly of carbonates (mainly calcite with lesser dolomite) and minor silicates (Jambor 1971).

There has been no metal production from the 5 abovementioned camps since 1990. Reasons span from depletion of ores and reduction in metal prices to exploration challenges, such as, land not open to exploration, special requirements needed for exploration, and thick sequences of overlying Huronian sedimentary rocks, making exploration of buried targets difficult in some areas of the embayment. Unfortunately, there has been limited recent exploration for cobalt-bearing metals within the district. In the mining camps, the silver-cobalt veins are typically narrow and pinch and swell. Productive ore shoots are erratic, but carry exceptionally high grades (Smyk 1987). Thus, there is potential for small, but high-grade deposits of cobalt-bearing metals in the embayment. Modern induced polarization (IP) and versatile time domain electromagnetic (VTEM) geophysical exploration techniques, which have the potential to penetrate through cover rocks and detect buried targets in areas undetected by older geophysical techniques, are recommended. Geophysical exploration and subsequent diamond drilling are, therefore, warranted in "ignored" but prospective areas, particularly in the North Williams–Barr–Brigstocke–Sladen–Rorke–Dufferin townships transect within the north-central section of the embayment (*see* Figure 6). In other parts of the world, for example the Democratic Republic of Congo, exploration for cobalt-bearing metals has centred on the re-evaluation and redevelopment of past mining centres (brownfield exploration sites), as well as identification and development of newly discovered or previously undeveloped deposits and/or prospects (Wilburn 2012). This approach could be relevant to the Cobalt Embayment.

Data Mining of Surficial and Deep Overburden Surveys in the Kirkland Lake Resident Geologist District

The Ontario Geological Survey (OGS) has conducted regional geochemical surveys for more than 3 decades. Overtime, the surveys evolved in the type of media sampled, but the methodologies used to sample, process and report results for a particular media remained consistent. Initially, data were released in hard copy, usually as Open File Reports (OFR), but most of the survey data are now available in digital format, published as Miscellaneous Releases—Data (MRD) data sets (Table 11 and Figure 7). The development and availability of Geographical Information System (GIS) software has improved the speed and visual capabilities of displaying the data. Some data manipulation is required to get the data into a consistent format and to ensure that a consistent datum is used for point location.

Gold grain data are available for the till and alluvium surveys (*see* Table 11). Data is available for total gold grains observed per sample and further subdivided into 3 groupings as described by DiLabio (1990): pristine, modified and reshaped. Total gold grains observed was recorded for the Kirkland Lake Initiatives Program (KLIP) data set, and the number, size and shape per sample are listed for the Black River–Matheson (BRiM) data set, using the classification of Averill (1988): delicate, irregular and abraded.

Pristine grains do not appear to have been damaged by glacial transport, suggesting that the grains were found proximal to their point of origin (DiLabio 1990). As such, the total number of pristine grains recovered is a very low proportion of the total grains recovered. A recommendation for exploration using modern alluvium data in the Round Lake Batholith area was published in the 2015 Report of Activities (Guindon et al. 2016). A review of other data sets using GIS to put the data into geological context offers some interesting areas for follow up. A few are presented below.

Till sampling results from a survey in the Detour Lake and Burntbush area, north of Lake Abitibi, are shown in Figure 8. The red circles identify the locations of till sample sites (Gao 2015a, 2015b), with total gold grain counts indicated on the left and pristine grain counts, on the right. Pristine grains were recovered from 2 samples that are underlain by clastic sedimentary rocks with banded iron formation. This may suggest that the pristine grains are from a deposit type similar to that found in the Geraldton area.

Two samples with abundant pristine gold grains were collected in Ingram Township, north of New Liskeard (Gao 2012a, 2012b; Figure 9). This is an unexpected location for the recovery of gold grains. Rocks that host silver-arsenide veins are located immediately to the north. Such veins are known for hosting high-grade silver and cobalt. Some of these deposits also contain some gold. Recent exploration by Brixton Metals Corporation intersected 4.9 g/t gold and 397 g/t silver over 4 m (Brixton Metals Corporation, news release, August 11, 2016).

Many more targets can be found mining the data in these and other data sets from across the province.

Table 11. Surficial and deep overburden geochemical surveys published by the OGS, sampling media and associated publications (*see* Figure 6 for survey locations).

Area	Type	OFR	MRD	Authors
Cobalt–Mattawa	Alluvium	6088	MRD102	Reid, J.L.
Elk Lake–Cobalt	Alluvium	6119	MRD124	Reid, J.L.
Gogama–Shining Tree	Alluvium	6227	MRD220	Felix, V.E. and Matson, A.L.
Matachewan–Kirkland Lake	Alluvium	6124	MRD129	Guindon, D.L. and Reid, J.L.
Temagami–Marten River	Alluvium	6043	MRD072	Allan, S.E.
Peterlong Lake–Radisson Lake	Lake Sed	5942/6053	MRD027, MRD070	OFR5942: Bajc, A.F. et al.; MRD027: Hamilton, S.M.; OFR6053 and MRD070: OGS
Shining Tree	Lake Sed	6062	MRD081	Russell, D.F. and Hamilton, S.M.
Temagami	Lake Sed	6144	MRD137	Takats, P.A. and Dyer, R.D.
BRiM – backhoe	Overburden	5749	MRD001	OFR5749: McClenaghan, M.B; MRD001: OGS
BRiM – Sonic	Overburden	5800	MRD001	OFR5800: McClenaghan, M.B; MRD001: OGS
Kirkland Lake Initiatives Program (KLIP)	Overburden	5335/ 5355/ 5356/ 5394/ 5395/ 5456/5506	MRD004	OFR5335: Averill & Thomson; OFR5355: Thomson & Lourim; OFR 5356: Routledge et al.; OFR 5394&5395: Lourim; OFR 5456: Averill and Fortescue; OFR5506: Fortescue et al. MRD004: OGS
Cobalt–New Liskeard	Till	6259	MRD284	Gao, C.
Detour Lake–Burntbush	Till	6297	MRD312	Gao, C.
Matachewan	Till	5957	MRD029	Bajc, A.F.
Peterlong Lake–Radisson Lake	Till	6060	MRD024	OFR6060: Bajc, A.F. and Crabtree, D.C.; MRD024: Bajc, A.F.

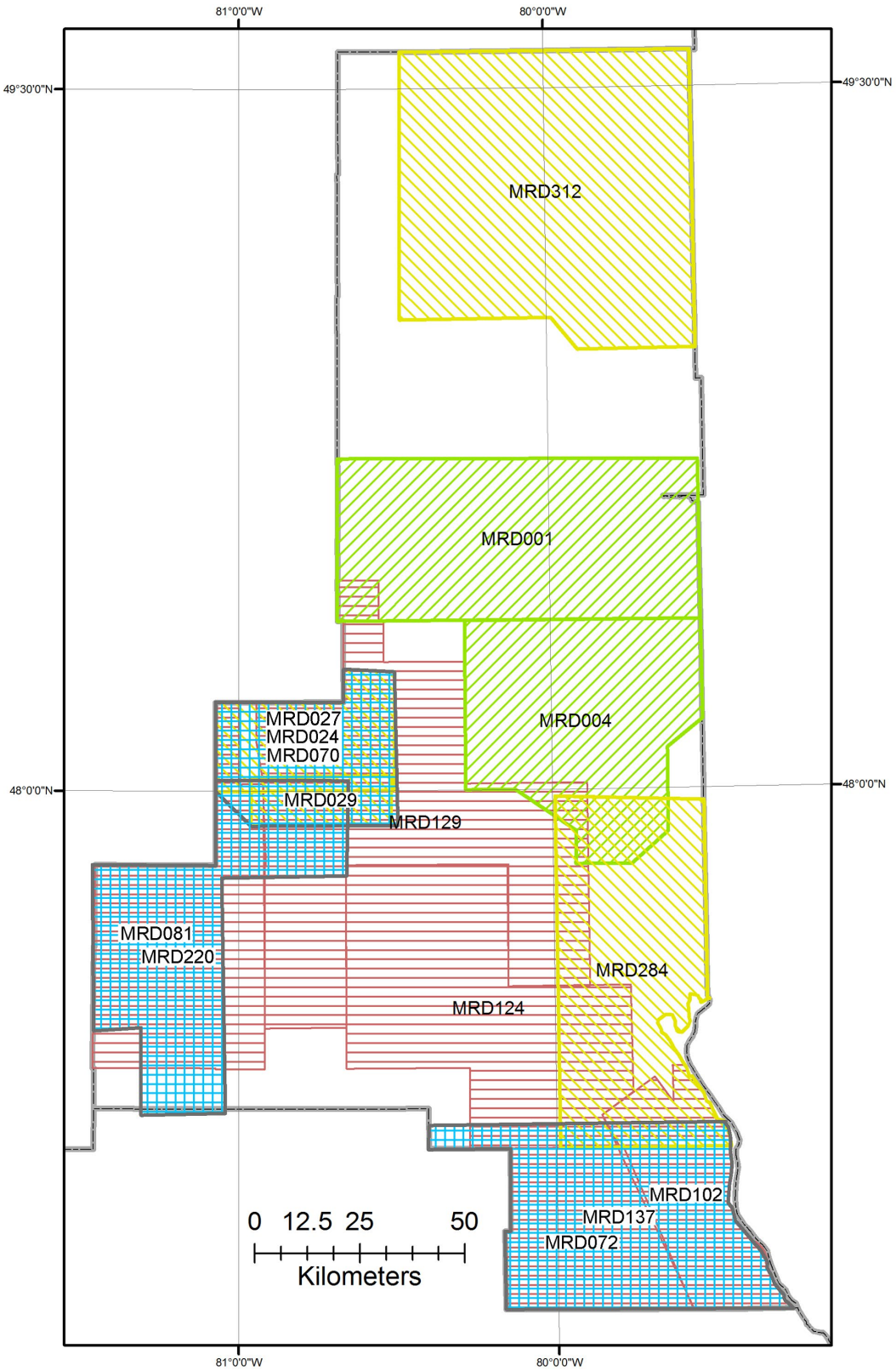

Figure 7. Location of OGS surficial and deep overburden geochemical surveys (showing survey extents of published Miscellaneous Release—Data) within the Kirkland Lake Resident Geologist District. Colours reflect survey type: alluvium (brown), lake sediment (blue), overburden (green) and till (yellow).

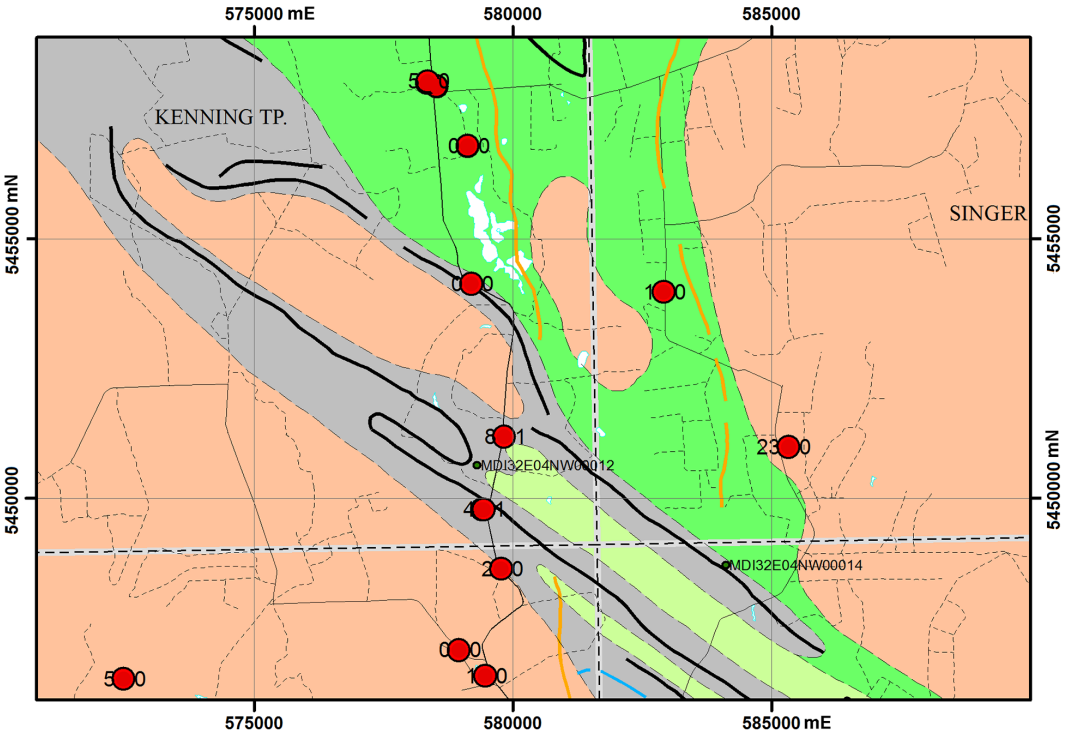

Figure 8. Location of till samples (red circles) in the Burntbush and Detour Lake area, showing total gold grain counts to the left and pristine gold grain counts to right (Gao 2015a, 2015b) plotted on geology *from* Ayer et al. (2009). Pristine gold grains are underlain by clastic sedimentary rocks with associated iron formation. Universal Transverse Mercator (UTM) co-ordinates in North American Datum 1983 (NAD83), Zone 17.

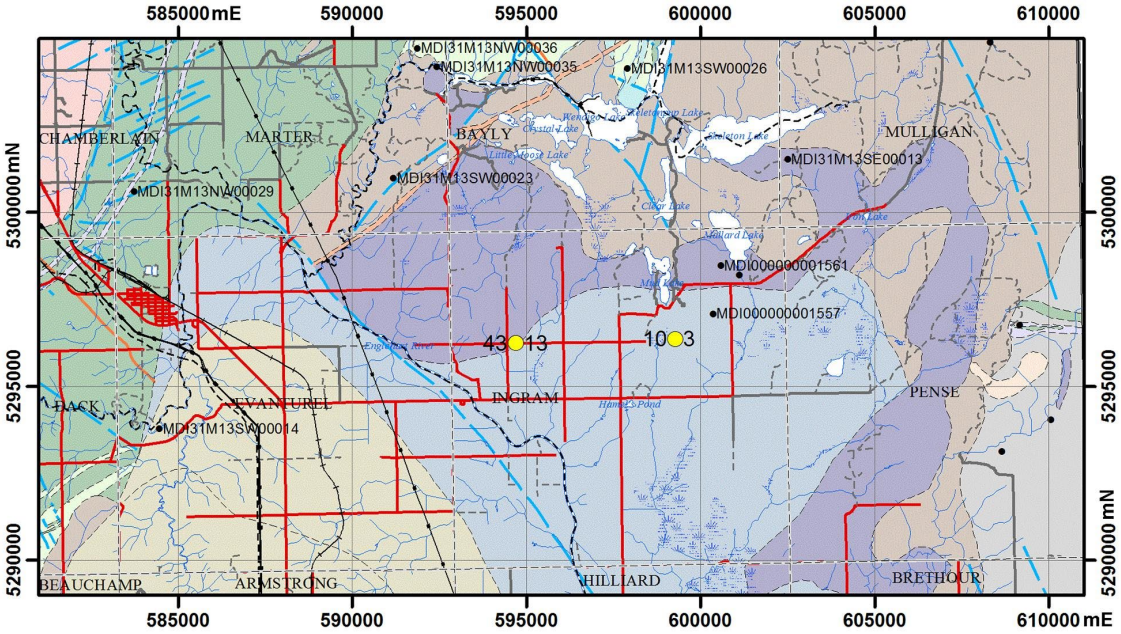

Figure 9. Location of 2 till samples (yellow circles) with abundant pristine gold grains, collected in Ingram Township, north of New Liskeard (Gao 2012a and 2012b). Total gold grain counts are shown on the left and pristine gold grain counts on the right. Geology from Ayer, Trowell and Josey (2004). Pristine gold grains are underlain by Paleozoic rocks but near areas with silver-arsenide vein mineralization. Universal Transverse Mercator (UTM) co-ordinates in North American Datum 1983 (NAD83), Zone 17.

OGS ACTIVITIES AND RESEARCH BY OTHERS

Ontario Geological Survey Activities

Numerous airborne geophysical maps of the Smooth Rock Falls Area in the Cochrane district, in addition to Report of Activities (2015) volumes, for the various Regional Geologist districts, were received and listed in Table 8, which reports recent additions to the Kirkland Lake office library database. A detailed description of activities carried out by the Ontario Geological Survey (OGS) is published in the Summary of Field Work and Other Activities, 2016, Open File Report 6323. None of the OGS field work was carried out in the Kirkland Lake Regional Geologist District.

University Studies

COLORADO SCHOOL OF MINES

B. Frieman, under the supervision of Y. Kuiper, is completing a PhD thesis on the structural study of the Larder Lake–Cadillac Deformation Zone (LLCDZ). He has also recently submitted a paper on "The constraints on the geodynamic evolution of the southern Superior Province: U/Pb laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) analysis of detrital zircon in successor basins of the Archean Abitibi and Pontiac sub-provinces of Ontario and Quebec, Canada" (in press; Y. Kuiper, pers. comm.).

Another PhD student, M. T. Nassif, continues fieldwork on an economic and structural geology study of Osisko Mining Inc.'s Garrison property (G. Matheson, pers. comm.).

LAKEHEAD UNIVERSITY

A brief reconnaissance field visit to look at the Pacaud komatiites was undertaken by P. Hollings, in support of a proposed MSc study in the area.

LAURENTIAN UNIVERSITY

The Abitibi fluid inclusion study in the Kirkland Lake area continued, with the aim of characterizing the fluids present in the Kirkland Lake system and the Upper Beaver deposit, using microthermometry and chemical analyses. Electron microprobe analyses are being undertaken on decrepitate mounds and possibly Raman and LA-ICP-MS. The mound work on the Kirkland Lake samples is part of an applied MSc project undertaken by I. Newman and supervised by D. Kontak (G. Tuba, pers. comm.).

Two MSc students (I. Chappell and C. Kelly) continue their studies in the Black Fox/Hislop areas, under the joint supervision of D. Kontak and B. Lafrance, and supported by both Kirkland Lake Gold Ltd. and Primero Mining Corp. Another MSc student, L. Arteaga, has been working with H. Gibson and D. Kontak south of Kirkland Lake on an Osisko Mining Inc./Talisker property, the Miller Project in the Boston Creek area (D. Kontak, pers. comm.). This particular study focusses on the temporal and spatial relationships between gold mineralization and nearby intrusive rocks.

UNIVERSITY OF OTTAWA

M. Cige Tatchum Ouafo is working on a project in the Kirkland Lake area, supervised by O. Nadeau in association with Kirkland Lake Gold Ltd. The project is focussed on the distinction and characterisation of metamorphic, barren and auriferous hydrothermal alterations, at the Kirkland Lake Archean Intrusion-Related Gold Deposit, of the Abitibi, Ontario (O. Nadeau, pers. comm.).

WESTERN UNIVERSITY

K. Feick recently completed an MSc thesis with the title: "An Evaluation of Lithologies and Geochemistry in the Upper Beaver Deposit of the Kirkland Lake Area: Towards a Refined Gold Exploration Model". The project was supervised by N. Banerjee, and supported by Canadian Malartic Corporation. A second MSc student, L. Stammers, is currently investigating the geochemical constraints of the gold mineralization sources from the South Mine Complex and the Main and '04 Breaks at Macassa Mine, Kirkland Lake. This project is supervised by N. Banerjee and supported by Kirkland Lake Gold Limited (N. Banerjee, pers. comm.).

REGIONAL LAND USE GEOLOGIST ACTIVITIES—NORTHEAST REGION

Land Use Planning Activities

The northeast Regional Land Use Geologist, based in Timmins, co-ordinates input into land use planning activities in the Sault Ste. Marie, Timmins and Kirkland Lake Resident Geologist districts and the part of the Sudbury District that is north of the French River. The northeast Regional Land Use Geologist position was staffed throughout 2016 by Catherine Daniels, *P.Geo*.

The boundaries of the Regional Land Use Geologists' regions are indicated on Figure 10. Readers interested in Regional Land Use Geologist activities in the portion of the Sudbury or Sault Ste. Marie Resident Geologist districts that are within the Southern Land Use Region are advised to review a copy of the annual Report of Activities for Southern Ontario.

The objective of the position is to ensure that geoscience information is considered in policy and land use planning decisions. The geoscience information relates to :

- mineral-related values and economic opportunities;
- natural geological and mining-related hazards;
- renewable and non-renewable energy sources; and,
- groundwater resources.

Program activities that support this objective include helping develop, deliver and administer provincial policies, practices and procedures; and providing advice and guidance to municipalities, agencies and others involved in or affected by land-use planning regarding geoscience-related matters.

In 2016, the northeast Regional Land Use Geologist dealt with a variety of land use planning issues throughout the northeast region. The following sections summarize the work that was done.

CROWN LANDS

The Ministry of Northern Development and Mines (MNDM) engages with the Ministry of Natural Resources and Forestry (MNRF) when Crown land use planning activities have the potential to impact provincial mineral interests, or to expose those using Crown lands to natural geological or mining-related hazards. These activities relate to forest management planning; energy and other major infrastructure projects; Far North land use planning; proposals to modify existing parks or create new ones; and various other initiatives related to Crown land use.

Figure 10. Extent of Regional Land Use Geologists' areas of responsibility (red lines indicate the regional boundaries; grey lines indicate municipal boundaries).

Crown Land Use Policy Atlas

The Crown Land Use Policy Atlas (CLUPA; https://www.ontario.ca/page/crown-land-use-policy-atlas) contains area-specific land use policies for Crown lands in central and northern Ontario, to the northern limit of forestry activities in the province. These policies are established under the authority of the *Public Lands Act*.

In 2016, the northeast Regional Land Use Geologist and the Land Use Policy and Planning Co-ordinator continued to work with other branches of MNDM and with MNRF in regard to Crown Land Use Management areas and mineral exploration interests.

Crown Land Disposition

In 2016, the northeast Regional Land Use Geologist with the Land Use Policy and Planning Co-ordinator, continued discussions with MNRF and the City of Elliot Lake regarding the disposition of Crown land to the City of Elliot Lake for new cottage lot developments.

Forest Management Planning

The forest management planning process involves consideration of a wide range of values, including mineral values, in the context of forestry activities, and the relevance of legislation other than the *Crown Forest Sustainability Act*, such as the *Mining Act*. The northeast Regional Land Use Geologist provided input into the development of the Romeo Mallette Forest Management Plan 2019–2029, the Hearst Forest Management Plan 2017–2027, the White River Forest Management Plan 2018–2028, the Big Pic Forest Management Plan 2017–2019 (Contingency Plan), the Pic River Forest Management Plan 2017–2019 (Contingency Plan), the Temagami Forest Management Plan 2011–2021, and the Nipissing Forest Management Plan 2019–2029.

Approved forest management plans, with detailed information about annual operations, including plans for creating new access routes or decommissioning existing routes, and maps showing forest access roads are posted on the MNRF Web site (www.efmp.lrc.gov.on.ca/eFMP/home.do).

Far North Land Use Planning

The Far North Land Use Planning Initiative is about working with First Nations to identify where development can occur and where land will be dedicated to protection in the Far North of Ontario (https://www.ontario.ca/page/far-north-land-use-planning-initiative). The Far North encompasses 42% of Ontario's land mass in an area generally north of the areas where forest management planning is done (for the planning area boundary, *see* www.ontario.ca/rural-and-north/far-north-ontario). Detailed information about Far North Land Use Planning and the *Far North Act* is available (*see* www.ontario.ca/page/far-north-land-use-planning-initiative).

All but a few First Nation communities are working on a range of land use planning activities, although they are not all at the same stage in the planning process. In northeastern Ontario, Constance Lake First Nation has completed its Terms of Reference and continues to work on the draft plan. Other communities are working on gathering information for their planning areas, and learning about the land use planning process. In 2016, the northeast Regional Land Use Geologist

- participated in the Mushkegowuk Council Planning Forum, organized by MNRF's Far North branch;
- provided information and support to the MNRF Far North Branch with regard to the mineral sector and geoscience, as they apply to land use planning.

In addition, work on geoscience atlases, with information about more than 20 geoscience-related themes, continued in 2016. Copies of the atlases were provided to MNRF Far North Branch in Timmins.

Withdrawal Orders

Other work related to Crown land use in the northeast region included reviews of 5 applications for withdrawal of lands from staking under Section 35 of the *Mining Act*. Some applications were for mining rights only and some were for both surface and mining rights. The requests were made by the Ministry of Indigenous Relations and Reconciliation (MIRR), MNRF and private land owners for a wide range of reasons, including

- Mississaugi No. 8 Land Agreement (MNRF);
- Matachewan, Treaty Land Entitlement (MIRR);
- Moose Cree, Treaty Land Entitlement (MIRR);
- Thessalon First Nation boundary claim (MIRR); and,
- Recreational Use, Mattagami Township.

Reviews by the northeast Regional Land Use Geologist ensured that mineral potential, mineral sector activity and mining-related hazards were identified and considered before decisions were made.

Aggregates

The northeast Regional Land Use Geologist ensured that mineral potential, mineral sector activity and mining-related hazards were identified and considered before decisions were made regarding a proposed Major Amendment for Aggregate Permit 405052 (A01-020) source to a Category 9/12 received by the Ministry of Transport (MTO).

Other

The northeast Regional Land Use Geologist provided support to multiple ministries in the evaluation of potential lands for agriculture dispositions in northeastern Ontario. Geoscience information was prepared and provided for this initiative.

MUNICIPAL AND PRIVATE LANDS

The Ministry of Northern Development and Mines supports municipal and private land use planning through the One Window Planning Service led by the Ministry of Municipal Affairs (MMA). When requested, the northeast Regional Land Use Geologist provides input into, and reviews, draft Official Plans, Official Plan Amendments, draft plans of subdivision and consent (severance) applications to ensure that provincial mineral interests, natural geological hazards and mining-related hazards are appropriately considered in the planning process.

Municipal Planning

The Provincial Policy Statement (PPS), which guides municipal planning in Ontario, is issued under the provisions of the *Planning Act*. The PPS was last modified in 2014. The revision includes enhanced provisions to help ensure that municipal Official Plans recognize mining operations and areas with significant mineral potential, so that they can be protected from incompatible land uses.

As a participant in MMA's One Window service for Official Plans and their amendments, the northeast Regional Land Use Geologist provided comments, mineral values mapping and other input as required for Official Plans and Official Plan Amendments for the municipalities of Sault Ste. Marie, Black River–Matheson, Kapuskasing, Hearst, Cobalt, Espanola, Armstrong and Larder Lake, as listed in Table 12.

In addition, information was provided, and reviews were done, in conjunction with 12 by-law amendments, 11 consent (severance) applications and 1 subdivision proposal, as listed in Table 12. The northeastern Regional Land Use Geologist attended the Northeastern Ontario Planning Authorities Workshop to network with clients and service providers engaged in municipal planning.

Table 12. Municipal planning initiatives with MNDM input, northeastern Ontario, 2016.

Consent (Severance) and Subdivision Applications
Consent, Coleman Township (4)
Consent, South Lorrain, Unincorporated Township
Consent, Sheraton, Unincorporated Township
Consent, Henwood, Unincorporated Township
Consent, Marter, Unincorporated Township
Consent, City of Timmins
Consent, Munro, Unincorporated Township
Consent, Otto, Unincorporated Township
Subdivision, City of Timmins

Completed Official Plans and Related Initiatives
Black River–Matheson, Township of
Hearst, Township of
Larder Lake, Town of
Cobalt, Township of
Moosonee, Township of
Timmins, City of (11)

Official Plans and Related Initiatives Under Development
Sault Ste. Marie, City of
Espanola, Town of
Armstrong, Township of

FIRST NATIONS

In addition to doing work related to Far North land use planning, the northeast Regional Land Use Geologist provided support to various initiatives of the MIRR, such as providing geoscience information in advance of withdrawal requests.

Other Activities

The northeast Regional Land Use Geologist also undertook other related work in 2016, as outlined below.

GEOSCIENCE POLICY OPTIONS

A goal of Ontario's Mineral Development Strategy (http://www.mndm.gov.on.ca/en/mines-and-minerals/mineral-development-strategy) is to develop geoscience policy options that would integrate geoscience information into government decision making and inform provincial land-use planning decisions related to the environment, ecology, climate change and public health and safety. A committee consisting of a core team with members from MNDM and an inter-ministerial group with representatives from various provincial ministries was set up to help develop options, consult with other Ontario Public

Service (OPS) geoscientists and scientists for their input and perspective and promote awareness that geoscience policy options are being prepared. The northeast Regional Land Use Geologist participated on the committee by attending teleconferences and providing input to geoscience policy-related initiatives.

INVESTMENT READY SITES

Ontario's "Investment Ready: Certified Site" program, operated by the Ministry of Economic Development, Employment and Infrastructure promotes an inventory of sites that may be of interest to potential investors and purchasers. It pre-screens the suitability of sites for development, and provides detailed information about the sites' access to utilities and transportation, and their environmental status. In 2016, the northeast Regional Land Use Geologist provided review and feedback on the Investment Ready Certified Site Program re-launch and new application form. No sites were reviewed during 2016.

CLASS ENVIRONMENTAL ASSESSMENTS

Class Environmental Assessments ("Class EAs") are documents that set out a standard environmental assessment process to evaluate the potential environmental effects of a project. There are currently 11 Class EAs in effect in Ontario, relating to the development of new infrastructure, such as dams, transmission lines, pipelines, highway corridors, commuter rail stations and bus terminals, and sewer and water facilities; the establishment of new parks and conservation reserves; forest management plans; and Crown land dispositions.

The northeast Regional Land Use Geologist worked with staff from MNRF and other ministries to ensure that relevant geoscience information and provincial mineral interests were identified and accommodated early in the planning process of projects subject to Class EAs. In 2016, feedback was provided for reviews of the following 2 Class EA projects within northeastern Ontario:

- the City of Greater Sudbury's Azilda Wastewater System; and,
- the Côté Gold Project.

GUIDANCE MATERIALS

In 2016, the northeast Regional Land Use Geologist was called upon by partner ministries to review and provide input on proposed new or updated policies, and/or supporting guidance materials. Comments were prepared and submitted for the following:

- Strategic Plan for Ontario's Wetlands 2016–2030;
- Ontario Municipal Board (OMB) Review Consultation;
- One Window Screening Criteria: A Checklist of Provincial Interests - Specific Ministry Policy Areas for MNDM; and,
- Technical Compendium – Technical Studies where a Provincial Ministry may have a Review Involvement.

CONFERENCES

The northeast Regional Land Use Geologist engaged with indigenous and industry sector clients at the Canadian Aboriginal Minerals Association (CAMA) conference in Ottawa, and the "Mining Summit" in Timmins. As well, the northeast Regional Land Use Geologist engaged with industry sector clients at the Canadian Land Reclamation Association (CLRA) National Annual General Meeting and Conference in Timmins.

The northeast Regional Land Use Geologist also engaged with representatives from the northeastern municipalities at the Municipal Services Office-North planning meeting in Sudbury.

MINERAL DEPOSIT COMPILATION GEOLOGIST—NORTHEASTERN ONTARIO

The Mineral Deposit Compilation geologists (MDCG) investigate and document mineral deposits and occurrences across the province. Through field visits, comprehensive literature research and personal research, they work with regional and district Resident Geologist Program staff to ensure that the Mineral Deposit Inventory (MDI) database is regularly updated. Regular updates are required to ensure that the Ministry of Northern Development and Mines is using the most up-to-date information in making land-use planning and policy decisions. A.C. Wilson is the northeastern Ontario MDCG.

A focus was made on updating MDI records for the Black River–Matheson land-use planning update. To date, data for 6 of the townships have been compiled and entered into the database.

Complete township updates were compiled and entered for Hislop, Playfair, Walker, Cook, Benoit and Melba, in the Larder Lake Mining Division. Complete township updates were also compiled and entered for Cameron, Denison, Drury, Hallam, Baldwin, Porter, Foster, Mongowin, Merrit and Papineau Townships in the Sudbury Mining Division. Complete township updates were also compiled and entered for: Yeo, Potier, Arbutus and Huffman, in the Porcupine Mining Division. Twenty-three records were updated for Riggs Township in the Sault Ste. Marie Mining Division. Complete township updates were also compiled and entered for Bathurst, Cavendish, Elmsley, Glamorgan, Kitley, Monmouth, Niagara and Snowdon, in the Southern Ontario Mining Division.

The northeastern MDCG also worked on changes and updates to MDI records for a variety of land use planning decisions in the Larder Lake Mining Division and the Sault Ste. Marie Mining Division.

Total changes to the provincial MDI database, completed by the northeastern Ontario MDCG, in 2016 included 589 updated records, 174 records deleted and 3 new records. A breakdown, by office, of the provincial records revised by the Northeastern Mineral Deposit Compilation Geologist is provided in Table 13.

The MDI database is a dynamic compilation of over 19 000 records describing most of the known mineral occurrences in Ontario. It is an important reference tool for explorationists interested in exploring and acquiring mining properties in Ontario. When used in conjunction with other spatial databases generated by the Ontario Geological Survey, it provides an additional tool for making mineral discoveries in Ontario.

Table 13. Mineral Deposit Inventory records revisions in 2016 (Ontario Geological Survey 2016).

Resident or District Office	Updates	Deletions	New
Kirkland Lake	134	7	2
Sault Ste. Marie	23	0	0
Southeastern Ontario	303	152	1
Sudbury	70	15	0
Timmins	59	0	0
Total	589	174	3

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Ontario

Ontario Geological Survey
Regional Resident Geologist Program

Kirkland Lake Regional Resident Geologist (Sudbury District)—2016

by

A.S. Péloquin, D.G. Farrow, F. Belley–Biswas and L.A. Bardeggia

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Kirkland Lake Regional Resident Geologist (Sudbury District)—2016

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INTRODUCTION

The Sudbury District Geologist Office administers to the judicial Districts of Greater Sudbury, Manitoulin, Parry Sound, Muskoka, parts of Nipissing District and the County of Renfrew (Figure 1). The Sudbury District encompasses approximately 45 000 km^2 and more than 340 geographical townships. The Sudbury District Geologist Office is located on the campus of Laurentian University in the Willet Green Miller Centre, 3rd Floor, 933 Ramsey Lake Road, Sudbury, P3E 6B5.

The Sudbury mining camp is one of the oldest and most active in the world, with nickel-copper mining operations related to the Sudbury Igneous Complex (SIC) providing the basis of economic activity in the Sudbury region. Since 1883, more than 1.6 billion tons of ore have been raised from Sudbury's deposits, yielding some 40 billion pounds of copper, 44 billion pounds of nickel and 62 million ounces of precious metals (Naldrett 2013).

In general, the Sudbury District is underlain, from north to south, by a diverse assemblage of Archean granitic, metavolcanic, mafic intrusive and gneissic rocks of the Superior Province; Paleoproterozoic mafic intrusive, volcanic and sedimentary rocks of the Huronian Supergroup of the Southern Province; the Sudbury Igneous Complex and related mafic intrusive rocks and supracrustal crater fill of the Whitewater Group; various lithologies within the Central Gneiss Complex of the Grenville Province; and Paleozoic sedimentary rocks of the Michigan Basin.

The global economy continued to be sluggish in 2016. S&P Global Market Intelligence (2016), Corporate Exploration Strategies, reported a drop of 21% in global exploration spending; however, the report recognized positive signs on financing. These trends impact exploration activity in the Sudbury District. Statistics of claim-staking activity and exploration expenditures for the Sudbury Mining Division over the last decade are presented in Table 1. More unpatented mining claims were allowed to lapse than were staked. However, the dollar value of assessment work performed in 2016 increased from 2015 values.

In addition to grassroots prospecting and major mining company projects, junior mining companies explored wholly-owned, optioned or joint-ventured properties. Many of these efforts occurred within or near the Sudbury Igneous Complex (SIC) contact sublayer or in associated quartz diorite offset dikes outside the SIC, radiating from or concentric to the contact sublayer. Exploration associated with Nipissing diabase dikes, Archean greenstone belts and metasedimentary rocks of the Paleoproterozoic Huronian Supergroup was also undertaken.

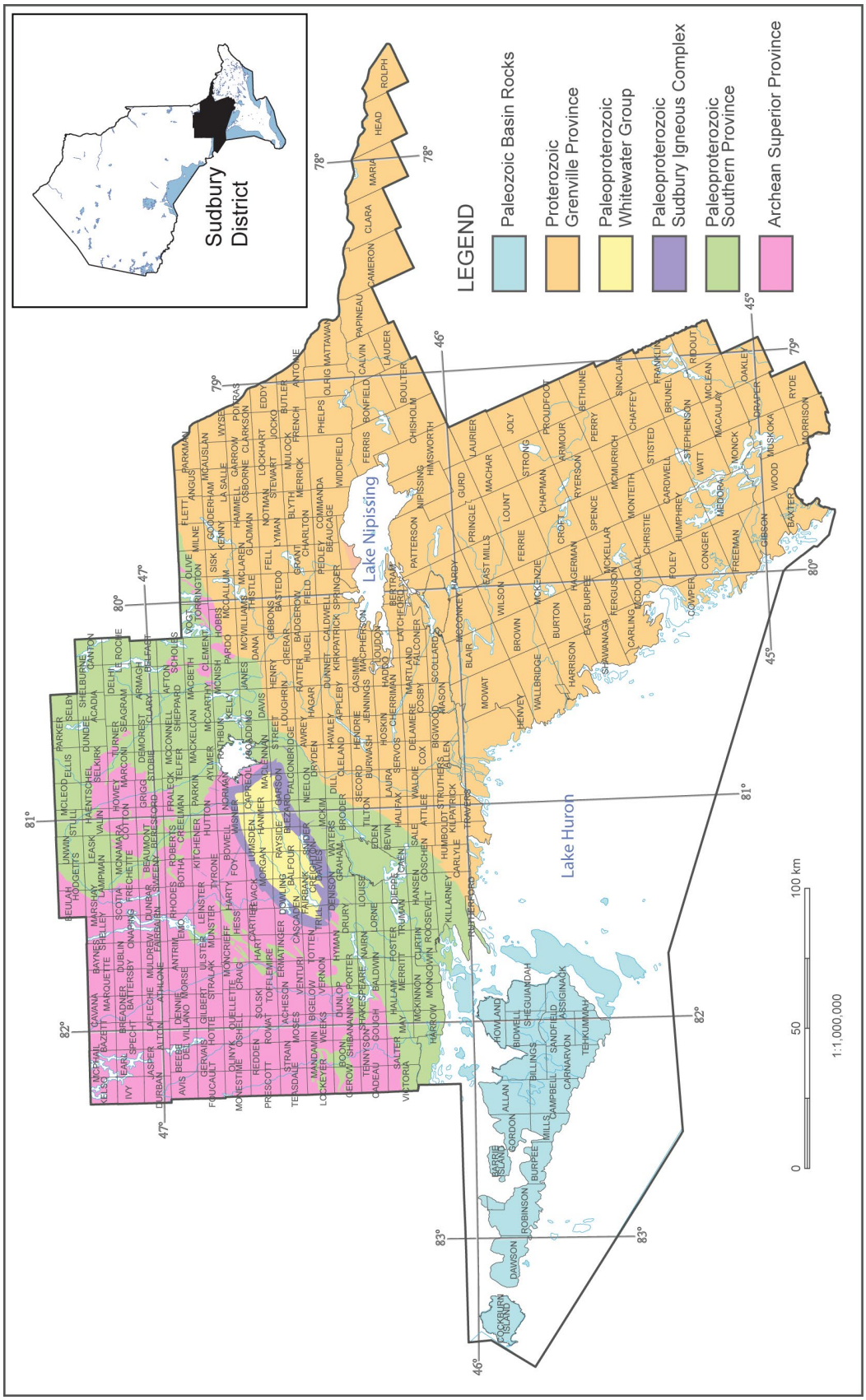

Figure 1. Bedrock geology of the Sudbury District, geology *modified from* Ontario Geological Survey (2011).

Sixteen reports of exploration activities completed in 2016 were received by the Sudbury District Geologist Office (Table 2 and Figure 2). A total of 134 Exploration Plans and Permits were active for the Sudbury District during all or part of 2016 (Table 3). Six plans and 41 permits expired during 2016; 21 plans and 29 permits were ongoing. Fourteen new plans and 23 new permits were issued.

Advanced and long-term projects once again received most of the attention in the district. Gold, graphite and rare earth elements were the focus of non-base metal exploration. Some mid-tier junior exploration companies were active, despite reduced risk tolerance and the need for cost-effective spending. Six companies benefited from the Junior Exploration Assistance Program (JEAP); 8 projects were targeted by this funding (Table 4).

Dollar values in this report are given in Canadian currency (C$), unless otherwise stated. Ore reserve statistics mentioned in this report may not necessarily be National Instrument 43-101 (NI 43-101) compliant unless otherwise stated. Activities and financial statements reported for quarterly periods may be abbreviated as Q (Q1 for first quarter, etc.) in this report.

MINING ACTIVITY

Nickel, Copper and Platinum Group Elements

In 2016, 9 nickel-copper mines operated within the Sudbury Basin (Figure 3).

As shown in Figure 4, nickel prices rose erratically throughout 2016, from $3.85 US$/lb in January to a high of $5.07 US$/lb in November, closing December at $4.53 US$/lb. Copper began 2016 at $2.06 US$/lb in January and showed price fluctuations in the $2.06 to $2.28 US$/lb range, until November when the price rose to $2.62 US$/lb, settling back to $2.50 US$/lb in December. The price variations in nickel were aligned with the fluctuations, and overall decrease, in London Metal Exchange (LME) inventories through 2016. However, LME copper inventory fluctuations were not mirrored by the copper price until late in the year. The October 2016 World Bank Commodity Markets Outlook Report (World Bank Group 2016) suggests that copper prices were supported by strong demand from China's construction sector and the power grid.

Gold and platinum prices over 2016 exhibit overall domed patterns with internal fluctuations (Figure 5). Both metals show erratic overall price increases in the beginning of the year through to the summer, followed by equally erratic overall price declines. Gold began 2016 at $1062.38 US$/oz in January, rising to $1368.74 US$/oz in July and falling to $1157.4 US$/oz at the end of December. Platinum's lowest price in 2016 was $814 US$/oz in January 2016; it rose to $1182 US$/oz in August and fell back to $898 US$/oz in December. Palladium prices were also volatile, but underwent an overall increase throughout 2016. Palladium started 2016 at $555 US$/oz in January, rising and falling throughout the year to close in December at $670 US$/oz. The 52 week low for palladium was $470 US$/oz in January and the 52 week high was $770 US$/oz in November. Global economic uncertainty continued to affect Sudbury area producers in 2015. Only Glencore Canada Corp. had released its year-end production report for 2016 at the time of publication. For Vale Canada Ltd. and KGHM International Ltd., the third Quarter production results are summarized here.

VALE CANADA LIMITED

Vale's Sudbury mining, milling, smelting and refining operations report an annual nominal production capacity of 66 000 metric tons of refined nickel, and additionally produce nickel oxide feed for the refinery in Wales (Vale 2016a).

In 2016, Vale had 6 operating mines in the Sudbury District: Copper Cliff, Creighton, Garson, McCreedy East/Coleman, Stobie and Totten mines (*see* Figure 3). The total proven and probable reserves in Vale's Sudbury mines, as given in their 2015 20-F report (Vale 2016a), are shown in Table 5.

(www.vale.com: | Canada | investors | information to the market [accessed February 08, 2017]).

Table 1. Summary of recorded claims and assessment work credits in the Sudbury District, 2006–2016.

Year	Recorded Claim Units	Cancelled Claim Units	Active Claim Units	Total ($) Assessment Work
2016	1 395	2 651	12 244	7 603 687
2015	1 612	2 688	13 316	7 454 102
2014	1 257	4 042	14 147	4 503 432
2013	1 141	2 734	16 932	10 188 942
2012	736	2 100	17 691	14 582 592
2011	3 077	2 258	20 143	9 662 626
2010	2 964	3 591	18 768	6 482 550
2009	1 445	8 053	19 203	7 179 712
2008	2 749	4 041	25 709	6 698 594
2007	8 870	2 589	26 448	6 855 097
2006	4 729	2 700	17 472	5 751 411

Table 2. Exploration activity in the Sudbury District in 2016 (keyed to Figure 2).

Abbreviations

ASSAY.....Rock analysis
BULK.....Bulk sampling
DH-GPHYS.....Downhole geophysics
DRILL.....Diamond drilling
GMAP.....Geological mapping
LC.....Line cutting
LIDAR.....Light detection and ranging survey
PROSP.....Prospecting
PW.....Physical work
SAMP.....Sampling
SHAFT.....Preparations for shaft sinking
STRIP.....Overburden stripping
TRVS.....Traverse
VLF-EM.....Very low frequency electromagnetic survey

	Company Name	Property/Project	Commodity	Township(s)	Type of Work
1	F. Delabbio	Delabbio claim 4219156		Aylmer	GMAP
2	Flag Resources (1985) Ltd.			Rathbun	VLF-EM
3	Green Swan Capital Corp.	Copper Prince Property	Co, Au	Falconbridge	SAMP, ASSAY, STRIP, GMAP, DRILL
4	Inventus Mining Corp.	Pardo paleoplacer gold property	Au	Pardo	PROSP, STRIP, SAMP, GMAP, ASSAY
5	T.P. Martel	Parkin limestone Property	Limestone	Parkin	PW, SAMP, TRVS
6	Northern Sphere Mining Corp. & Trueclaim Exploration Inc.	Scadding gold JV property	Au	Scadding	BULK
7	407043 Ontario Limited			Capreol	GMAP, LC, SAMP, ASSAY
8	P. Overton	Claim 4275123	Silica	Valin	ASSAY, LC, SAMP
9	[1]Pacific North West Capital Corp.	River Valley Property	PGE	Dana, Pardo	GMAP, PROSP, SAMP, ASSAY, DRILL
10	T.H. Sheppard	Sheppard claim 4203306		Aylmer	SAMP
11	T.H. Sheppard	Sheppard claim 4203306		Aylmer	GMAP
12	R.I. Stewart	Sargesson lake property		Janes	SAMP, GMAP
13	Sudbury Platinum Corp.	Lockerby East & West Graham property	Ni, Cu, PGE	Graham, Creighton	DH-GPHYS
14	Transition Metals Corp.	North Vermillion property	Zn, Pb, Cu	Fairbank	GMAP, SAMP
15	Wallbridge Mining Company Ltd.	Wallbridge Mining Ltd properties	Cu, Ni, PGE, Au	Levack	LIDAR
16	Wallbridge Mining Company Ltd.	Parkin Property	Cu, Ni, PGE, Au	Parkin	DRILL, ASSAY

[1]*Name changed to New Age Metals, February 2017.*

Table 3. Summary of exploration plans and permits in the Sudbury District (expiring, ongoing and initiated in 2016).

Status	Type		Number	Activities
Expired in 2016	**Plans**		2	Geophysical survey
			2	Line cutting, geophysical survey
			1	Line cutting, pitting and trenching, geophysical survey
			1	Line cutting, mechanized stripping, geophysical survey
		Total	*6*	
	Permits		11	Mechanized drilling
			18	Mechanized drilling, mechanized stripping
			8	Mechanized drilling, mechanized stripping, pitting and trenching
			2	Line cutting, mechanized drilling, mechanized stripping, pitting and trenching
			2	Mechanized stripping
		Total	*41*	
Ongoing in 2016	**Plans**		5	Geophysical survey
			1	Line cutting, mechanized drilling, pitting and trenching, geophysical survey
			4	Line cutting, geophysical survey
			6	Line cutting, pitting and trenching, geophysical survey
			1	Line cutting, mechanized stripping
			2	Pitting and trenching, geophysical survey
			1	Mechanized stripping
			1	Mechanized stripping, pitting and trenching
		Total	*21*	
	Permits		13	Mechanized drilling
			13	Mechanized drilling, mechanized stripping
			1	Line cutting, mechanized drilling, pitting and trenching
			1	Line cutting, mechanized drilling, mechanized stripping, pitting and trenching
			1	Mechanized stripping
		Total	*29*	
Initiated in 2016	**Plans**		2	Geophysical survey
			1	Line cutting
			1	Line cutting, mechanized drilling, pitting and trenching
			1	Line cutting, geophysical survey
			5	Line cutting, pitting and trenching, geophysical survey
			1	Line cutting, mechanized stripping, geophysical survey
			3	Mechanized stripping
		Total	*14*	
	Permits		1	
			5	Mechanized drilling
			7	Mechanized drilling, mechanized stripping
			4	Mechanized drilling, mechanized stripping, pitting and trenching
			1	Line cutting, mechanized drilling, mechanized stripping, pitting and trenching
			1	Line cutting, mechanized stripping, pitting and trenching
			4	Mechanized stripping
		Total	*23*	

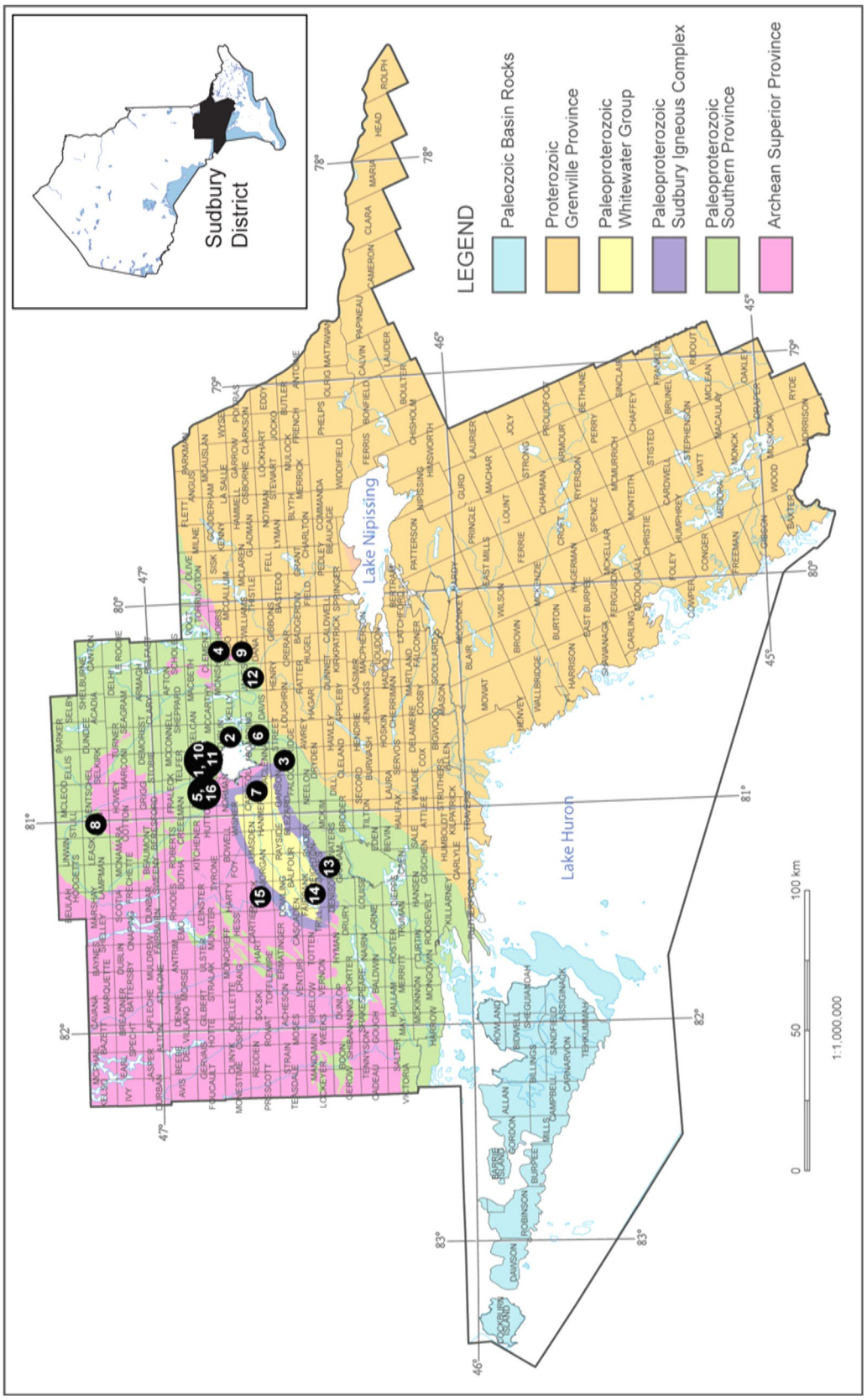

Figure 2. Exploration activity in the Sudbury District in 2016 (keyed to Table 2); geology *modified from* Ontario Geological Survey 2011.

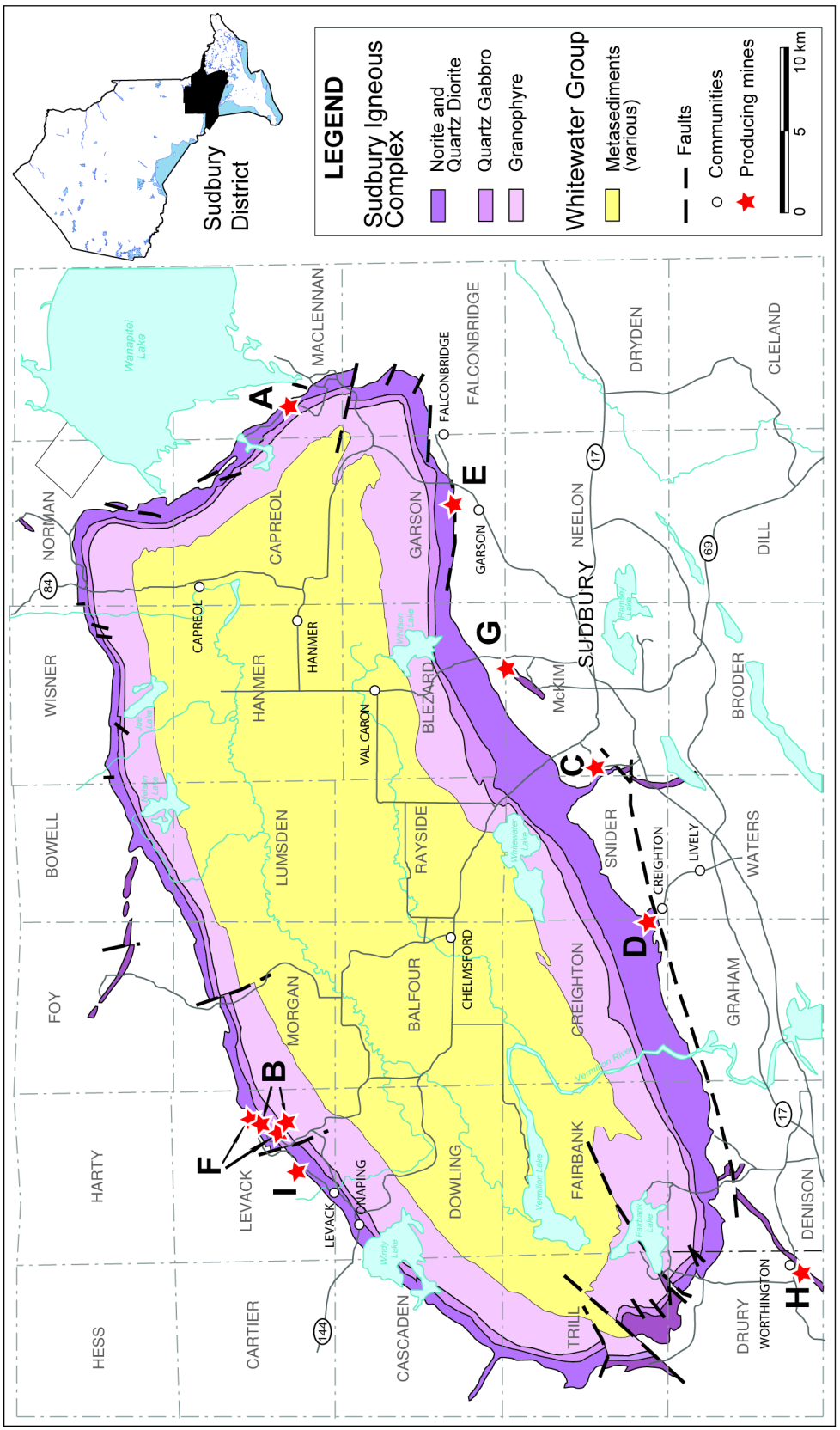

Figure 3. Producing mines in the Sudbury District 2016; geology *modified after* Ames et al. (2005).

Table 4. Companies benefiting from the Junior Exploration Assistance Program (JEAP) in the Sudbury District in 2016.

JEAP File No.	Company	Project Name
16009	Sudbury Platinum Corp	Aer-Kidd
16011	[1]Pacific North West Capital Corp	River Valley
16023	Inventus Mining Corp	Pardo
16024	Canadian Continental Exploration Corp	Eagle Rock
16028	Wallbridge Mining	Parkin
16031	Wallbridge Mining	Sudbury Regional
16043	Green Swan Capital Corp.	Copper Prince
16048	Sudbury Platinum Corp	Rosen

[1] *Name changed to New Age Metals, February 2017.*

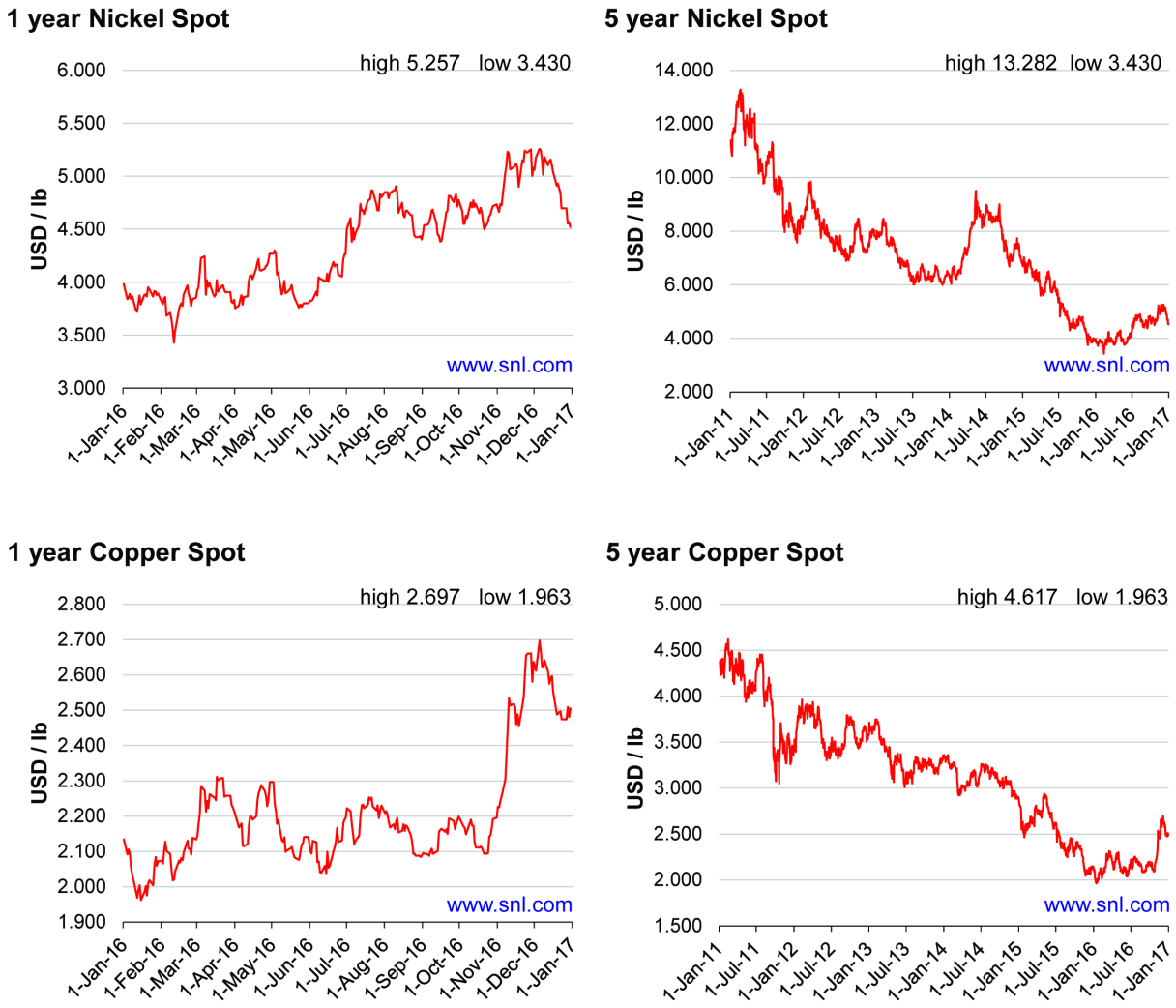

Figure 4. Spot prices for nickel and copper over the last 1 year and 5 years (prices in US$/lb; www.snl.com).

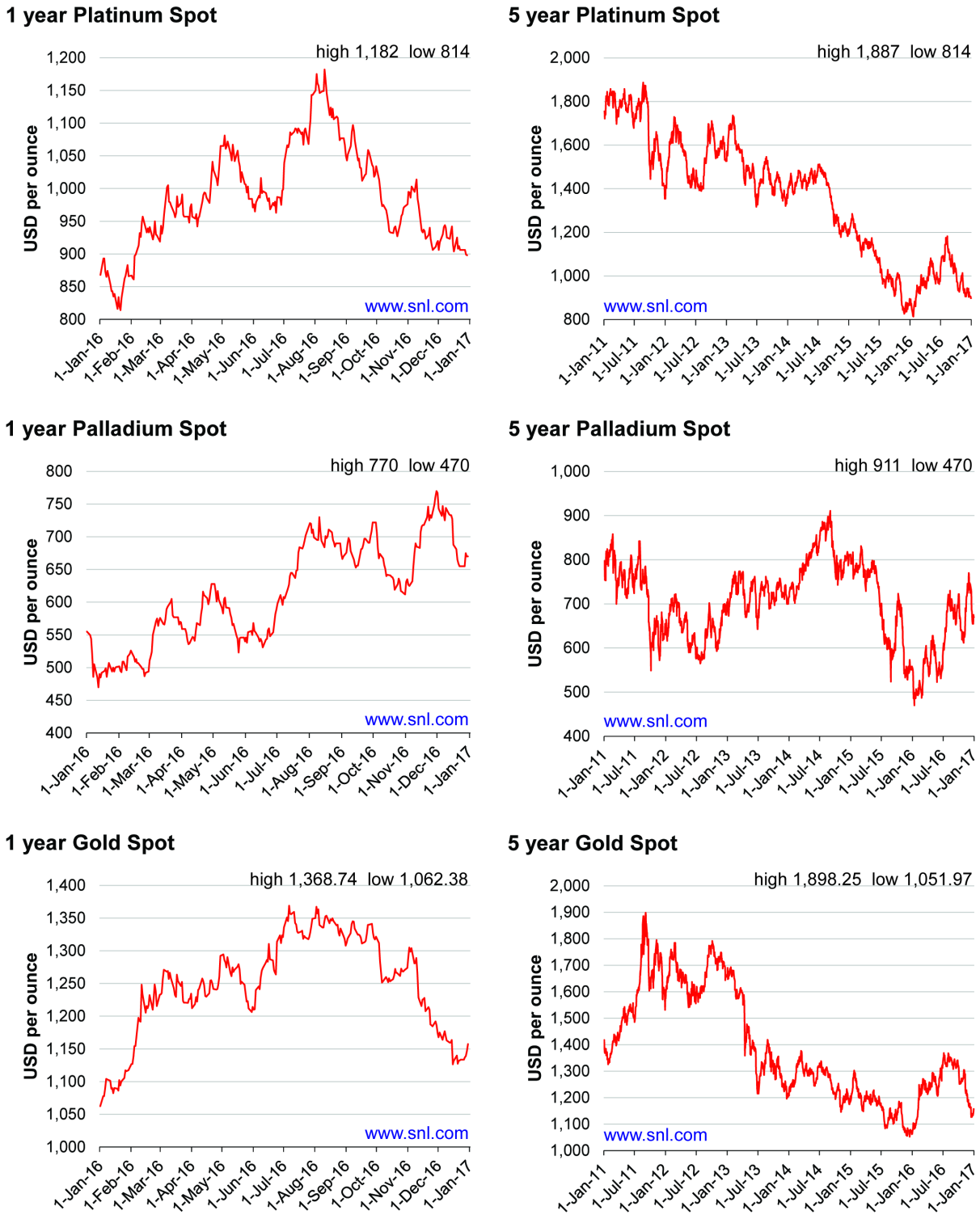

Figure 5. Spot prices for platinum, palladium and gold for the last 1 year and 5 years. Prices in US$/oz (www.snl.com).

Table 5. Vale Sudbury ore reserves as of December 2015 (Vale 2016a).

Commodity	[1]Total Proven and Probable Reserves	Recovery (%)
(Mt)	76.4	-
Ni (%)	1.27	75 – 85
Cu (%)	1.61	90 – 95
Co (%)	0.4	20 – 40
Gold (g/t)	0.4	80 – 90
Platinum (g/t)	1.1	80 – 90
Palladium (g/t)	1.1	80 – 90

[1]Defined as "…mineral reserve estimates are of in-place material after adjustments for mining depletion and mining losses and recoveries, with no adjustments made for metal losses due to processing."(Vale 2016a)

Vale Sudbury Metal Production at Q3 2016

In the first 3 quarters of 2016, nickel production from Vale's Sudbury mines reached 60 500 tonnes (Table 6). This was 46.1% higher than production over the first 9 months of 2015. Sudbury operations underwent a scheduled maintenance of its surface plants in August 2015, accounting for the lower 2015 production. A maintenance shutdown is also scheduled in 2017 to accommodate the conversion to a single furnace operation (Vale 2016b).

Production of copper from Sudbury reached 89 000 tonnes in the first 3 quarters of 2016, and was 34% higher than production in the first 9 months of 2015 (*see* Table 6). The lower 2015 production was a result of planned maintenance carried out in August 2015 (Vale 2016b).

Byproduct production for the first 3 quarters of 2016 included 596 tonnes cobalt, 140 000 ounces of platinum (troy), 274 000 ounces of palladium (troy) and 1 544 000 ounces of silver (troy) (Vale 2016b; *see* Table 6). Gold production from Sudbury alone was not reported in the Q3–2016 production report. Vale's gold volume from nickel and copper concentrates in Q3 was a record 118 000 ounces (troy), in part due the better operational performance in Sudbury. The total gold output for the first 9 months of 2016 (from all nickel–copper concentrates) was 345 000 ounces (troy), an increase of 14.2% from the 303 000 ounces (troy) produced in the same period of 2015 (Vale 2016b).

Table 6. Vale Sudbury Operations 2015–2016 Q3-YTD Production Comparison (Vale 2016b).

Q3 – Year-To-Date Data			
Commodity	**2016**	**2015**	**Change %**
Ni metal (kt)	60.5	41.4	46.1
Cu metal (kt)	89.0	67.0	34
Co metal (t)	596	479	24.4
Silver (koz)	1544	1151	34.1
Platinum (koz)	140	116	20.7
Palladium (koz)	274	262	4.6
[1]Gold (koz)	345	303	14.2

k, kilo
koz, kilo-ounce troy
[1]Gold from all Ni-Cu Concentrates (includes Sudbury)

Update on Clean AER Project

In January of 2016, Vale had spent $625 million on the AER (Atmospheric Emissions Reduction) project and surface smelter upgrades, and were on track to reach their 2018 commitment (*Sudbury Star, January 23, 2016*). The Clean AER Project will reduce sulphur dioxide emissions by 85%, to 20 000 t/year from 150 000 t/year, and reduce greenhouse gas emissions by 40% from the current levels. It will also reduce dust and metals emissions by 35 to 40% (www.vale.com: | Canada | About Vale | Communities | Sudbury | Sudbury Environment | Our commitment to air quality in Sudbury | Clean AER [accessed April 5, 2017]).

GLENCORE CANADA CORPORATION

Glencore Canada Corporation (Glencore) Sudbury Integrated Nickel Operations (INO) encompass exploration, mining, milling and smelting. The Strathcona Mill processes ore from Glencore's Sudbury mines, and custom feed ores from third parties. Two forms of concentrate are produced: nickel-copper and copper. The maximum processing capacity of the mill is about 2.75 million tonnes of ore per year. The Sudbury Smelter smelts nickel-copper concentrate from Glencore's Sudbury, Raglan and XNA (Australia) operations; it also processes custom-feed materials. The smelter is capable of annually producing up to 95 000 tonnes of nickel, copper and cobalt in matte.

Glencore operates 2 underground nickel-copper mines in Sudbury: Nickel Rim South and Fraser (*see* Figure 3); Nickel Rim South Mine being Sudbury's largest current mining operation.

The totals for Measured and Indicated Resources, and Proven and Probable Reserves in Glencore's Sudbury mines, given in their resources and reserves report as of 31 December 2016 (Glencore 2017a), are shown in Table 7 (www.glencore.com: | investors | reports and results [accessed February 08, 2017]; www.sudburyino.ca [accessed February 08, 2017])

Table 7. Glencore Sudbury ore resources and reserves as of December 2016 (Glencore 2017a).

[1]Total Resources and Reserves		
Commodity	**Total Measured & Indicated Resources**	**Total Proven & Probable Reserves**
(Mt)	25.9	9.04
Ni (%)	2.13	1.43
Cu (%)	1.26	1.47
Co (%)	0.05	0.04
Platinum (g/t)	0.65	0.75
Palladium(g/t)	0.69	0.80

[1]*Defined as "Cut-off grades are calculated for each individual mine site or resource based on a metal equivalent or net smelter return value taking into account all recoverable metals." (Glencore, 2017a)*
M, million

Glencore Sudbury Metal Production 2016

Glencore reports production from its Sudbury Integrated Nickel Operations (Sudbury INO) as part of its 'Integrated Nickel Operations' (INO), which include Sudbury, Raglan (Quebec) and Nikkelverk (Norway). See Table 8 for annual production comparisons: 2015–2016.

In 2016, INO produced 66 200 tonnes of nickel as metal and in concentrate from its own sources, a 16 600 tonne (33%) increase from 2015, mainly because of the planned six-week Sudbury smelter shutdown in 2015 and the processing of stockpiled material from that time (Glencore 2017b).

Table 8. Integrated Nickel Operations (INO) 2015–2016 annual Production Comparison (Glencore 2017b).

Commodity	2016	2015	Change %
Ni metal (kt)	65.6	49.1	34
Ni in concentrates (kt)	0.6	0.5	20
Cu metal (kt)	16.6	14.9	11
Cu in concentrates (kt)	34.6	31.1	11
Co metal (kt)	1.0	0.8	25
Gold (koz)	37	35	6
Silver (koz)	624	610	2
Platinum (koz)	90	76	18
Palladium (koz)	173	157	10
Rhodium (koz)	6	5	20

k, kilo

KGHM INTERNATIONAL LTD.

During 2016, KGHM International Ltd. (KGHM) operated one mine in the Sudbury area: the Morrison Mine (formerly the Footwall Deposit of the lower Levack Mine; *see* Figure 3). The ore from the mine is processed at Vale's Clarabelle plant in Sudbury.

The Morrison Deposit, located in the lower part of the decommissioned Levack Mine, is characterized as a footwall-style copper deposit where copper mineralization occurs in multiple, sharp-walled, high-grade copper-nickel-precious metal veins within a larger mineralized envelope. The veins vary from approximately 12 m down to 0.3 m in width, and contain massive sulphides dominated by the copper mineral chalcopyrite and nickel minerals pentlandite and millerite. The deposit also includes significant precious metals, including platinum, palladium and gold. Resources reported for the Morrison Mine are given in Table 9 (KGHM 2016b; http://kghm.com/en: | investors | reports-and-presentations [accessed February 13, 2017]).

Table 9. Morrison Mine ore resources (KGHM 2016b).

Commodity	Total Resources
(Mt)	0.22
Ni (%)	1.20
Cu (%)	6.65
[1]TPM (oz/t)	0.22

[1]*TPM – precious metals (gold, platinum, palladium)*

KGHM Sudbury Metal Production at Q3 2016

In the first 3 quarters of 2016, KGHM produced 1600 tonnes of nickel from the Morrison Mine (Table 10); this is the same production value as from the same period in 2015 (KGHM 2016e).

Copper production from the Morrison Mine was 11 100 tonnes in the first 3 quarters of 2016, an 1100 tonne (11%) increase compared to the first 3 quarters of 2015 (*see* Table 10). This was mainly due to higher copper content in the ore in the first half of 2016 (7.30% in 2016 compared to 5.70% in the first half of 2015) (KGHM 2016e).

The higher metal content was also evident in the increase in Total Precious Metals (TPM – gold, platinum, palladium). The TPM produced in the first 3 quarters of 2016 was 35.3 koz troy, compared to 26.6 koz troy in the same period in 2015 (*see* Table 10; KGHM 2016e).

Table 10. KGHM Sudbury Operations 2015–2016 Q3-YTD Production Comparison (KGHM 2016e).

Q3 – Year-To-Date Data			
Commodity	**2016**	**[1]2015**	**Change %**
Ni (kt)	1.6	1.6	-
Cu (kt)	11.1	10	11
[2]TPM (koz)	35.3	26.6	32

k, kilo
koz, kilo-ounce troy
[1]2015 values include McCreedy West production
[2]TPM – precious metals (gold, platinum, palladium)

Industrial Minerals

Reflecting the lethargic economy, industrial mineral production for a variety of commodities declined in the Sudbury District in 2016. Commodities produced included dolostone, silica, trap rock, flagstone, organic soil conditioner, crushed garnet and several varieties of coloured landscape stone and aggregate (Table 11 and Figure 6). Several companies and individuals extracted sand and gravel for various purposes. The information in this section, regarding active industrial mineral producers, was extracted from public domain news.

BOREAL AGROMINERALS INC.

Spanish River Carbonatite

Boreal Agrominerals Inc. is quarrying and selling material extracted from the Spanish River carbonatite as an organic fertilizer. The material is excavated, trucked, screened and packaged for sale as "Volcanic Mineral Plus®". Ore reserve estimates in 2014 were 2 800 000 tonnes to a depth of 7.5 m (*Sudbury Mining Solutions Journal*, June 1, 2014, v.11, p.14-15).

MOHAWK GARNET INC.

Mohawk Garnet Mine

In 2008, Mohawk Garnet Inc. (MGI) entered into a Memorandum Of Understanding (MOU) to develop the Mohawk Garnet Mine (*Northern Life*, April 14, 2008). In 2013, the construction of 2 new facilities, with an estimated production capacity of 1000 tonnes of abrasive per day, was completed (www.mohawkgarnet.com | about-us [accessed February 08, 2017]; *Sudbury Star*, November 17, 2013). MGI bankrupcy proceedings began in May of 2016, culminating with the company being adjudged bankrupt in August 2016 (www.grantthornton.ca | Creditor updates | Mohawk Garnet Inc. [accessed February 08, 2017]).

Table 11. Industrial mineral and dimension stone producers in the Sudbury District in 2016 (keyed to Figure 6).

No.	Company/Individual	Township/Area	Commodity
1	Algonquin Natural Stone	Watt	Granite, gneiss; building stone, cut stone, landscaping stone
2	Algonquin Stone	Franklin	Granite, gneiss; flagstone, landscaping stone
3	Allstone Quarry Products Inc.	Bigwood	Granite; building stone, landscaping stone, flagstone, cut stone
4	Birkendale Natural Stone	Franklin	Granite, gneiss; flagstone, building stone, landscaping stone, armour stone,
5	Boreal Agrominerals Inc.–Spanish River Carbonatite	Venturi, Tofflemire	Vermiculite, carbonatite
6	Brent Quarries	Medora, Humphrey, Watt	Granite, granitic gneiss; flagstone, landscaping stone, wall stone, armour stone
7	Callander Industries Ltd. (Gary M. Mote)	McAuslan, Jocko, Garrow	Quartz-muscovite gneiss; veneer stone, flagstone, landscaping stone
8	Canadian Colour Rock Inc.	Gordon, Robinson, Aylmer	Dolostone; flagstone, building stone, landscaping stone
9	Colonial Brick & Stone Inc.	Robinson	Limestone; veneer, landscaping stone, flagstone, building stone,
10	Cushman Stone and Gravel Inc.	Perry	Granitic gneiss
11	Fowler Construction Company Limited	McDougall	Flagstone, landscaping stone, wall stone, aggregates
12	Keystone Granite	Franklin	Flagstone, stairs, landscaping stone
13	McFayden's Stone Quarry	Franklin	Granitic gneiss; flagstone, building stone, landscaping stone
14	Mill Lake Stone Quarry Limited	McDougall	Granitic gneiss; flagstone, building stone, landscaping stone, thin stone, veneer
15	[1]Mohawk Garnet Inc.	Street	Garnet abrasive
16	NaturStone Corporation	McAuslan	Mica stone (gneiss)
17	Odawa Stone Ltd. Partnership (2294669 Ontario Ltd.)	Robinson	Amabel, dolostone; cladding, paving, landscape, armour, countertops
18	Silicorp Developments Inc.	Wyse	Quartz; landscape stone, veneer, polished stone
19	Taillefer Quarry	Aylmer	Quartz, sandstone conglomerate; building stone, landscaping stone, monuments
20	Ted Boyes and Sons Construction Limited	Ryerson	Gneiss
21	The Rock Centre	Poitras	Granite, limestone, slate, sandstone; flagstone, landscaping stone, aggregate
22	Trillium Stone Inc.	Ryerson	Landscape stone, building stone, flagstone, armour stone, veneer stone
23	Upper Canada Stone Company Ltd. –River Valley Quarry	Gibbons	Marble, limestone; landscaping stone, building stone, ledgerock, specialty aggregates, terrazzo
24	Van Dyk Natural Stone Supplies Inc	Franklin	Granitic gneiss; landscaping stone, building stone

Note: [1]Mohawk Garnet Inc. ceased production in 2016.

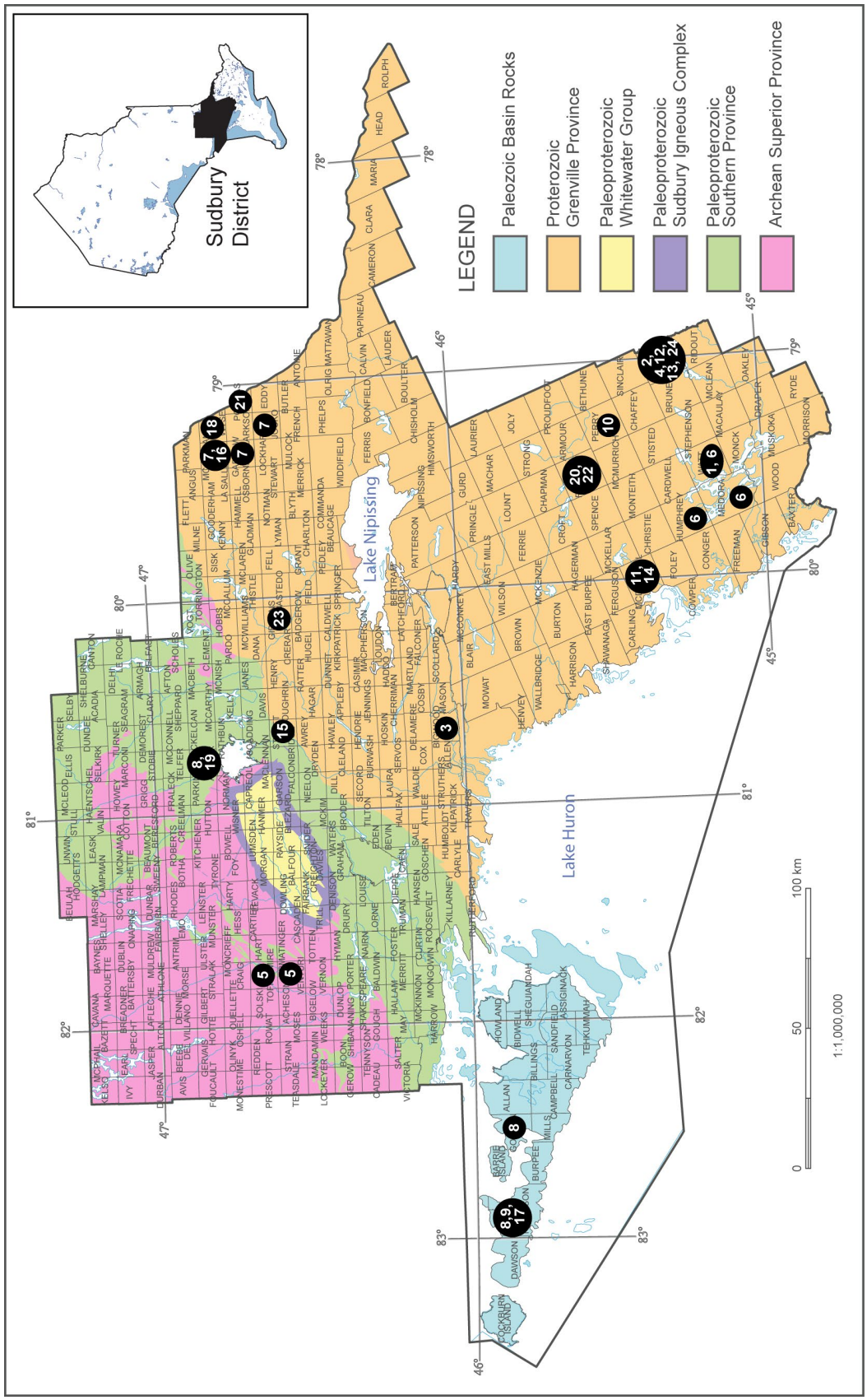

Figure 6. Industrial mineral and dimension stone producers in the Sudbury District in 2016 (keyed to Table 11); geology *modified from* Ontario Geological Survey (2011).

ADVANCED EXPLORATION AND DEVELOPMENT

Although several projects in the Sudbury District have reached the advanced exploration stage, the continued soft commodity prices (and high London Metal Exchange inventories) resulted in some to be consigned to "back burner" status. As the value of metals recover, advanced exploration projects are expected to be revived.

Nickel, Copper and Platinum Group Elements

KGHM INTERNATIONAL LIMITED

Victoria Project – Preproduction stage

The Victoria Property, situated at the junction of the Sudbury Igneous Complex (SIC) and the Worthington offset dike, is located in the South Range of the Sudbury Structure in Denison Township (Figure 7). The footwall rocks in this area consist of a Paleoproterozoic assemblage of metasedimentary sequences with felsic and mafic metavolcanic rocks and gabbroic intrusive rocks. The Worthington offset dike joins the main mass of the SIC in an intensely faulted and poorly exposed embayment structure at the location of the historic Victoria Mine site. The property hosts a "Frood-style" footwall breccia deposit with Ni-Cu-Pt-Pd-Au mineralization.

The Victoria property has seen a long history of exploration and mining. Operations at the Victoria Mine originally began in 1899 under the Mond Nickel Company and continued through 1923, producing 888 000 tons of ore grading 2.99% copper and 2.12% nickel (*Sudbury Mining Solutions Journal,* December 1, 2013, v. 10, p.15). The mine was reopened by Inco Ltd. in 1970 and operated until 1978. In 2002 FNX Mining Ltd. acquired the rights to the Victoria property from Inco. Exploration on the property was reinitiated in 2008 and resulted in the 2010 Zone 4 discovery.

In Q1-2016 KGHM initiated a "technical assumptions and risks" review of the Victoria project (KGHM 2016c). This review was ongoing as of Q3 (KGHM 2016e). In addition, the Management Board modified the schedule for and optimised the organisational structure of the project. In Q2-2016, part of the optimisation work included adjusting the employment structure to the new scope and schedule of the project (KGHM 2016d). The period Q3-2016 saw completion of the detailed technical documentation of the water purification station and the drainage-storage system. The cash expenditures on the Victoria Project in the first 9 months of 2016 were 20 million US$ (KGHM 2016e).

Mineral resources as reported by KGHM (KGHM 2015) are given in Table 12. The ore from the mine will be processed in the Vale Clarabelle plant in Sudbury. The "new" Victoria Mine is expected to be operational by 2021 with an estimated mine life of 13 years (KGHM 2016a).

http://kghm.com/en: | Our Business | Projects under development | Victoria [accessed February 13, 2017].

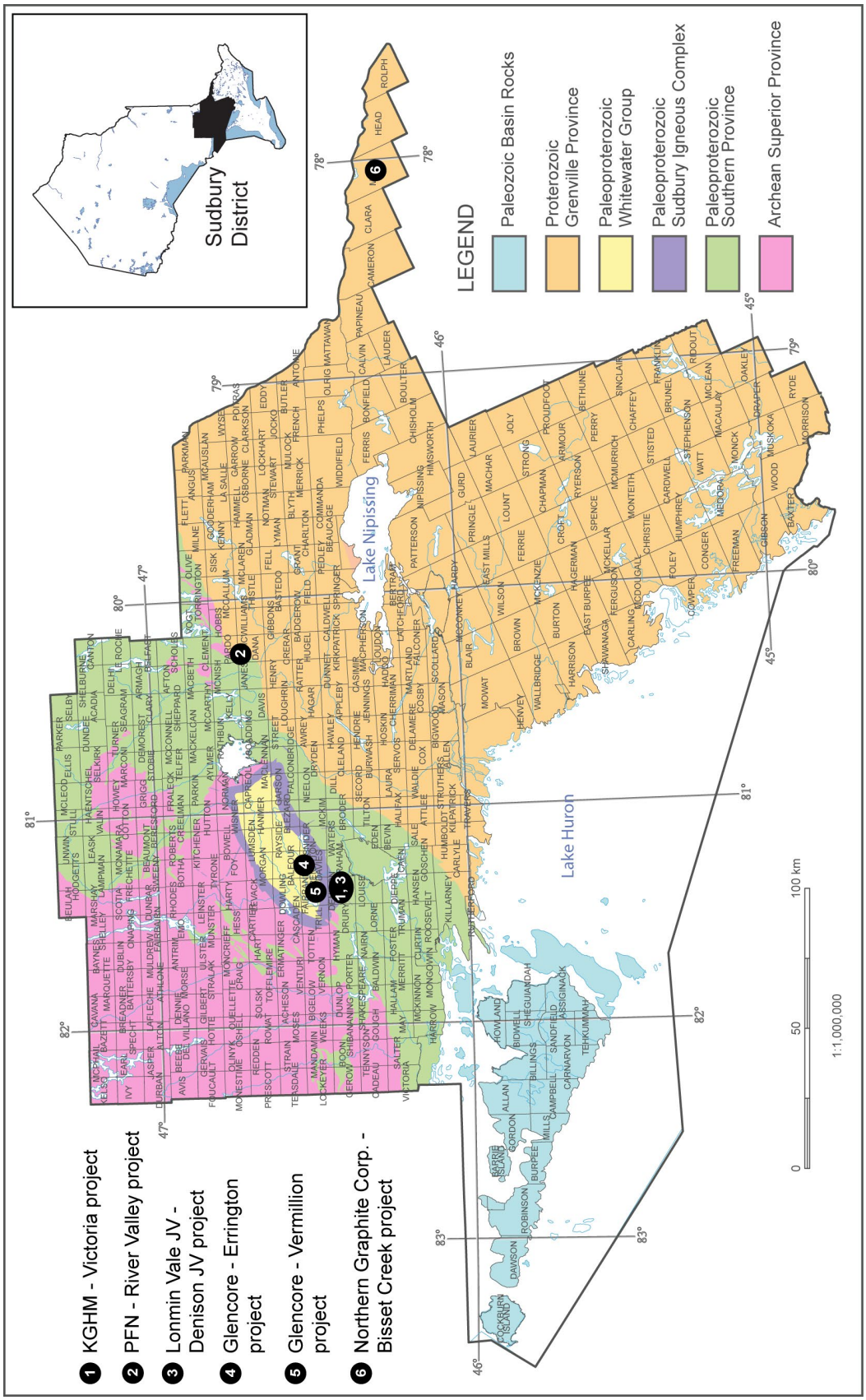

Figure 7. Location of advanced exploration projects in the Sudbury District; geology *modified from* Ontario Geological Survey (2011).

Table 12. KGHM Victoria Mine ore resources as of December 2014 (KGHM 2015).

Commodity	Indicated Resources	Inferred Resources
(Mt)	0.48	13.08
Ni (%)	1.23	2.76
Cu (%)	1.41	2.64
Co (%)	0.03	0.06
Au (g/t)	0.22	0.97
Pt (g/t)	0.47	3.08
Pd (g/t)	1.35	4.45
[1]TPM (g/t)	2.04	8.50

[1]TPM – precious metals (gold, platinum, palladium)

NEW AGE METALS (FORMERLY PACIFIC NORTH WEST CAPITAL CORPORATION)

River Valley PGM Project

The River Valley PGM (RVP) project of New Age Metals (NAM; formerly Pacific North West Capital Corporation (PFN)) is located in Dana and Pardo townships, approximately 60 km east of Sudbury (*see* Figure 7). The 100% NAM-owned precious metals deposit is hosted in a gabbro breccia unit on or near the contact of the Paleoproterozoic age River Valley Intrusion (RVI) with footwall rocks of the Grenville Province. The deposit has been traced for 12 km along strike and drilled to a depth of about 220 m. It contains 10 zones separated by faults with offsets of up to 1 km.

NAM (as PFN) reported ore resources for the River Valley PGM project are given in Table 13.

Table 13. NAM River Valley PGM project ore resources (McCracken 2012).

Commodity	Total Measured & Indicated Resources	Inferred Resources
[1]PdEq Cut-off	0.80	0.80
(Mt)	91.3	35.9
Pd (g/t)	0.58	0.36
Pt (g/t)	0.22	0.14
Rh (g/t)	0.021	0.014
Au (g/t)	0.04	0.03
Ag (g/t)	0.34	0.11
Cu (%)	0.06	0.06
Ni (%)	0.02	0.03
Co (%)	0.003	0.003
[1]PdEq (g/t)	1.38	1.07

[1] PdEq =((Au grade$Au*Factor1)+(Pt grade*$Pt*Factor1)+(Pd grade*$Pd*Factor1)+(Ni grade*$Ni*Factor2)+(Cu grade*$Cu*Factor2) +(Co grade*$Co*Factor3))/($Pd*Factor1)*
where PdEq formula values:
Au, US1271 per oz
Pt, US1885 per oz
Pd, US896 per oz
Ni, US 9.74 per lb
Cu, US3.00 per lb
Co, US15.90 per lb
Factor1, 0.0321508 (converts ounces per tonne to grams per tonne)
Factor2, 22.04622 (converts pounds to grade percent)
Factor3, 0.002205 (converts pounds to ppm).

NAM was active in 2016, raising capital for a review of existing drill information and geological interpretation of River Valley in order to outline additional targets in the northern portion of the property, and to finalize the next phase of metallurgical testwork (NAM (as PFN), press release, March 28, 2016). In addition, they received JEAP funding, increased their property position (Figure 8) by procuring new claims through acquisition and staking, and undertook field and drill programs (NAM (as PFN), press releases, April 6, July 13, August 4, October 5 and 11 and November 3 2016).

Results reported by NAM from grab sample taken during the field programs on their River Valley (RVP) and River Valley Extension (RVX) projects are given in Table 14 (NAM (as PFN), press release, December 6, 2016).

Five drill holes in the RVP program returned mineralized intervals (NAM (as PFN), press release, December 13, 2016; Table 15).

NAM proposes the next steps in PGM exploration at River Valley to include 3-D geological modelling of the 2016 drill results, and IP surface and borehole geophysical surveys to aid in identifying and prioritizing drill targets for 2017 (NAM (as PFN), press release, December 13, 2016).

http://newagemetals.com | Projects | River Valley PGM Project [accessed February 13, 2017].

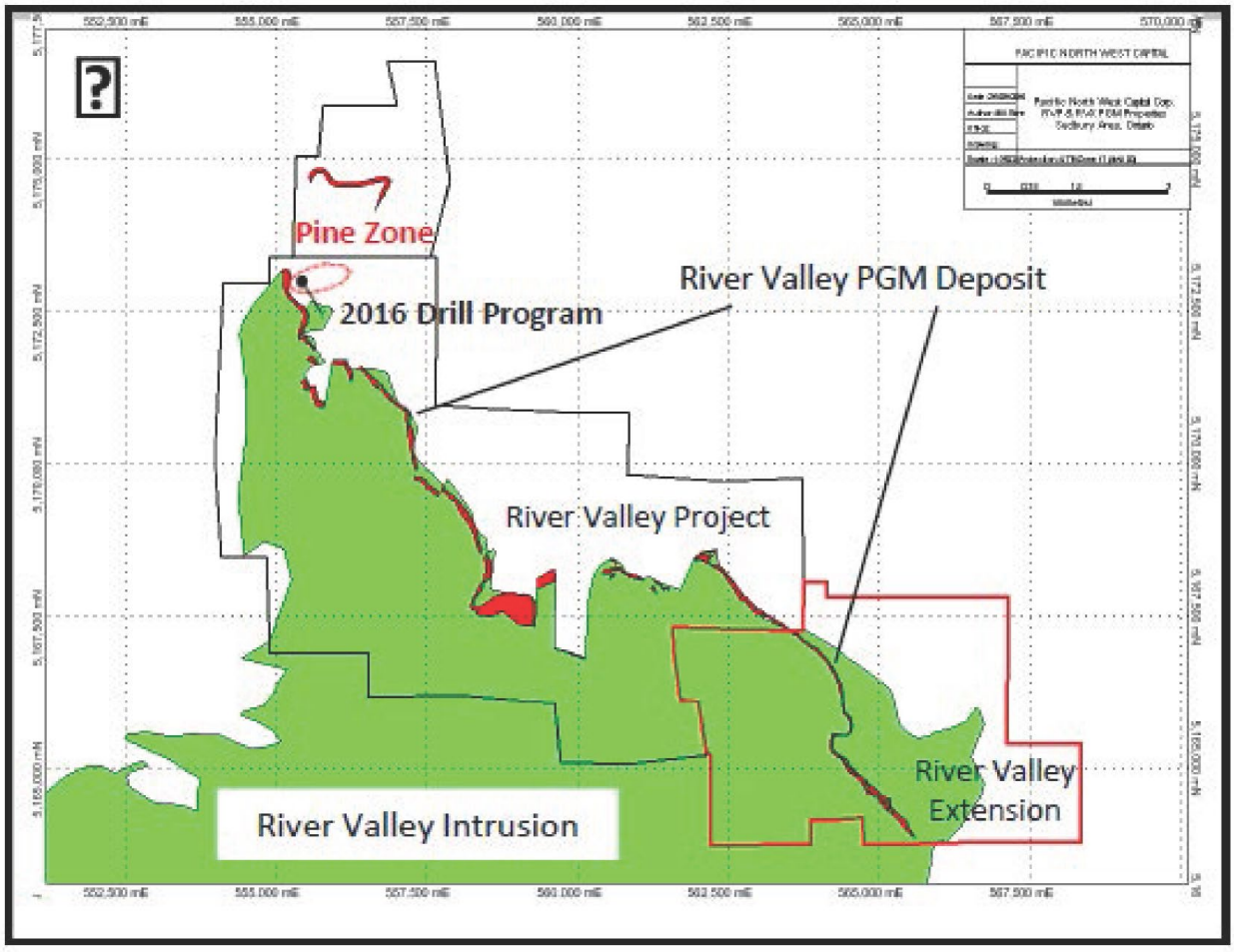

Figure 8. New Age Metal updated property positions for the River Valley and River Valley Extension projects (published with permission from New Age Metals; figure from New Age Metals website: http://newagemetals.com | Investors | Presentations | Investor Presentation [accessed February 13, 2017]).

Table 14. Results from New Age Metals' grab samples, River Valley and River Valley Extension projects.

Project	Sample	Pd (g/t)	Pt (g/t)	Pd+Pt (g/t)	Au (g/t)	Cu%	Ni%
RVP	TR2-2016	3.536	1.215	4.751	0.158	0.248	0.064
	TR1-2016	0.716	0.264	0.980	0.052	0.082	0.010
	LH9-2016	3.222	1.138	4.360	0.126	0.150	0.015
	RZ2016-30	2.716	0.738	3.454	0.164	0.297	0.026
	RZ2016-31	1.854	0.499	2.353	0.123	0.282	0.022
RVX	20429	0.516	0.554	1.070	0.120	0.073	0.060
	20426	1.540	0.901	2.441	0.020	0.183	0.051
	25265	0.771	0.344	1.115	0.123	0.201	0.135
	RZ2016-33	0.612	0.553	1.165	0.019	0.019	0.003
	RZ2016-38	9.524	3.071	12.595	0.070	0.034	0.025
	RZ2016-40	0.678	1.294	1.972	0.054	0.149	0.027

Table 15. Results from New Age Metals' diamond drill campaign, River Valley project.

Project	BHID	Interval (m)	Pd (g/t)	Pt (g/t)	Au (g/t)	Cu%	Ni%
RVP	DN-T2-06	18	1.901	0.665	0.111	0.18	0.04
	including	9	3.016	1.049	0.176	0.28	0.05
	DN-T2-10	20	1.440	0.476	0.072	0.14	0.03
	including	4	2.399	0.753	0.071	0.19	0.04
	DN-T2-11	17	1.367	0.470	0.072	0.15	0.04
	including	8	1.815	0.608	0.083	0.18	0.05
	DN-T2-13	3	1.588	0.603	0.086	0.16	0.03
	DN-T3-13	8	0.984	0.352	0.066	0.14	0.02

LONMIN PLC & VALE CANADA LIMITED JOINT VENTURE

Lonmin is exploring for PGM deposits around the Sudbury Basin in joint ventures with Vale Canada (Denison JV) and Wallbridge Mining Company Limited (*see* Wallbridge Mining Company Limited under "EXPLORATION ACTIVITIES" in this report).

Denison JV

The Denison 109 FW deposit is located in the footwall of the Crean Hill Mine adjacent to a previously exploited contact sulphide deposit in the South Range of the Sudbury Igneous Complex (*see* Figure 7). PGM concentrations in this zone appear unique amongst previously described ore types at Sudbury. Controls on PGM-gold mineralization are related to ductile shears that crosscut Huronian volcanic rocks and the SIC. The localized deformation has been overprinted by a chlorite-epidote alteration. The Denison 109 FW Zone has a very low sulphide content and abundant visible gersdorffite (Gibson et al. 2010). The PGM tenor is at the enriched portion of a South Range contact deposit with a similar range of Cu/(Cu + Ni) (Stewart and Lightfoot 2010).

The resources reported, as of September 30 2016, for the Denison 109 FW Zone JV remained unchanged from 2015 (Lonmin PLC 2016a; Table 16). The deposit is Lonmin's only Platinum Group Element (PGE) Mineral Resource outside of the Bushveld Complex.

Table 16. Lonmin PLC Denison 109 FW Zone JV ore resources.

[1]Total Indicated & Inferred Resources (as of September 30th)	
Commodity	**2016**
(Mt)	0.19
Pt-Pd-Au (g/t)	0.586
Pt-Pd-Au (Moz)	0.04
Pt (Moz)	0.02

Moz, Million troy ounces
[1]Values are reported based on a Lonmin PLC's 50% ownership.

In 2015, Lonmin's Denison drilling programs included 6 drill holes testing a second area of PGE mineralization on the Denison property, the 9400 Zone (Lonmin PLC 2016b). In 2016, 2 programs of metallurgical drilling were undertaken on the 109 FW and 9400 zones. Mineralization at both prospects is open at depth and remain future exploration targets. Another PGM target was drilled elsewhere on the Denison property, and 2 holes were drilled on other Vale joint venture properties (Lonmin PLC 2016b).

Zinc, Copper, Lead, Silver and Gold

GLENCORE CANADA CORPORATION

Glencore had planned to reopen the Errington and Vermillion past-producing mines prior to the base metal commodity price collapse (*Sudbury Mining Solutions Journal*, June 1, 2013, v.10 p.5; http://vermilionriverstewards.ca | categories |concerns | mining | Errington & Vermilion Project | Archive for the 'Errington & Vermilion Project' Category | Errington – Vermilion Mining Project – Presentation by Glencore, November 13, 2014 [accessed February 13, 2017]). Plans reported for the proposed development included the construction of a concentrator 3 km from the Strathcona mill site.

Both the Errington and Vermillion mines are located in the southwestern corner of the Sudbury Basin (*see* Figure 7). These zinc-copper-lead-silver-gold deposits are hosted in a local and distinct carbonate chert unit (the Vermilion member) at the contact between the underlying Onaping formation and the overlying Onwatin formation. They are associated within a shear zone, and are characterized by a high magnetic signature. The ore bodies are intensely folded, faulted and offset by steep southeasterly dipping reverse faults.

Errington

The Errington Mine is located in Balfour and Creighton townships, and operated from 1924 to 1928. The company has more than a dozen studies completed or underway at Errington, including archeology, water, risk management, geochemistry and species at risk.

Glencore had completed 50 000 m of drilling as of December 2015 (Glencore 2017a) to confirm the morphology and grade of the historical resources that were based on 1070 historical diamond drill holes. Resources for the Errington Mine, as reported in Glencore's resource and reserves as of December 31, 2015 (Glencore 2017a), are given in Table 17. The resources were interpolated using Inverse Distance Squared (ID2).

Table 17. Errington Mine (Glencore) ore resources.

Total Measured & Indicated Resources (as of December 31st)		
Commodity	**2016**	**2015**
(Mt)	9.0	9.0
Zinc (%)	4.0	4.0
Lead (%)	1.2	1.2
Copper (%)	1.1	1.1
Silver (g/t)	53	53
Gold (g/t)	0.8	0.8

M, Million

Vermillion

The Vermillion Mine is located in Fairbank Township, and was in operation from 1952 to 1957. Post-production ore hoisted at Vermillion was stockpiled; in 1992 the stockpile was shipped to Kidd Creek for processing.

As of December 31, 2015, Glencore had completed 10 000 m of drilling to confirm the deposit morphology and grade of the historical resources that were based on 609 historical diamond drill holes (Glencore 2017a). Resources for the Vermillion Mine as of December 31 2015 (Glencore 2017a) are given in Table 18. The resources were interpolated using Inverse Distance Squared (ID2).

Table 18. Vermillion Mine (Glencore) ore resources.

Total Measured & Indicated Resources (as of December 31st)		
Commodity	**2016**	**2015**
(Mt)	3.2	3.2
Zinc (%)	4.4	4.4
Lead (%)	1.2	1.2
Copper (%)	1.3	1.3
Silver (g/t)	53	53
Gold (g/t)	0.9	0.9

M, Million

Industrial Minerals

NORTHERN GRAPHITE CORPORATION

Bissett Creek Project

Northern Graphite Corporation (NGC) holds 100% interest in the Bissett Creek graphitic gneiss deposit near Mattawa, in Maria Township (*see* Figure 7). The property consists of 5 unpatented mining claims and 2 mining leases covering about 2967 hectares in total area (Northern Graphite Corporation 2016).

Proposed development of the deposit consists of an open pit mine and a processing plant with conventional crushing, grinding and flotation circuits followed by concentrate drying and screening. Production is aimed to be almost entirely large and extra-large flake graphite concentrates.

The resource estimates for Bissett Creek as reported in Northern Graphite Corporation (2016) are given in Table 19. However, the company reports that the resource estimates may be expanded as the ore has not been closed off by drilling.

The updated Feasibility Study economics are given in Table 20.

The Ministry of Northern Development and Mines acknowledged the amended Bissett Creek Mine Closure Plan as filed on Aug. 13, 2013 (Northern Graphite Corporation 2016). Northern Graphite Corporation reports that it is moving forward with plans to bring the mine into production, that the detailed engineering and design is partially complete (NGC 2017).

Table 19. Bissett Creek Resource Estimate, May 6, 2013 (Northern Graphite Corporation 2016).

	Measured & Indicated Resources			**Inferred Resources**		
Cut-off Grade	**Tonnage (Mt)**	**Cg (%)**	**In Situ Graphite (Mt)**	**Tonnage (Mt)**	**Cg (%)**	**In Situ Graphite (Mt)**
[1]1.02	**69.791**	**1.74**	**1.213**	**24.038**	**1.65**	**0.396**
1.50	37.565	2.14	0.803	11.971	2.02	0.242
1.75	23.439	2.45	0.574	6.274	2.39	0.150
2.00	15.902	2.73	0.435	3.564	2.79	0.100

M, Million Cg, graphitic carbon
[1]base case cut-off grade

Table 20. Summary of 2013 updated Feasiblity Study (FS) economics (Northern Graphite Corporation 2016).

	2013 FS Update (base case)	**2012 FS**
Probable reserves (Mt)	28.3 Mt[1]	19.0 Mt
Feed Grade (%Cg)	2.06%[1]	1.89%
Waste to ore ratio (excl. low grade stockpile)	0.79	0.50
Processing rate (tonnes per day - 92% availability)	2670	2300
Mine life[1] (years)	28	23
Mill recovery (%)	94.7%	92.7-94.7%
Average annual production (t)	20 800 t	15 900 t
Capital cost ($M – incl. 10% contingency)[1]	$101.6 M	$102.9 M
Cash operating costs ($/tonne of concentrate)[1]	$795/t	$968/t
Mining costs ($/tonne of ore)	$5.63/t	$5.79/t
Processing costs ($/tonne of ore)	$8.44/t	$9.60/t
General and administrative costs ($/tonne of ore)	$2.50/t	$2.94/t
C$/US$ dollar exchange rate	0.95	1.00
Graphite prices (US$/tonne)	$1 800	$2 100
Pre tax NPV @8% (C$ millions)	$129.9 M	$71.7 M
Pre tax IRR (%)	19.8%	15.65
After tax NPV @8% (C$ millions)	$89.3 M	$46.9 M
After tax IRR (%)	17.3%	13.7%

M, Million Cg, graphitic carbon
[1]" includes 24 million tonnes ("Mt") grading 2.20% Cg and 4.0 Mt grading 1.26% Cg of low grade stockpile ("LGS") to be processed at the end of the mine life. An additional 12.5 Mt LGS grading 1.26% Cg is stored in the pit and is available for processing through a future expansion or at the end of the mine life. The waste to ore ratio is 0.24 if the low grade stockpile is processed. All grades are diluted" (Northern Graphite Corporation 2016).

EXPLORATION ACTIVITY

As in previous years, copper, platinum group metals and nickel were the main commodities sought in the Sudbury District. There was a degree of interest shown in other base metals along with gold, silver and cobalt.

The search for industrial minerals focussed on graphite, garnet, silica, kyanite, dimension stone, agricultural calcium phosphate, mica, trap rock and other potential aggregate resources.

Nickel, Copper and Platinum Group Elements

SUDBURY PLATINUM CORPORATION

Aer–Kidd Project

Sudbury Platinum Corporation (SPC) is a privately owned subsidiary of Transition Metals Corporation (Transition Metals). Transition Metals holds 36% of SPC, the remainder being held by Royal Nickel Corporation (RNC), Resource Capitol Fund (RCF) and Technica Group (SPC 2016). SPC qualified for JEAP funding to advance its exploration programs on the Aer–Kidd and Rosen Projects (SPC, press release, June 1, 2016).

The Aer–Kidd Property is located on the Worthington offset dike (Figure 9). The property covers a 1.3 km section of the dike, including the historic former producing Howland pit, Robinson and Rosen mines. In June of 2016, SPC announced commencing its 2016 exploration program on the property. The proposed program included an 18 000 metre drill campaign to test near-surface and deep PGM-Ni-Cu potential, and geophysical resurveying of historic boreholes (Sudbury Platinum Corporation, press release, June 1, 2016).

Lockerby East and West Graham Properties

In January 2016, Transition Metals acquired former Sudbury exploration and development assets of First Nickel Inc. (Transition Metals press release January 25 2016). On May 5, 2016, SPC announced it had acquired these properties from Transition Metals (Transition Metals is the majority shareholder in SPC; SPC press release May 6 2016). The acquisition included 100% of the Lockerby East and South Patents, and a 70% interest in the West Graham Property. Landore Resources Ltd. hold the remaining 30% in the West Graham property. The properties are contiguous, covering approximately 390 hectares in the South Range of the SIC (*see* Figure 9).

In 2016, SPC contracted Lamontagne Geophysics to conduct Borehole UTEM IV® geophysical surveys on 7 historic drill holes completed by Falconbridge Ltd. (FL) and First Nickel Inc. (FNI). Eleven (11) other historic drill holes targeted to be surveyed were inaccessible; for these, borehole UTEM data completed by both FL and FNI were incorporated into Lamontage Geophysics interpretation (SPC, press release, November 21, 2016).

Lamontagne Geophysics key findings were:

- Identification of 9 very strong geophysical conductors extending over a combined distance of 1 100 metres, extending down-dip from the known Lockerby East Deposit to a vertical depth of 2 000 m.
- Modelled geophysical conductors occur in close proximity to the basal contact of the Sudbury Igneous Complex (SIC).

- Positive correlation between elevated nickel-copper sulfides in historic drill core and geophysical conductors.
- Minimal drilling had been completed on the West Graham–Lockerby East Trend below 1 400 metres where the strongest geophysical responses were observed.

SPC considers the Lamontagne interpretation of the old and new borehole geophysics, in conjunction with the historic mineral resources (West Graham and Lockerby East Deposits) to indicate a highly prospective mineralized trend (SPC, press release, November 21, 2016).

WALLBRIDGE MINING COMPANY LIMITED

Wallbridge Mining Company (Wallbridge) is exploring a large package of properties in Sudbury (Figure 10), and operating several exploration joint ventures with partners Lonmin PLC, Glencore and Vale including

- The North Range JV (NRJV) with Lonmin PLC (Lonmin)
  - North Range Properties
  - Wisner Properties JV
- The Sudbury Camp JV (SCJV) with Lonmin
- Parkin Offset Properties JV with Lonmin
- The East Range Properties
  - The Frost Lake JV with Glencore Integrated Nickel Operations (INO)
  - Capreol JV with Vale and Glencore INO
  - Drill Lake Property (100% Wallbridge)
  - Victor East Property (100% Wallbridge)

www.wallbridgemining.com: | Projects | Sudbury Projects [accessed February 08, 2017]

NORTH RANGE PROPERTIES IN THE NRJV

The North Range properties of the Wallbridge–Lonmin NRJV consist of 12 properties with copper–nickel–PGE potential. Offset dikes on the properties, most of which were discovered by Wallbridge, have a strike length of 56 km (www.wallbridgemining.com: | Projects | Sudbury Projects | North Range JV with Lonmin [accessed February 08, 2017]).

The 2016 exploration program on the North Range properties (October 1, 2015 to September 30, 2016) included target generation, fieldwork and land management. From January 1, 2016 to September 30, 2016, $100 635 was spent on these properties. The company announced its focus for the 2017 North Range properties exploration program, starting October 1, 2016, to be future target generation through data review, and limited geological and geophysical work (Wallbridge 2016).

WISNER PROPERTIES JV IN THE NRJV

The Wisner Property (Wisner) was added to the NRJV to advance exploration on properties surrounding the Broken Hammer Project. Wisner is located adjacent to Wallbridge's past-producing open pit mine, and covers 1120 hectares of prospective geology over a 10 km strike length. It consists of 5 properties with PGM and copper potential (www.wallbridgemining.com: | Projects | Sudbury Projects | Wisner Properties JV with Lonmin [accessed February 08, 2017]).

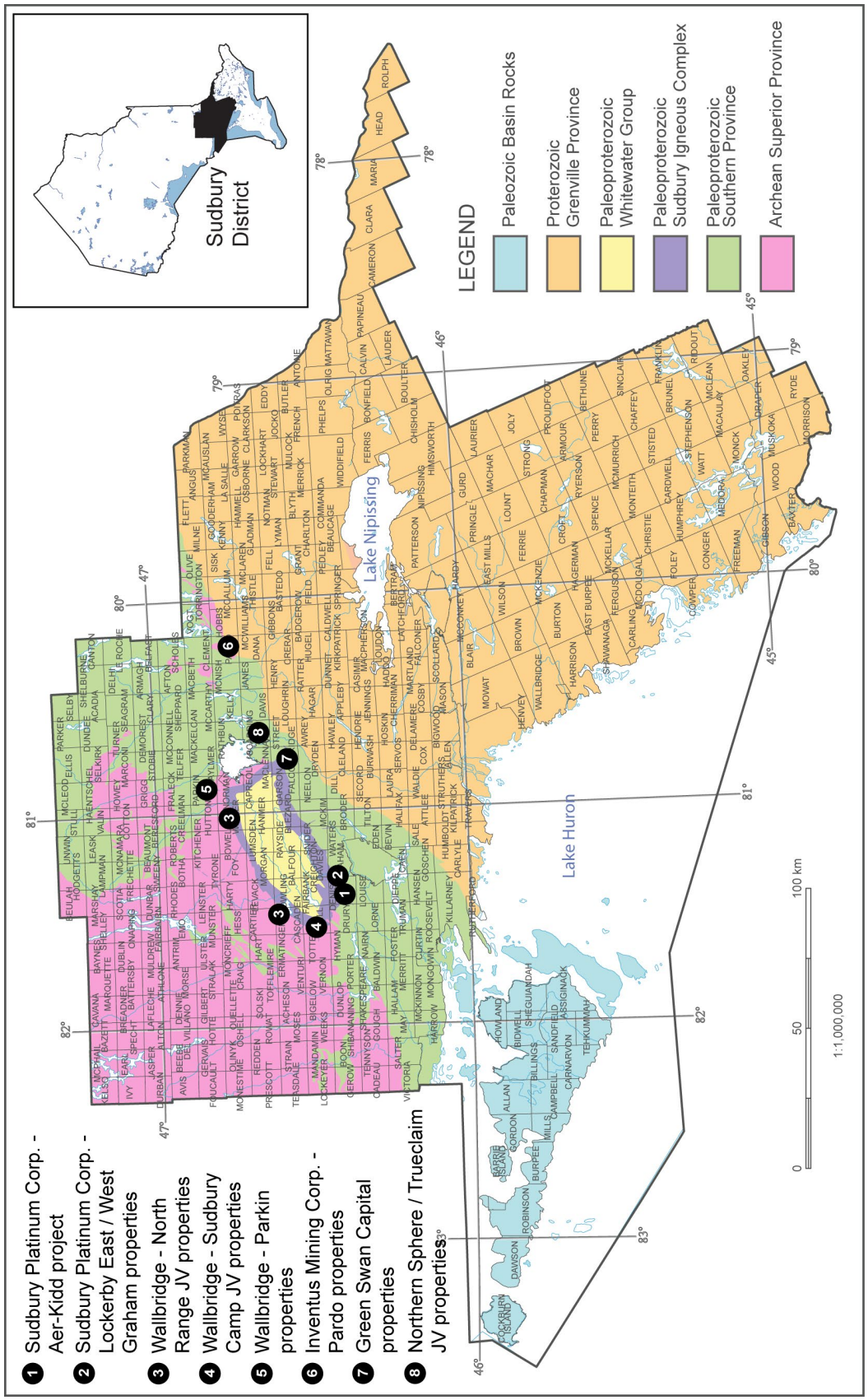

Figure 9. Location of actively explored projects in the Sudbury District discussed in this report; geology *modified from* Ontario Geological Survey (2011).

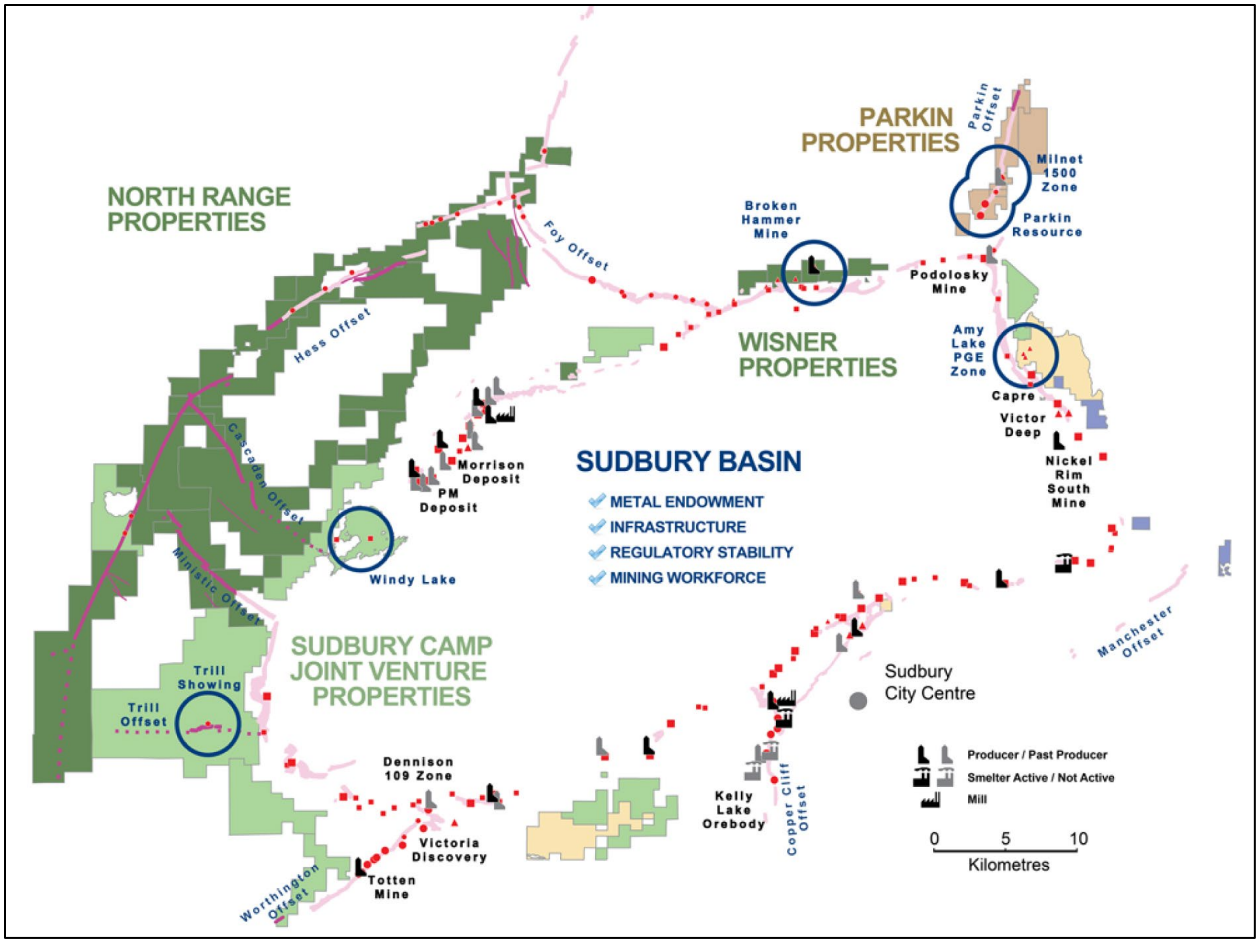

Figure 10. Map of the Sudbury Basin showing Wallbridge properties (blue) and Joint Venture properties (dark green = NRJV; light green = SCJV; pink = POJV; pale orange = Glencore JVs). Published with permission from Wallbridge Mining Company; figure from Wallbridge Mining Company website: www.wallbridgemining.com: | Projects | Sudbury Projects [accessed February 08, 2017].

Wallbridge reported that $88 386 were spent on the Wisner Properties in the NRJV, during the 9 months ending September 30, 2016. Fieldwork in 2016 identified 2 occurrences of anomalous copper in bedrock on the Wisner East property, and the presence of potential host rocks for Cu-PGM footwall mineralization underlying large areas of that property. Work proposed for the 2017 Wisner program includes follow-up work on the anomalous copper occurrences, and target generation through data review, and limited geological and geophysical work (Wallbridge 2016).

SCJV

The Wallbridge–Lonmin SCJV properties are in the near vicinity of active mining areas in Sudbury and include a number of Cu-Ni-PGE occurrences discovered by Wallbridge (www.wallbridgemining.com: | Projects | Sudbury Projects | Sudbury Camp JV with Lonmin [accessed February 08, 2017]).

The 2016 program ran from October 1, 2015, to September 30, 2016. During the 9 months ending September 30, 2016, $224 788 were spent on the SCJV. Fieldwork identified prospective host rocks for Cu-PGM footwall mineralization underlying large areas of the Trill property (Wallbridge 2016).

The Wallbridge 2017 SCJV program started on October 1, 2016. The company announced its focus for the 2017 SCJV exploration program to be future target generation through data review, and limited geological and geophysical work (Wallbridge 2016).

Parkin Properties

The past-producing Milnet Mine (Cu-Ni) is located on Wallbridge's Parkin Properties JV with Lonmin PLC. The Parkin Offset Dike with its potential for Cu-Ni-PGM deposits is the focus for exploration, and Wallbridge very actively explored the area in 2016. During the 9 months ending September 30, 2016, approximately $1.5 million were spent on the Parkin Properties. The company was also the recipient of JEAP funding for this project as well as for its regional exploration program (Wallbridge 2016).

Exploration activities included extensive diamond drilling programs, and initiating an environmental baseline study and a bulk sample permit. From October 1, 2015, to September 30, 2016, 59 drill holes were completed, and 68 significant intersections were identified in 46 of the 59 drill holes. Highlights of the 2016 Parkin Property drill program results are given in Table 21 (Wallbridge Mining, press releases, March 1, April 4, May 10 and May 31, 2016).

On May 31, 2016, Wallbridge announced that it had retained Tahgaiwinini Technical and Environmental Services Group (operated by Wanipitae First Nations) to complete an environmental baseline study for the Parkin JV (Wallbridge press release, May 31, 2016).

On October 13, 2016, Wallbridge announced that it had started new drilling at Parkin with the goal of establishing a significant resource above 600 m depth, and identifying new mineralized zones on the property (Wallbridge, press release, October 13, 2016).

Table 21. Selection of 2016 Parkin Property JV Drill Results (Wallbridge press releases 2016).

Date Reported	Drill Hole	[1]Length (m)	Ni (%)	Cu (%)	[2]TPM (g/t)	Pt (g/t)	Pd (g/t)	Au (g/t)
March 1, 2016	WMP-153	3.50	0.93	1.59	1.81	1.01	0.59	0.21
	WMP-154	3.55	2.10	0.48	0.91	0.47	0.40	0.04
April 4, 2016	WMP-170	24.25	1.22	1.50	2.15	0.81	0.96	0.38
May 10, 2016	WMP-195	7.46	1.36	1.02	1.59	0.67	0.74	0.18
	WMP-180	8.68	0.46	0.95	2.54	1.07	0.81	0.66
	WMP-182	7.70	0.86	0.98	2.19	0.85	1.06	0.28
	WMP-176	1.61	0.90	8.02	10.70	5.55	3.09	2.06
	WMP-175	3.78	0.75	2.12	2.79	0.94	1.62	0.23
May 31, 2016	WMP-199	10.30	0.85	1.61	1.40	0.61	0.64	0.15
	WMP-197	2.02	1.56	0.51	1.19	0.54	0.55	0.09

[1]Drill core length. Horizontal width perpendicular to the Parkin Offset dike is approximately 60-75% of the drill core length. True width of each mineralized intersection is unknown..
[2]Total precious metals ("TPM") equals Pt + Pd + Au

Gold and Gold–Cobalt

INVENTUS MINING CORPORATION

Pardo Property

The Pardo property, located 65 km northeast of Sudbury (*see* Figure 9), is road accessible and covers a sequence of Proterozoic rocks, which include the Matinenda and Mississagi formations (basal conglomerate units of the Huronian Supergroup assemblage). Gold mineralization defined to date is spatially associated with pyritic quartz pebble-bearing portions of both the Matinenda and Mississagi conglomerates (www.inventusmining.com: | Projects | Pardo Project [accessed February 08, 2017]).

Inventus Mining Corporation (Inventus) completed the purchase of the outstanding stake in the Pardo Property from Endurance Gold Corporation on November 30, 2016 (Inventus, press release, November 30, 2016). New ground was staked in the area prior to the finalization of the Joint Venture buy-out. With the new claims, the Inventus land position extends over 17 km from North to South (Inventus, press release, May 26, 2016).

Exploration activities on the Pardo Property focused on the newly discovered Cobble Zone and included fieldwork, outcrop stripping, channel sampling and drilling. The company was a recipient of JEAP funding for this project (Inventus, press release, August 11, 2016). Exploration expenditures on the Cobble Zone for the 9 months ending September 30, 2016 were $46 000. Little exploration was performed on the "Pardo Joint Venture" property. Expenditures on that portion of the overall Pardo Property for the 9 months ending September 30, 2016 were $3 000. Channel sampling was undertaken on an outcrop in the area the company proposes to bulk sample. Results from 11 channel samples over a 40 m apparent strike length returned a weighted average of 2.0 g/t gold over 3.16 m (approximate true width; Table 22) (Inventus, press release, August 11, 2016).

Table 22. Weighted average of channel sample results (Inventus press release August 11, 2016).

Number of Channels	Average Channel Length[1] (m)	Weighted Average Gold Grade (g/t)
11	3.16	2.0

[1]*Approximate true width*

GREEN SWAN CAPITAL GROUP

Copper Prince Property

In June of 2016, Green Swan Capital Group (Green Swan) announced the acquisition of 100% of the Copper Prince property in Falconbridge Township, Sudbury (*see* Figure 9). The property consists of 16 contiguous patented claims, covering 260 hectares (Green Swan, press release, August 15, 2016). In August, Green Swan increased its land holdings through staking, and an agreement to acquire 12 further claim units proximal to the Property (Green Swan, press releases, August 9 and August 29, 2016).

Green Swan actively explored the Copper Prince property for cobalt and gold throughout 2016. Activities included multiple surface grab and chip sampling programs, outcrop stripping and cleaning, and diamond drilling. The company was also the recipient of JEAP funding for the project (Green Swan, press release, August 9, 2016).

Following the initial chip and grab sampling program (Green Swan, press release, June 20, 2016), Green Swan collected 20 samples from the same areas to confirm the results (Green Swan, press release, August 15, 2016). The results from that 20-sample group are given in Table 23.

Table 23. Results from 20 grab samples collected on the Copper Prince property.

Grab Samples[1]					
Area (# of samples)	**Cobalt (%)**	**Gold (ppm)**	**Nickel (%)**	**Copper (%)**	**Sulfur (%)**
Main Zone (4)	0.32 –0.78	0.48-3.80	0.01-0.29	0.15-0.41	9.04-35.9
Blue Pit (7)	–	0.27-4.58	–	0.33-1.67	0.5-2.28
Ed's Watering Hole (9)	0.01-1.32	Up to 2.99	0.02-0.39	Up to 0.35	0.08-16.0

All zones are open in all directions PGM's have No Significant Results.
[1]Grab samples vary in size, are selective by nature and may not accurately represent all or part of the rest of the Property

Over the summer of 2016, outcrop stripping and cleaning of a historic pit around Ed's Watering Hole at the south end of the property was undertaken. Five new discontinuous mineralized quartz veins were discovered; 2 of which were sampled along with the previously known vein (Green Swan. press release. September 26. 2016). The results for these samples are given in Table 24.

Table 24. Results from grab samples of mineralized quartz veins on the Copper Prince property.

Grab Samples[1]				
Sample #	**Cobalt (%)**	**Gold (ppm)**	**Nickel (%)**	**Copper (%)**
60125	0.037	25.5	0.06	0.04
60127	0.024	2.16	0.02	0.01
60135	0.183	22.3	0.05	0.00
60136	0.014	0.56	0.12	0.36
60138	0.075	4.90	0.03	0.14

[1]Grab samples vary in size, are selective by nature and may not accurately represent all or part of the rest of the Property

Prior to diamond drilling, Green Swan collected a final set of grab samples from the south end of the property, near Ed's Watering Hole. Selected assay results were reported (Green Swan, press release, November 7, 2016), and are given in Table 25.

Table 25. Results from grab samples of mineralized quartz veins near Ed's Watering Hole.

Grab Samples[1]		
Sample #	**Au (g/t)**	**Co (%)**
60139	7.45	0.157
60142	1.46	0.057
60145	5.02	1.38
60147	1.06	0.034
60203	19.2	0.513
60204	44.6	0.117
60207	3.87	0.015
60210	4.15	0.002

[1]Grab samples vary in size, are selective by nature and may not accurately represent all or part of the rest of the Property

Green Swan completed a 300 m diamond drill program in the Ed's Watering Hole area of the Copper Prince property in late 2016. The first diamond drill hole, CP16-01 was drilled to intersect the down dip projection of mineralization reported from surface grab samples. A prominent structure intersected by that hole was also intersected in the other 4 drill holes of the program. Assay results from CP16-01 were released (Green Swan, press release, December 14, 2016), and are given in Table 26.

Table 26. Highlights from drill hole CP16-01on the Copper Prince property.

Length (m)	Au (g/t)
1.05	0.431
1.0	0.955
0.27	0.341
0.20	5.34

NORTHERN SPHERE MINING CORPORATION – TRUECLAIM EXPLORATION JOINT VENTURE

Scadding Gold Property

In May 2016, Northern Sphere Mining Corporation (Northern Sphere) entered into a joint venture agreement with Trueclaim Exploration Inc. (Trueclaim) on Trueclaim's Scadding Gold Property (Northern Sphere Mining Corporation, press release, May 2, 2016).

The Scadding Gold property is located in Scadding Township northeast of Sudbury, Ontario (*see* Figure 9), and consists of 7 contiguous mining leases containing a total of 56 mining claims covering 907 hectares. The property includes the historical reclaimed mine and mill site. The resource estimate for the property dates back to the 1980's and is noncompliant to NI 43-101 (Winter 2009). The Scadding Gold Mine was in production from 1984–1990 under the ownerships of first Westfield Minerals Limited, then Orofino Resources Limited.

Northern Sphere announced that they had initiated environmental permitting and contracted an environmental consultant. (Northern Sphere press release, Corporate Update, August 16, 2016).

2016 Assessment Files

In 2016, a total of 68 assessment files were received and processed through the Provincial Mining Recorders Office and the Sudbury District Geologist Office (Table 27 is keyed to Figure 11). Of these, 10 pertained to work done in 2016, and are, therefore, also included in Table 2 and Figure 2.

Table 27. Assessment files processed in the Sudbury District in 2016 (keyed to Figure 11).

No.	Township(s)	Company Name	Year	Type of Work	AFRO Number	Resident Geologist Office File Designation
1	Afton	Teck Resources Limited	2014	Borehole electromagnetic survey	2.56637	Afton-SP028
2	Afton	Teck Resources Limited	2014	UTEM borehole geophysical survey	2.56652	Afton-SP029
3	Afton	Norman R Nelson	2015	Magnetic survey	2.56439	Afton-SP030
4	Antoine	Kyanite Mining Corporation	2015	Sampling, assays	2.56752	Antoine-SP017
5	Antoine	Kyanite Mining Corporation	2015	Induced polarization survey, magnetic survey, line cutting	2.56754	Antoine-SP018
6	Aylmer	Thomas H. Sheppard	2014	Aerial photo and remote imagery	2.56217	Aylmer-SP041
7	Aylmer	Thomas H. Sheppard	2015	Geological mapping	2.56389	Aylmer-SP042
8	Aylmer	Fredric D. Delabbio	2015	Geological mapping	2.56883	Aylmer-SP043
9	Aylmer	Thomas H. Sheppard	2015	Geological mapping	2.56432	Aylmer-SP044

No.	Township(s)	Company Name	Year	Type of Work	AFRO Number	Resident Geologist Office File Designation
10	Aylmer	Thomas H. Sheppard	2015	Geological mapping	2.56452	Aylmer-SP045
11	Aylmer	Thomas H. Sheppard	2015	Traverse, geological mapping	2.56450	Aylmer-SP046
12	Aylmer	Thomas H. Sheppard	2015	Geological mapping	2.56464	Aylmer-SP047
13	Aylmer	Thomas H. Sheppard	2015	Geological mapping	2.56480	Aylmer-SP048
14	Aylmer	Thomas H. Sheppard	2015	Sampling, geological mapping, X-ray diffraction analyses	2.56391	Aylmer-SP049
15	Aylmer	F. Delabbio	2015-2016	Geological mapping	2.56884	Aylmer-SP050
16	Aylmer	Thomas H. Sheppard	2015	Geological mapping	2.57029	Aylmer-SP051
17	Aylmer	Thomas H. Sheppard	2016	Sampling	2.57050	Aylmer-SP052
18	Aylmer	Thomas H. Sheppard	2016	Geological mapping	2.57051	Aylmer-SP053
19	Battersby	ARW Exploration	2015	Diamond drilling, sampling, assays	2.56374	Battersby-SP003
20	Boon	Timothy P. Martel	2013-2015	Assays, induced polarization survey, sampling	2.56621	Boon-SP038
21	Capreol	407043 Ontario Limited	2016	Geological mapping, line cutting, sampling, assays	2.56793	Capreol-SP017
22	Cascaden	Wallbridge Mining Company Limited.	2015	Geological mapping, electromagnetic survey	2.56682	Cascaden-SP026
23	Chapman	Richard R.Meilleur	2013-2015	Prospecting, geological mapping	2.56066	Chapman-SP004
24	Clarkson	Precambrian Ventures Ltd.	2015	Assays, sampling, geological mapping	2.56254	Clarkson-SP009
25	Clarkson	Precambrian Ventures Ltd.	2015	Diamond drilling. stripping,	2.56483	Clarkson-SP010
26	Clement	Mount Logan Resources Ltd.	2015	Diamond drilling, assays	2.56469	Clement-SP022
27	Clement	B J Wright, R I Stewart	2015	Geological mapping, sampling	2.56610	Clement-SP023
28	Creighton-Davies	Vale Canada Ltd.	2010-2014	Diamond drilling, assays, resistivity survey, borehole electromagnetic survey	2.56336	Creighton-SP005
29	Davis	Fourtune Lake Explorations	2014-2015	Line cutting, magnetic survey, induced polarization survey	2.56504	Davis-SP098
30	Davis	John Brady	2014-2015	Stripping, geological mapping	2.56624	Davis-SP099
31	Dieppe	G R Salo	2014-2015	Manual work, mechanical work, sampling, washing, trenching, stripping	2.56763	Dieppe-SP024
32	Ermatinger	Champion Bear Resources Ltd, Wallbridge Mining Company Limited	2015	Electromagnetic survey, drilling	2.56672	Ermatinger-SP038
33	Ermatinger	Wallbridge Mining Company Limited	2015	Electromagnetic survey, geological mapping, assays, sampling	2.56712	Ermatinger-SP039
34	Fairbank	Transition Metals Corp.	2016	Geological mapping, sampling	2.56896	Fairbank-SP005
35	Foster	Kenneth Vaughan Naples	2014-2015	Sampling	2.56762	Foster-SP030
36	Hart	Wallbridge Mining Company Limited	2014-2015	Sampling, electromagnetic survey, geological mapping	2.56682	Hart-SP039
37	Hutton	VMS Ventures	2015	Overburden drilling, till-sampling, scanning electron microscopy	2.56392	Hutton
38	Janes	R I Stewart	2016	Sampling, geological mapping	2.57039	Janes-SP040
39	Kelly	B Wright,R Stewart, DLK Minerals, 8616868 Canada Ltd,	2015	Airborne magnetic survey, airborne electromagnetic survey	2.56417	Kelly-SP022
40	La Salle	Gary M Mote, Glen J Mote	2015	Stripping, sampling	2.56256	La Salle-SP004
41	Levack	Wallbridge Mining Company Limited	2015-2016	Light detection and ranging survey	2.56983	Levack-SP026

No.	Township(s)	Company Name	Year	Type of Work	AFRO Number	Resident Geologist Office File Designation
42	Levack	Glenncore Canada Corp., Vale Canada Ltd.	2012	Diamond drilling	2.57173	Levack-SP027
43	Loughrin	John G Brady	2015	Sampling, assays	2.56353	Loughrin-SP022
44	MacBeth	Randy I Stewart, Brian J Wright	2015	Geological mapping, stripping	2.56610	MacBeth-SP018
45	Mattawan	Ronald A Montreuil, R.J.M Garnets INC	2015	Trenching	2.56243	Mattawan-SP036
46	Mattawan	Ronald A Montreuil, R.J.M Garnets INC	2015	Trenching, line cutting	2.56647	Mattawan-SP037
47	McNish	Mount Logan Resources Ltd	2014	Diamond drilling, assays, sampling	2.56369	McNish-SP014
48	Moncrieff	Energold Minerals Inc	2014	High resolution aerial imagery survey, sampling	2.56090	Moncreiff-SP023
49	Monestime	Mark R Ardiel, Michael E Dubreuil	2015	Re-cutting lines	2.56608	Monestime-SP005
50	Morgan	WallBridge Mining Company Limited	2014	Geological mapping, beep mat survey, traverses	2.56070	Morgan-SP013
51	Norman	Allan Barry	2015	Geological mapping, sampling, assays, light detection and ranging survey	2.56352	Norman-SP079
52	Norman	Allan Barry	2015	Geological mapping, sampling, other	2.56218	Norman-SP080
53	Pardo	Mount Logan Resources	2014	Stripping, channel sampling, trenching, bulk sampling, geological mapping, assays	2.56304	Pardo-SP024
54	Pardo	Mount Logan Resources	2014	Diamond drilling, assays	2.56305	Pardo-SP025
55	Pardo	Mount Logan Resources	2014	Sampling, assays, Diamond drilling	2.56306	Pardo-SP026
56	Pardo	Mount Logan Resources	2015	Diamond drilling, assays	2.56370	Pardo-SP027
57	Parkin	John G. Brady	2015	Beep mat survey, trenching, stripping	2.56686	Parkin-SP127
58	Parkin	T P Martel	2016	Manual work, sampling, traverses	2.57136	Parkin-SP130
59	Rathbun	R J Fielding	2014	Geological mapping, stripping, assays	2.55638	Rathbun-SP065
60	Rathbun	Flag Resources (1985) Ltd	2016	Very low frequency electromagnetic survey	2.56815	Rathbun-SP066
61	Street	L.G Cook, J.C Cook	2013-2015	Line cutting, stripping, manual work	2.56363	Street-SP045
62	Tyrone	Wallbridge Mining Company Limited	2015	Borehole electromagnetic survey, electromagnetic survey, geological mapping, sampling, assays, diamond drilling	2.56578	Tyrone-SP027
63	Valin	Patti Overton	2014-2016	Assays, line cutting, sampling	2.56671	Valin-SP002
64	Venturi	Boreal Agrominerals Inc.	2012-2015	Industrial mineral testing	2.56284	Venturi-SP017
65	Vernon	Wallbridge Mining Company Limited	2015	Assays, sampling, geological mapping, Pulse electromagnetic survey	2.56712	Vernon-SP010
66	Waters	R J Fielding, T G Fielding	2014	Washing, prospecting	2.56697	Waters-SP030
67	Waters	M R Kosovsky	2014	X-ray fluorescence analyses, microscopy, sampling	2.56100	Waters-SP031
68	Wisner	Wallbridge Mining Company Limited, Glencore Canada	2014-2015	Geological mapping, sampling, diamond drilling, assays, borehole electromagnetic survey, versatile time domain electromagnetic survey, electromagnetic survey	2.56961	Wisner-SP039

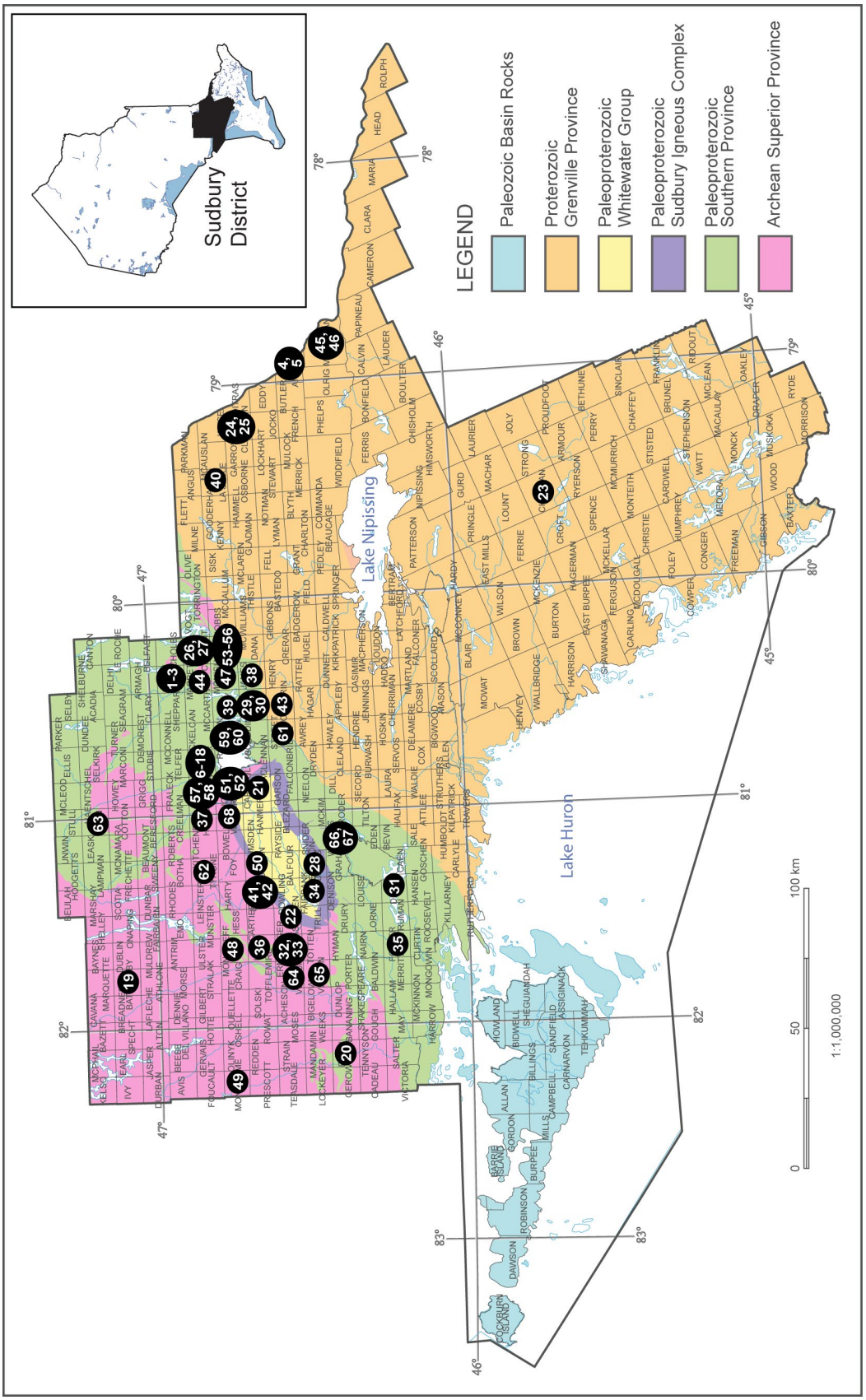

Figure 11. Location of assessment files processed in the Sudbury District in 2016 (keyed to Table 27); geology *modified from* Ontario Geological Survey 2011.

MINERAL RESOURCES NOT BEING MINED

Known mineral resources located within the Sudbury District not being mined in 2015 are reported in Table 28.

Table 28. Mineral deposits not being mined in the Sudbury District in 2016.

Abbreviations

AF ..... Assessment Files
CMH ..... Canadian Mines Handbook
MDC ..... Mineral Deposit Circular
MDI ..... Mineral Deposit Inventory
MRE ..... Mineral Resource Estimate
OFR ..... Open File Report
PR ..... Press Release
TR ..... Technical Report

Deposit Name (MDI No.)	Commodity	Tonnage-Grade Estimates and/or Dimensions	Ownership References	Reserve References	Status
Agnew Lake Mine	U, Th, Y	*Inferred resource: 4 564 kt of ore at 0.4 kg U_3O_8/t	Skead holdings Ltd.	Ursa Major minerals Inc. 2006 annual report	Active past producing mine
Alexander Centre Industries Quarry MDI41I02SE00018	Silica/quartz	*Inferred resource: 100 Mt of quartzite	Alexander Centre Industries Ltd.	OFR5948	Active past producing mine
Angus Deposit MDI31L14SW00014	Ti, Fe	Inferred resource: 48 983 200 t @ 48.09% Fe, 14.82% Ti, and 0.24 V.	Prophecy Development 80% ownership; Randsburg International Gold Corp. 20%	NI 43-101 TR, Jan 2014	Active developed prospect, Diamond drilling in 2013
Bissett Creek deposit MDI31L01SE00002	Graphite	Measured and indicated resource: 69.8 Mt @ 1.74% graphitic carbon. Inferred resource: 24.0 Mt @ 1.65% graphitic carbon.	Northern Graphite Corporation	PR, May 2013; CMH 2016-17 p. 313	Active developed prospect
Brazeau prospect MDI31L02NE00010	V, Ti, Fe, (garnet)	*Inferred resource: 99 790 t @ 0.76% V_2O_3, 7.9% TiO_2, 35.2% Fe in 2 lenses to a depth of 100 feet; a maximum of 861 826 t in 6 lenses to a depth of 100 feet.	High G Minerals Corp.	MDC011, p.271	Active prospect
Burwash Lake prospect MDI41P03SE00011	Fe	*Inferred resource: 15 pit/trench areas outlined containing 408 233 t per vertical feet, avg. 20.7 % Fe. Preliminary concentration tests – concentrate grading 68.2% Fe, 5.0% SiO_2 with 93% recovery	Camilleri, Jonathan Paul	MDC011, p.329	Active prospect; Diamond drilling 2016
Butler (Crocan Lake) prospect MDI31L11SE00012	Kyanite	*Reserves 45359237 tonnes	Kyanite Mining Corp.	NI 43-101 TR; Sept. 2015	Active prospect; Diamond drilling 2014
Butler Vermiculite MDI31L11SE00003	Vermiculite	*Inferred resource : Main zone has 83 762 t @ 53.2% vermiculite. 33E zone has 20 025 t @ 34.7% vermiculite	Northfil Resources Ltd.	AF: Butler-SP020	Active prospect
Cummings Lake prospect MDI41I16NE00036	Fe	*Indicated resource in the North zone: 170.9 Mt @ 26.7% soluble Fe. Inferred resource: 126.6 Mt @ 27.2% soluble Fe.	Trefstone Corp., M. Martin, D. Laronde	MDC011, p. 275	Active prospect
Errington Mine MDI41I11SW00005	Zn, Cu, Pb, Ag, Au	Measured resources : 6.7 Mt @ 3.94% Zn, 1.10% Pb, 1.15% Cu, 52 g/t Ag, and 0.84 g/t Au. Indicated resources : 2.3 Mt @ 4.3% Zn, 1.3% Pb, 1.1% Cu, 55 g/t Ag, and 0.8 g/t Au.	Glencore PLC	Glencore 2015 Resources and Reserves report, p. 22	Active past producing mine
Falcon Gold MDI41I10SE00003	Au	*Estimated 60 kt @ 0.23 oz/t Au	Pentland Firth Ventures Ltd.	E. Stringer prospector	Inactive

Deposit Name (MDI No.)	Commodity	Tonnage-Grade Estimates and/or Dimensions	Ownership References	Reserve References	Status
Fostung property MDI41I04NE00036	W	Inferred Resource: 12.4 Mt @ 0.213% WO_3	Sulpetro Minerals Ltd.	Scandium International Mining Corp. NI 43-101 TR, Nov. 2007	Active developed prospect
Geneva Lake Mine MDI41I13SE00002	Cu, Pb, Zn (Ag, Au)	*Inferred resource : 114 kt @ 10% Zn, 3% Pb. (1941-1944 production: 80 588t ore grading 3.34% Pb, 9.21% Zn)	Green Swan Capital Corp.	Green Swan NI 43-101 TR, Oct. 2013	Active developed prospect ; borehole geophysical surveys; DD-3; Exploration up to February 29, 2016
Kidd Copper Mine MDI06NW00012	Ni, Cu, Co, PGM	*786 kt @ 0.76% Cu and 0.57% Ni (unclassified)	J.P. Sheridan	N/A	
Kirwook Mine	Cu, Ni	Indicated resource: 601 182 t " 0.49% Cu, and 1.17% Ni. Inferred resource: 1 589 387 t " 0.97% Cu, and 1.27 Ni	KGHM	NI 43-101 TR, 2008	Active past producing mine
Lavergne-Springer REE zone	REE	Indicated resource: 4.167 Mt @ 1.139% REE, and 0.016 % Th	Canada Rare Earth Corp.	PR, Nov. 2013	Active developed prospect
Ontario Graphite Ltd. MDI31E11NE00004	graphite	51.5 Mt of indicated at average grade of 2.14% Cg, and 46.8 Mt of inferred at average grades of 2.00% Cg	Ontario Graphite Ltd.	CMH 2026-2017, p. 226	Active developed prospect, opening fall 2017
Parkin Marble MDI41I15SW00041	$CaCO_3$	*147 460 probable and possible tons of "good, fair and poor" calcite	J. Brady	AF Parkin-SP025	Inactive prospect
River Valley MDI0000000001421	PGM	91.3 Mt @ 0.58g/t Pd, 0.22 g/t Pt, 0.045 g/t Au	[1]Pacific North West Capital Corp.	[1]Pacific North West Capital Corp. 2012 MRE (NI 43-101)	Active prospect
Rock Brook Resources property MDI31E12SE00004	$CaCO_3$	*593 333t @ 77.939% total carbonates over an area 500 feet long by 222 feet wide, to a depth of 100 feet.	Rock Brook Resources Corp.	OFR5647, p. 25	Active developed prospect
Rutter Nepheline MDI41I02SE00005	Zircon, nepheline	*50 Mt proven and probable reserves	996824 ONTARIO Ltd.	OFR6276, p.41-42	Active developed prospect
Stralak deposit MDI41I13SE00044	Zn, Cu, Pb (Ag)	*Inferred resources : 329 925 t @ 3.18% Zn, 25.35 g/t Ag, and 0.32% Cu over a width of 8.6 feet to an average depth of 157 feet.	Osisko Mining Corp.	Lateegra Gold Corp. press release 08/02/2010	Inactive, last active 1993, diamond drilling
Vermillion Mine MDI41I11SW00006	Zn, Cu, Pb, Ag, Au	Measured resources : 2.8 Mt @ 4.22% Zn, 1.16% Pb, 1.34% Cu, 52.6 g/t Ag, and 0.91 g/t Au. Indicated resources : 0.4 Mt @ 5.3% Zn, 1.3% Pb, 1.1% Cu, 56 g/t Ag, and 1.1 g/t Au.	Glencore PLC	Glencore 2015 Resources and Reserves report, p.22	Active past producing mine
Victoria MDI41I06NW00014	Ni, Cu	Indicated Resource: 482 kt, @ 1.41%Cu, and 1.23% Ni. Inferred Resource: 13.081 M t of ore, @ 2.64% Cu, and 2.76%.	KGHM International Ltd.	2014 mineral resources and reserves report, p.23.	Active developed prospect

**Note: Some resource estimates in this table are historic and do not follow the required disclosure for reserves and resources as outlined in National Instrument 43-101. All figures were reported by previous authors.*
Abbreviations: m = metres, t = tonnes, oz/t = ounce per tonne, kt = kilo-tonnes, Mt = million tonnes, @ = at.
[1]Name changed to New Age Metals, February 2017.

DISTRICT GEOLOGIST OFFICE STAFF ACTIVITIES

In 2016, D. Farrow, *P.Geo.*, District Geologist (January through November), S. Péloquin, *P.Geo.*, District Geologist (December), L.A. Bardeggia, District Geological Assistant (January through July), and F. Belley–Biswas, Acting District Geological Assistant (August through December), staffed the Sudbury District Geologist Office. Madison Tapscott was the Summer Employment Opportunities program student from June to August. A summary of activities of the Sudbury District Geologist Office in 2016 is provided in Table 29.

Over 300 in-person client requests, and more than 400 email or phone requests, were handled by Sudbury District Geologist office staff in 2016. Requests included consultation and research assistance. Prospectors, mining company personnel and members of the general public were served. Staff completed 2 property visits during the year. The Mineral Deposit Inventory (MDI) database is maintained by both the Sudbury District office and the Mineral Deposit Compilation Geologist. Five Mineral Deposit Inventory (MDI) entries were updated in the Sudbury office in 2016; *see* the "MINERAL DEPOSIT COMPILATION GEOLOGIST" report in the Kirkland Lake District Report of Activities in this report for more information on the MDI.

The Sudbury District Geologist office delivers month-end reports (MER) on mining and exploration news and activity in the district. The MER are published as "Activity Reports-Mineral Exploration" on OGSEarth (www.mndm.gov.on.ca/en | mines-and-minerals | Land Tenure and Geoscience Resources | ogsearth | Activity Reports-Mineral Exploration). OGSEarth data can be viewed using user-friendly geographic information programs such as Google Earth (www.google.com/earth/). The MER can also be viewed in table format at: www.mndm.gov.on.ca | Mines and Minerals | Geology | Resident Geologist Program (RGP) | mineral sector activity.

Madison Tapscott assisted with locating donated files, compiling information for their classification, reviewing and updating files in the assessment file library, and assisted office staff in the field.

Staff provided 4 field trips of the Sudbury Basin: 2 to other Resident Geologist Program (RGP) and Ontario Geological Survey (OGS) staff; and 2 to university students and faculty. Staff also attended 2 RGP field trips (Cobalt and Larder Lake Areas), 2 OGS field trips (Drury Township and the Grenville Central Gneiss Belt), and one industry field trip as part of the Northeastern Ontario Mines and Minerals Symposium (Wallbridge Parkin property).

Office staff attended training sessions in ArcGIS, the use of the KT-10 magnetic susceptibility meter, Utility Terrain Vehicle operation and safety, and Standard First Aid and CPR.

D. Farrow and L.A. Bardeggia attended the Northeastern Ontario Mines and Minerals Symposium in Sudbury. During the Symposium, L.A. Bardeggia assisted in providing a workshop on OGS online resources, including oral presentations and one-on-one sessions for clients. F. Belley–Biswas attended the Northeastern and Southern Resident Geologist Program meeting in Kirkland Lake.

As co-chair of the Willet Green Miller Centre Joint Health and Safety Committee, D. Farrow participated in workplace safety inspections and committee meetings and attended Workplace Safety and Prevention Services local networking sessions.

As part of continuing professional development, staff attended talks and presentations from various local organizations such as the Goodman School of Mines, Sudbury Prospectors and Developers Association, Sudbury Geological Discussion Group and the Laurentian University Earth Science Department/Harquail School of Earth Sciences.

Table 29. Summary of activities of the Sudbury District Geologist Office in 2016.

Activity	Number
Office visits	332
Telephone/Email inquiries	406
Property visits	2
Field trips attended	5
Field trips given	4
Symposia attended	2
Assessment files and donations processed	182
MDI Records updated	5

The Sudbury District Geologist Office provides free, short-term loans of a Beep Mat, metal detector, UV lamps, a scintillometer and a proton procession magnetometer to qualified explorationists. Binocular and polarizing microscopes are available for in-office use.

The office is located within the John B. Gammon Geoscience ("Mines") Library, 3rd Floor, Willet Green Miller Centre, Laurentian University, 933 Ramsey Lake Road, Sudbury, ON, P3E 6B5. The Sudbury District Geologist can be reached at 705-670-5741, and the Sudbury District Geological Assistant, at 705-670-5733.

PROPERTY VISITS

River Valley PGM Property Visit – F. Belley–Biswas

LOCATION AND ACCESS

The River Valley PGM property is located in the Dana and Pardo Townships, approximately 60 km northeast of Sudbury. The property can be accessed via Highway 17, Highway 539, and Highway 805. Dirt roads beyond Glen Afton provide access to various parts of the property (Figure 12).

PROPERTY GEOLOGY

The River Valley intrusion is part of the Paleoproterozoic East Bull Lake Intrusive suite, dated between 2 491 and 2 475 Ma, and is located in the Southern and Grenville provinces (*see* Figure 13). The mineralization consists of Platinum Group Metals (PGM), and is primarily hosted in a gabbro breccia occurring on or near the contact between the River Valley Intrusion and the footwall rocks of the Grenville province. The deposit has been traced along strike for 12 km, where the River Valley Intrusion is either in contact with the Huronian Mississagi Formation or in contact with mafic and felsic metavolcanic rocks of the lower Huronian Supergroup (*see* Figure 13). This contact-style PGM mineralization consists of disseminated to blebby chalcopyrite and pyrrhotite in the matrix of the breccia, and occasionally within the more mafic fragments of the breccia. These sulphides commonly contain between 1 g/t and 5 g/t of a combination of platinum, palladium and gold.

PROPERTY HISTORY

Prospecting and exploration in the property has been ongoing since the early 1960s (Table 30).

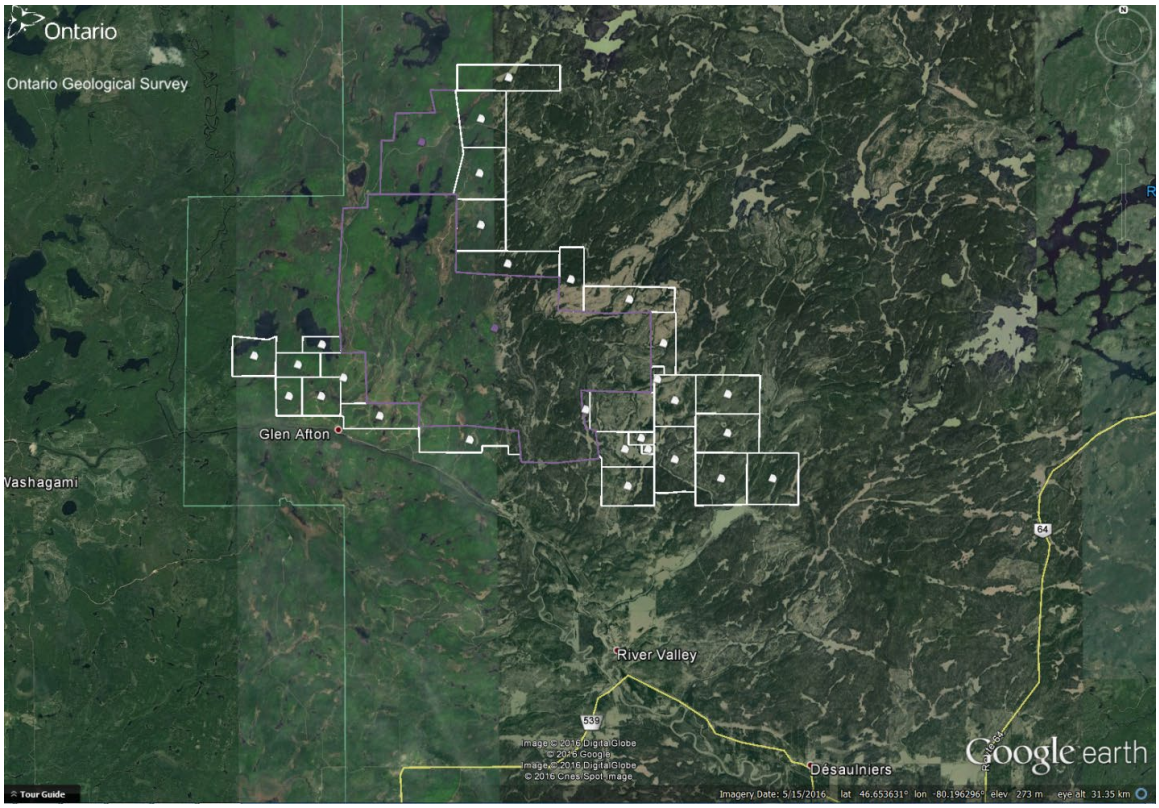

Figure 12. Google Earth™ image of the River Valley PGM property.

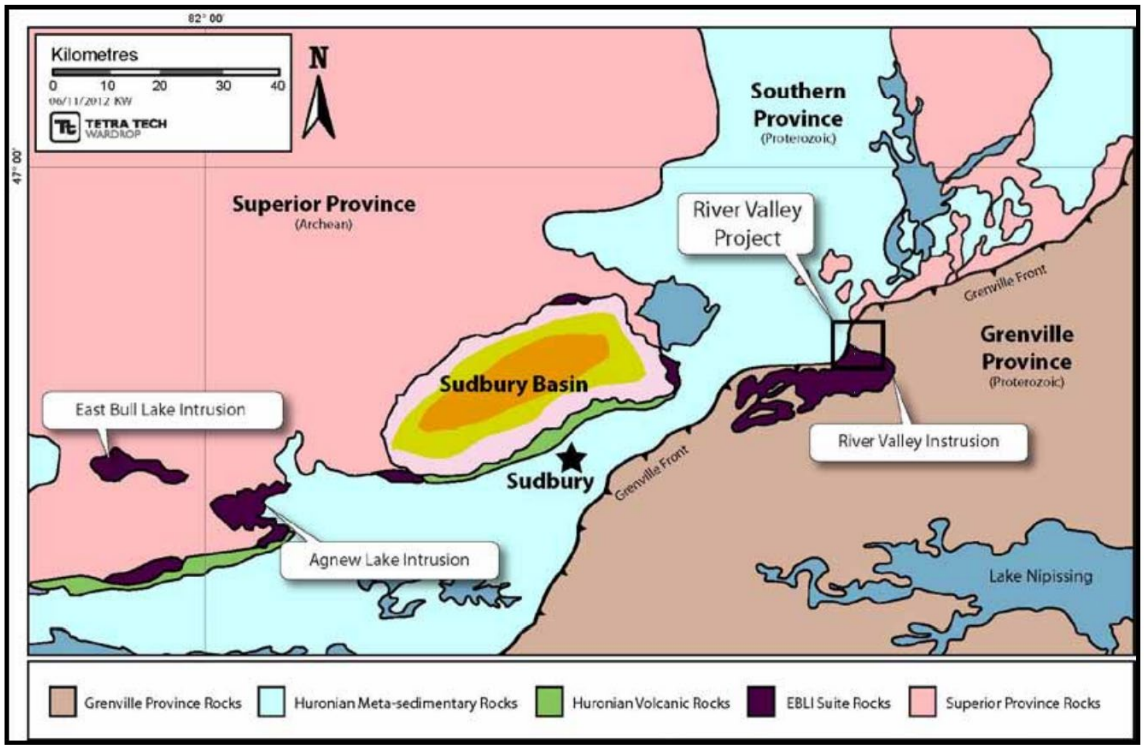

Figure 13. Geological map of the River Valley Intrusion area. EBLI: East Bull Lake Intrusion (published with permission from New Age Metals; figure from River Valley PGM Project NI 43-101: McCracken 2012).

Table 30. River Valley PGM property history.

Abbreviations

AEM ..... Airborne electromagnetic survey
AGPHY ..... Airborne geophysical survey
AMAG ..... Airborne magnetic survey
ARAD ..... Airborne radiometric survey
ASSAY ..... Rock analysis
BULK ..... Bulk sampling
CHNL ..... Channel sampling
DD ..... Diamond drilling
EM ..... Electromagnetic survey
GMAP ..... Geological mapping
GPHYS ..... Geophysical survey
GRAV ..... Gravity survey
IP ..... Induced polarization survey
LC ..... Line cutting
MAG ..... Magnetic survey
PITS ..... Pit digging
PROSP ..... Prospecting
RES ..... Resistivity survey
SAMP ..... Sampling
SOIL-SAMP ..... Soil/till sampling
STRIP ..... Overburden stripping
TRNCH ..... Trenching
TRVS ..... Traverse

Year	Company	Activities
1963	Tomrose Mines Ltd.	PROSP, TRNCH
1963	Tomrose Mines Ltd.	DD
1965	Falconbridge Ltd.	EM
1966	Azen Mines Ltd.	MAG
1968	Kenco Exploration (Canada) Ltd.	AMAG, AEM
1969	Kenco Exploration (Canada) Ltd.	TRNCH, PITS
1996	WMC International	TRVS, AGPHYS, EM, SOIL-SAMP
1997	Tenajon Resources	GMAP, PROSP, STRIP, CHNL
1998	Luhta, Bailey, and Orchard	PROSP, SAMP
1999	Aquiline Resources	GMAP
1999	Mustang Minerals	PROSP, SAMP, LC
1999	Pacific North West Capital Corp./ Amplats	PROSP, SAMP, GMAP, STRIP, ASSAY, IP, MAG
2000	Platinum Group Metals Ltd.	SOIL-SAMP, SAMP, PROSP, GMAP, ASSAY
2000	Mustang Minerals	GMAP, SAMP, PROSP, MAG
2000	Mustang Minerals	IP, RES
2000	Pacific North West Capital Corp./ Amplats	LC, GPHYS, GMAP, PROSP, SAMP, DD, ASSAY
2001	Aquiline Resources	GMAP, SAMP, CHNL, IP, RES, MAG
2001	Mustang Minerals	GMAP, SAMP, GPHYS, MAG, IP, DD
2001	Pacific North West Capital Corp./ Amplats	SAMP, DD, ASSAY
2002	Aquiline Resources	IP, RES, MAG
2002	Mustang Minerals	MAG, DD, LC, MAG, IP, GMAP, SAMP, PROSP
2002	Pacific North West Capital Corp./ Amplats	GMAP, SAMP, STRIP, LC, IP, MAG, DD, ASSAY
2003	Aquiline Resources	DD
2003	Pacific North West Capital Corp./ Amplats	AMAG, AEM, ARAD
2004	Pacific North West Capital Corp./ Amplats	GMAP, SAMP, DD, ASSAY
2005	Pacific North West Capital Corp./ Amplats	BULK, ASSAY, TRNCH, GMAP, SAMP, DD
2006	Pacific North West Capital Corp.	SAMP, CHNL, PROSP, GMAP, LC, IP, MAG, GRAV, ASSAY
2007	Pacific North West Capital Corp.	STRIP, CHNL, ASSAY
2008	Pacific North West Capital Corp.	GMAP, CHNL, ASSAY
2009	Pacific North West Capital Corp.	ASSAY
2010	Pacific North West Capital Corp.	ASSAY
2011	Pacific North West Capital Corp.	DD, ASSAY, IP
2012	Pacific North West Capital Corp.	DD, ASSAY
2013	Pacific North West Capital Corp.	ASSAY
2015	Pacific North West Capital Corp.	DD, ASSAY
2016	Pacific North West Capital Corp.	DD, ASSAY

Note: Pacific North West Capital Corp. changed name to New Age Metals, February 2017.

PROPERTY VISIT

On September 12, 2016, the District Geological Assistant participated in a property visit that was organized by New Age Metals (NAM; formerly Pacific North West Capital Corporation (PFN)) for shareholders, stakeholders, media, analysts, institutional portfolio managers and local interested parties. The project geologists introduced the local geology, gave a tour of the discovery site in Dana North Zone, showed the structures and outcrops associated with their 2015 discovery of the Pine Zone (formerly T2) (*see* Figure 14), and displayed some of the core collected during their 2011 diamond drilling programs.

The Dana North zone is in northwest Dana Township; it is bound by West Boundary Shear Zone (WBSZ), which is interpreted to be synchronous with the Grenville Front, and is in thrust contact with Quartzite of the Huronian Mississagi Formation to the northeast. This zone has Measured and Indicated Resources of 7.4 Mt with 132 g/t Pd + Pt at a cut-off grade of 1.7 g/t PdEq (PdEq defined in Table 13; McCracken 2012).

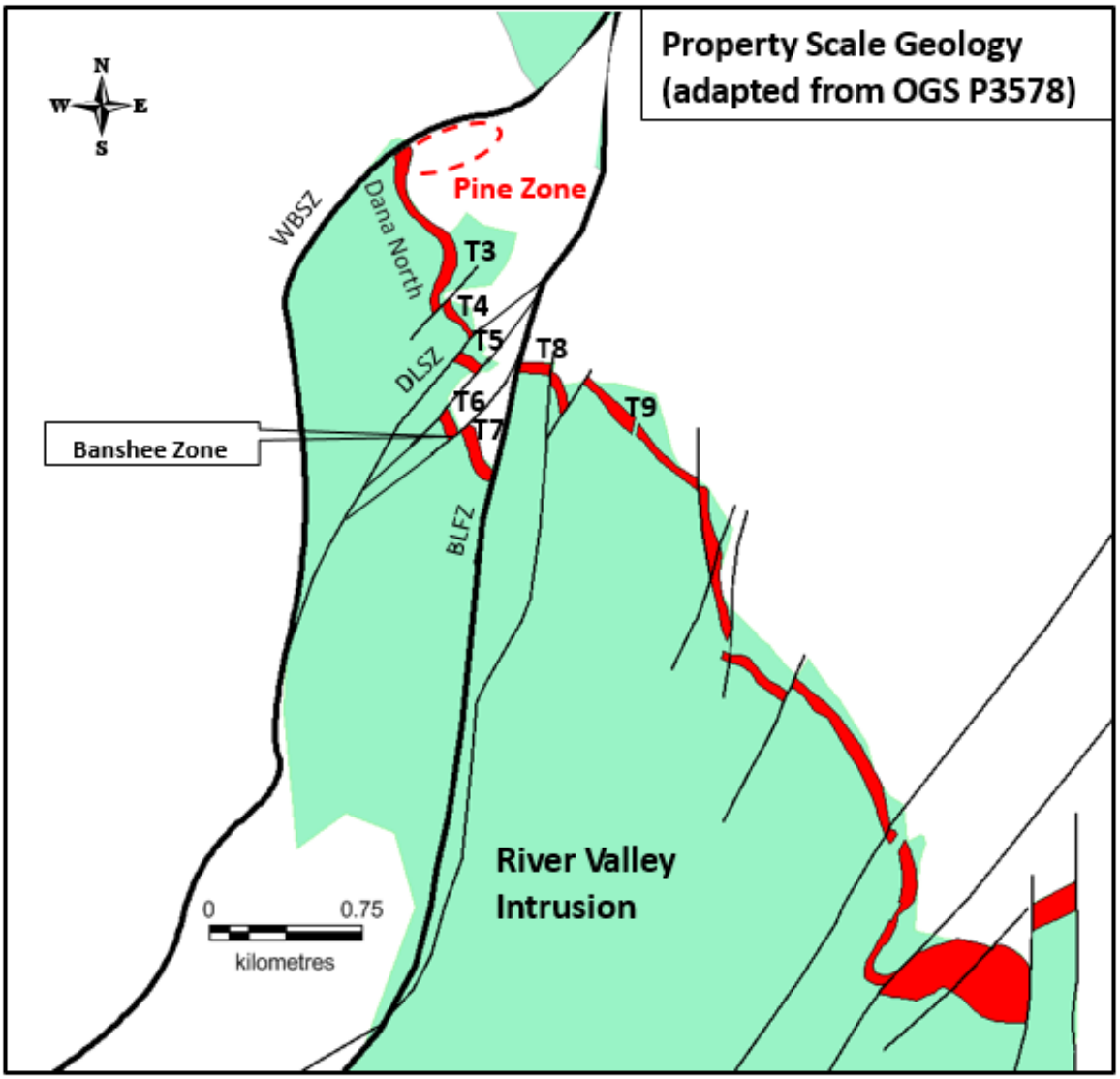

Figure 14. Simplified property geological map showing mineralization zones (red), and 2015 Pine Zone (formerly T2) discovery at the north end of the PGM deposit (Published with permission from New Age Metals; figure from New Age Metals website: http://newagemetals.com | Investors | Presentations | Investor Presentation [accessed February 13, 2017]).

The Pine Zone was discovered during a drilling program in 2015, after a surface induced polarization chargeability survey displayed an anomaly to the east of Dana North Zone. The program indicated a high-grade mineralization zone at depth, in the footwall, to the east of the Dana North mineralization zone (NAM (as PFN), press release, March 11, 2015). In 2016, NAM (as PFN) was granted financial assistance from the Junior Exploration Assistance Program (JEAP) of the Ontario Prospectors Association (NAM (as PFN), press release, June 6, 2016). After a surface exploration program over the summer, and an additional drilling program in the fall, NAM confirmed the discovery of the new Pine Zone (formerly T2) mineralized zone (NAM (as PFN), press release, December 13, 2016).

RECOMMENDATIONS FOR EXPLORATION

Soda Metasomatism as a Possible Iron Oxide-Copper-Gold (IOCG) Deposit Indicator in the Sudbury District – D.G. Farrow

Soda metasomatism in the Southern structural province of the Canadian Shield is well known, but not well understood. In the Sudbury area these regionally albitized rocks occur in a roughly arcuate trend, extending from near Bruce Mines in the west to the Temagami area northeast of Lake Wanapitei, passing south of the Sudbury Igneous Complex (SIC) (Gates 1991).

U/Pb geochronology of hydrothermal monazite in albitized rocks east of the Sudbury complex indicates that metasomatic albitization occurred in the Sudbury–Wanapitei Lake area at 1700 ± 2 Ma, coeval with granitic plutonism in the Southern Province, between 1750 and 1700 Ma (Schandl, Gorton and Davis 1994).

It has been postulated that the regional soda metasomatism of the area may be related to the Sudbury impact event at 1850 Ma; however, the U/Pb geochronological evidence cited above indicates that later felsic plutonism or more deep-seated carbonatitic or alkalic intrusions at depth could have acted as the driving mechanism for the sodium-rich fluids.

In the Sudbury district, economic interest in these rocks has focused on several small deposits of gold (illustrated in Figure 15), but the characteristics of these deposits in many ways display an affinity with iron oxide-copper-gold (IOCG) deposits found in other parts of the world. It has been proposed that the former Scadding Gold Mine, east of the SIC is a modified IOCG deposit (Schandl and Gorton 2007).

Some of these shared characteristics are

- Proterozoic in age (most)
- Located along cratonic margins
- Common alterations include sodium, potassium, iron, calcium and silica
- Associated with major fault and/or fracture systems
- Mineralization includes copper and copper-iron sulphides, iron oxide, gold, uranium, silver, cobalt (all variable)
- Elevated levels of rare earth elements (REE)
- Brecciated country rocks

With these factors in mind, it is recommended that prospecting be carried out for potential IOCG deposits in Paleoproterozoic Huronian rocks along the aforementioned arcuate trend of soda-rich rocks as well as in townships northeast of Lake Wanapitei underlain by the Wanapitei aeromagnetic anomaly.

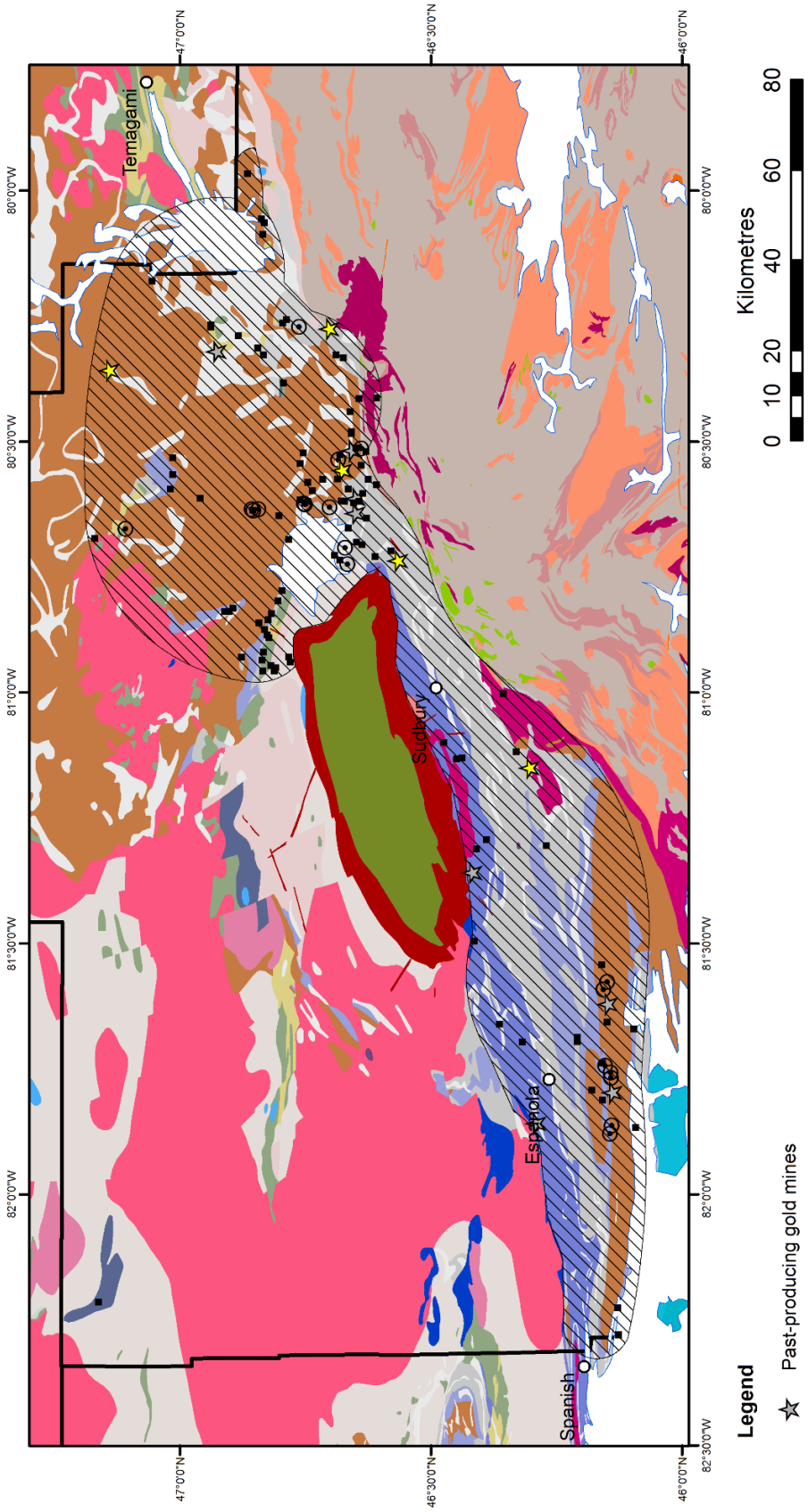

Figure 15: Sodium metasomatic mineralization and mineral occurrences in the Sudbury District (geology *modified from* Ontario Geological Survey 2011)

This anomaly indicates the presence of an intrusive body up to 5 km deep underlying an area between eastern Lake Wanapitei and western Lake Temagami.

Metasomatic soda-rich rocks are mostly pink, sometimes tan coloured. They are easily recognized in contrasting host rocks such as greywacke, siltstones, paraconglomerates, limestones and diabase. They are difficult to recognize in similarly coloured rocks, such as feldspathic quartzites, arkoses and granite (Meyer 1987).

Townships within the area of interest include Phyllis, Vogt, Hobbs, Pardo, Clement, Scholes, Afton, Macbeth, McNish, Janes, Davis, Kelly, McCarthy, Sheppard, Mackelcan, Rathbun, Scadding, Street, Falconbridge, Dryden, Neelon, Dill, Broder, Waters, Tilton, Bevin, Caen, Goschen, Stalin, Dieppe, Killarney, Rutherford, Roosevelt, Truman, Foster, Curtin, Merritt, Mongowin and McKinnon.

OGS ACTIVITIES AND RESEARCH BY OTHERS

The bedrock geology encompassed by the Sudbury District includes parts of terrains formed from the Archean through Paleozoic time periods. Three Precambrian provinces, the Superior, Southern and Grenville, are represented, as are the Phanerozoic rocks of Manitoulin Island. The great Quaternary glaciation events also left a profound mark on the area, carving the landscape and depositing an array of surficial deposit types. This tremendous variety offers a smorgasbord of research opportunities for geoscientists. Of particular interest is the unique and significant Sudbury structure that attracts geoscientists from all over the world. The Sudbury Igneous Complex and its mineral deposits continue to attract attention and generate lively debate, even after 130 years of commercial production and myriad scientific investigations. A selection of research projects and publications related to the Resident Geologist Program's Sudbury District is presented below.

Ontario Geological Survey

DRURY AND DENISON TOWNSHIPS

Bedrock Mapping

The Southwest Sudbury Structure bedrock geology mapping project, focussing on 1:20 000 scale mapping of Drury, Denison, Trill and Fairbank townships, was initiated by the Ontario Geological Survey (OGS) in 2015 as part of the 5-year, multidisciplinary research program on Low Sulfide PGE-rich Sudbury Footwall Mineralization, being conducted by the Mineral Exploration Research Centre (MERC) at the Harquail School of Earth Sciences, Laurentian University (Simard, Gordon and Généreux 2016). This is a collaborative program with OGS and the private sector to develop an integrated geological, geochemical and geophysical exploration model for low-sulphide, PGE-rich mineralization in the Sudbury Basin.

The following lists the authors' 2016 highlights of Drury Township remapping.

-using Huronian Supergroup and Sudbury Igneous Complex (SIC) stratigraphy to help identify pre-(folding and thrusting) and post-(northeast faults) SIC structures;

-identifying several new and prospective Sudbury Breccia belts;

-identifying a major east-trending dextral mylonite zone (possibly continuing eastward to the Creighton fault); and

-documenting the various styles of mineralization present in the township, namely nickel-copper-PGE mineralization related to the SIC, magmatic sulphide mineralization in the Nipissing Intrusive Suite and the Drury Township intrusion, and remobilized shear zone–hosted sulphide mineralization.

The first of 2 related graduate theses, initiated in 2015 as part of the bedrock geology and surficial mapping through the Ontario Geological Survey–Laurentian University Graduate Mapping School Agreement, continued in 2016: PhD thesis project, C-A. Généreux. In addition, a BSc thesis on a detrital zircon study of the Ramsay Lake Formation was initiated in 2016 at McMaster University in collaboration with the Ontario Geological Survey and the Jack Satterly Geochronology Laboratory at the University of Toronto.

Publication of the 1:20 000 scale Drury Township bedrock geology map and a Miscellaneous Release—Data (MRD) are planned for 2017. Mapping related to the Southwest Sudbury Structure mapping project will continue eastward into Denison Township in 2017.

As part of the Low Sulfide PGE-rich Sudbury Footwall Mineralization project, Généreux (Généreux et al. 2016) is undertaking a four-year PhD thesis through the Laurentian University–Ontario Geological Survey (OGS) Mapping School Agreement. The thesis, part of the 5-year, multi-disciplinary research program being conducted by the Mineral Exploration Research Centre (MERC) at the Harquail School of Earth Sciences, Laurentian University, focuses on the identification of the structural, lithologic and metamorphic controls on low-sulphide PGE mineralization in the South Range.

The goals of the project are to

1) determine the sequence of structural and metamorphic events in the South Range;

2) determine the relative timing between structures, metamorphism and low-sulphide PGE mineralization;

3) determine the pressure and temperature achieved during the tectonic history of the low-sulphide PGE deposits and the South Range; and

4) contribute to the development of an exploration model for low-sulphide PGE mineralization in the South Range.

The authors' results from the 2015 and 2016 field seasons showed the following.

At least 5 deformation events affect the southwest portion of the South Range of the SIC.

- east-trending thrust faulting
- north-northeast-directed shortening resulting in large F_2 isoclinal folds and a strong regional S_2 foliation.
- northeast-trending faulting.
- strike-slip dextral shearing and formation of a large-scale mylonite zone.
- late east-west compression.

Detailed bedrock mapping in the 2017 field season will focus on the mylonite zone within Drury Township and will follow it eastward into Denison Township to determine the relative timing between these structures and their relationships with the 5 main deformation events.

Quaternary Mapping

The Quaternary geology of the Drury and Denison townships (southwest corner of the Sudbury Basin) was mapped recently by Hashmi (2016).The Preliminary Map published (Hashmi 2016) is the first of the products proposed for this study (Hashmi 2015) and which include the following.

- detailed surficial geology map
- Open File Report
- digital data release

These products will provide a review of the Quaternary deposits, glacial history and an interpretation of the geochemical and indicator mineral results from all analytical work.

AMBIENT GROUNDWATER GEOCHEMISTRY PROGRAM

Sudbury Area

"The Ambient Groundwater Geochemistry Program (AGGP) was introduced in 2007 to provide a high-quality characterization of groundwater geochemistry across Ontario and to delineate natural trends that may affect usability of the groundwater resource (Hamilton, Brauneder and Mellor 2007). "

The groundwater geochemical mapping study completed in 2016 in the Sudbury and surrounding area is the first AGGP component in northern Ontario (Dell, Fudge and Hamilton 2016).

The objectives of the 2016 study were

- to expand on the existing AGGP database and continue the ongoing water-quality mapping of major bedrock and overburden units;
- to conduct a geochemical groundwater comparison of Precambrian Shield aquifers with the Paleozoic sedimentary rock aquifers in southern Ontario; and
- to test the methodology and potential for sampling radiological and radiochemical parameters, including radon and gross alpha-particle and gross beta-particle activity concentrations.

OGS DATA RELEASE

The following section provides a brief description of data released in 2016 by the OGS, that may be of interest to anyone working in the Sudbury District area, as Miscellaneous Release—Data (MRD) and databases which are available for download from the Geology Ontario online application: http://www.geologyontario.mndm.gov.on.ca/.

Nipissing Gabbro Intrusion Geochemistry, Sudbury Area

> This digital release, MRD 336 (Jobin–Bevins 2016), contains whole-rock geochemical data and assay data; field photographs, photomicrographs and back-scatter electron microscope images; and a summary of the project results. All these data were collected as part of a study of platinum group element mineralization in Nipissing gabbro intrusions in the Southern Province in and around Sudbury, Ontario, between September 1996 and May 2004. This project (Project Unit 97-012) was a collaborative effort between the Ontario Geological Survey, the Department [Harquail School] of Earth Sciences at Laurentian University in Sudbury and the Department of Earth Sciences at the University of Western Ontario in London, Ontario, in support of a PhD thesis study by the author (Jobin–Bevans 2004).
>
> This release comprises 104 images (as .jpg files), 2 Microsoft® Excel® 2010 (*.xlsx*) workbook files and 6 documents in portable document format (*.pdf*). The data are organized into 3 folders: Geochemistry, Photographs, Presentations and Publications.

The description of this data release was taken *from* Ontario Geological Survey, Release Notice June 7, 2016 at http://www.mndm.gov.on.ca/, MNDM | NEWS | MINES and MINERALS | ONTARIO GEOLOGICAL SURVEY PUBLICATIONS RELEASE NOTICE | JUNE 7, 2016.

Nepewassi Area, Central Gneiss Belt, Grenville Province

> This digital release, MRD 338 (Van de Kerckhove and Easton 2016), contains a geological map, a station location map, field notes, outcrop photographs, whole rock geochemical data, and magnetic susceptibility and scintillometer data collected as part of the Nepewassi mapping project (Project Unit 13-029) between June 2013 and September 2015, and related publications by the authors.
>
> The Nepewassi mapping project was undertaken to improve our understanding of the Nepewassi domain of the Central Gneiss Belt of the Grenville Province. The project area is located to the west of Lake Nipissing, and consists of a regional study area, bounded by latitudes 46°05′N to 46°27′N and longitudes 80°05′W to 80°30′W, and a detailed study area, bounded by latitudes 46°11′N to 46°19′N and longitudes 80°11′W to 80°26′W. S.R. Van De Kerckhove worked in the regional study area in 2013, but spent most of the 2014 field season mapping in the detailed study area as part of the requirements of an MSc thesis study at the Department of Earth Sciences at Dalhousie University in Halifax, Nova Scotia (Culshaw, Van De Kerckhove and Jamieson 2013; Van De Kerckhove 2014, 2015). R.M. Easton mapped in the regional study area in 2014 (Easton 2014). This digital data release contains all the data collected as part of both studies.
>
> This release comprises 492 images (as *.jpg* files), 6 Microsoft® Excel® 2010 (*.xlsx*) workbook files and 12 documents in portable document format (*.pdf*). The data are organized into 6 folders: Field Data, Geochemistry, Geology, Geophysics, Photographs, Publications.

The description of this data release was taken *from* Ontario Geological Survey, Release Notice August 9, 2016, http://www.mndm.gov.on.ca/, MNDM | NEWS | MINES and MINERALS | ONTARIO GEOLOGICAL SURVEY PUBLICATIONS RELEASE NOTICE | AUGUST 9, 2016.

Mineral Deposit Inventory Database, MDI—2016

This database is an inventory of mineral deposits in the province of Ontario and supersedes previous MDI releases. The publication can be downloaded from: http://www.geologyontario.mndm.gov.on.ca/.

> Originally compiled in the early 1970s by the Resident Geologist Program (RGP), the database is continually being reviewed and updated by RGP staff. There are 49 new records, 714 updated records and a total of 19 179 records in the 2016 MDI database (Ontario Geological Survey 2016a).
>
> Each MDI record provides all or some of the following information: deposit name(s), location, status (e.g., occurrence, prospect, producer, past producer), commodities, character/classification, geological structure, lithology, minerals and mineral alteration, geochemistry, exploration history, and production and reserve data where available. Also included are notes on deposit visits and references to additional publications related to the deposit.
>
> The compressed (*.zip*) download file provides MDI data in 2 formats: 1) a relational database, and 2) MDI provincial coverage in a geospatial GIS (ESRI® shape file) format. The complete MDI relational database is provided in Microsoft® Access® 2010 (*.mdb*) format. For the geospatial data, basic mineral deposit information (MDI number, commodities and property status) is provided. Geospatial data are provided in North American Datum 1983 (NAD83) geographic co-ordinate system using Geodetic Reference System 1980 (GRS80).

The description of this database update was taken *from* Ontario Geological Survey, Release Notice April 5, 2016, http://www.mndm.gov.on.ca/, MNDM | NEWS | MINES and MINERALS | ONTARIO GEOLOGICAL SURVEY PUBLICATIONS RELEASE NOTICE | APRIL 5, 2016.

Aggregate Resources of Ontario, ARO—2015

This new database provides data in GIS-format of aggregate resources that have been compiled for the Province of Ontario. This publication can be downloaded from: http://www.geologyontario.mndm.gov.on.ca/ and as well from OGSEarth (www.ontario.ca/ogsearth).

> This compilation is based on data compiled from aggregate resources inventory mapping conducted by the OGS from 1980 to 2015. It is intended that this compilation will be updated annually. This compilation includes data updated from the previously published information and may include newer geological data and/or mapping, where the latter are available (Ontario Geological Survey 2016b).
>
> It is important to note that this compilation is not intended to be used as a standalone product and the referenced original reports should always be consulted in conjunction with this compilation. Information contained within the referenced original reports (i.e., test results, resource properties and potential) is still highly relevant. However, it is possible that resource estimates provided in the referenced original reports may no longer be accurate, and may not reflect the data contained in this compilation. It must also be noted that, although the data represented in this compilation have been modified and updated since the release of the previously published information, the referenced original publications have not been revised to incorporate these changes.
>
> The compressed (*.zip*) download file provides ARO—2015 data in geodatabase format using ESRI® ArcGIS® 9.3.1 with a completed project file (*.mxd*). Geospatial data are provided in North American Datum 1983 (NAD83) geographic co-ordinate system using decimal degrees. A user document and readme file that explains the GIS content is provided.

The description of this new compilation was taken *from* Ontario Geological Survey, Release Notice February 9, 2016, http://www.mndm.gov.on.ca/, MNDM | NEWS | MINES and MINERALS | ONTARIO GEOLOGICAL SURVEY PUBLICATIONS RELEASE NOTICE | February 9, 2016.

Academia, Research and Publications

LAURENTIAN UNIVERSITY

Department of Earth Sciences and MERC (Mineral Exploration Research Centre)

On September 6th, 2016, Laurentian University benefited from 2 funding announcements. Mining entrepreneur David Harquail announced a donation of $10 million to Laurentian University's Department of Earth Sciences and its Mineral Exploration Research Centre (MERC) through the family Midas Touch Foundation. The department has been named the Harquail School of Earth Sciences in recognition of the contribution from the Franco–Nevada Corporation chief executive officer and his family (*Sudbury Star*, September 06, 2013).

The second announcement came from the federal government with an investment of almost $49.3 million in the Metal Earth project at the university. Another $55 million in cash and in-kind donations had already been made to Laurentian for Metal Earth.

> Metal Earth is a Canadian $104 million applied R&D program led by Laurentian University. With funding from the Canada First Research Excellence Fund and federal/provincial/industry partners, this initiative will be a strategic consortium of outstanding Canadian researchers from academia and allied Canadian and international research centres, government, and industry. (http://merc.laurentian.ca/metalearth [accessed February 13, 2017])

The Metal Earth project will involve research from Laurentian and other universities. It is expected to fund 35 post-doctoral fellows, research assistants, technicians and support staff. Graduate and

undergraduate students will be employed through the project, as well as several subcontractors will also be employed.

What the university calls "an unprecedented investment in research that will help the mineral industry lower the risk of exploration investing in Canada and abroad… will also reverse current lower discovery rates of new mineral deposits." (*Sudbury Star*, September 06, 2013).

> "Metal Earth will transform our understanding of the genesis of base and precious metal deposits during Earth's evolution. It will make Canada a world leader in metal endowment research and world-class innovator through open source delivery of new knowledge and the implementation of new technology." (http://merc.laurentian.ca/metalearth [accessed February 13, 2017])

Research

Current Research Funding

Lesher, C.M., Geochemistry, Mineralogy, and Petrogenesis of Ultramafic Inclusions in Sublayer Norite, Sudbury Igneous Complex (with Wang and Lightfoot), China Scholarship Council and NSERC Discovery.

Lesher, C.M., Contact Metamorphism and Anatexis in the Footwall Aureole of the Sudbury Igneous Complex (Jorgensen and Tinkham), CEMI and NSERC Discovery.

Lesher, C.M., Geology, Mineralogy, Geochemistry, and Petrogenesis of the South Range Melanorite and Implications for the Crystallization History of the Sudbury Igneous Complex (with Strongman, Walker, Baird, Lightfoot, Golightly and Pattison), NSERC Discovery.

McDonald. A.M., The mineralogy of sulphide ores from the North Range, Sudbury Basin (with Keays, Gauld, L.U. and L. Cochrane, Thompson, and Vale).

Post Doctoral Fellows

Petrus, J., Development of laser ablation analytical methods in surficial geochemical mineral exploration/Sudbury Impact mineral chemistry (Supervisor: Dr. M. Leybourne).

PhD Candidates

Généreux, C-A., Structural and metamorphic evolution of the South Range in the Drury and Denison townships, Sudbury, with emphasis on the controls on low-sulphide PGE mineralization. Supervisors: Dr. B. Lafrance and Dr. D. Tinkham.

Hashmi, S., Surficial mapping and geochemical and mineralogical characterization of Ni-Cu-PGE mineralization in the Denison and Drury townships. Supervisors: Dr. M. Leybourne, Dr. A. Bajc, Dr. S. Hamilton.

Hechler, J., Geochemistry of Sudbury mine tailings, Supervisor: Dr. G. Spiers, Committee: Dr. M. Schindler, Dr. F. Caron and Dr. M. Burnham.

Jorgensen, T., Evolution of the Sudbury Igneous Complex Contact Metamorphic Aureole and Controls on Anatexis. Supervisors: Dr. D. Tinkham and Dr. M. Lesher.

Olaniyan, O., Sudbury Basin Structural Investigation. Supervisor: Dr. R.Smith.

Stewart, C., Characterization of the Nature and Origin of Different Alteration Types in the Sudbury Structure, Sudbury, Ontario. Supervisor: Dr. D. Kontak.

Wang, Y., Mineralogy, Geochemistry, and Petrogenesis of Ultramafic Inclusions in Sublayer Norite, Sudbury, Ontario. Supervisors: Dr. M. Lesher and Dr. P. Lightfoot.

MSc Candidates

Enright, J., A Study of Footwall Alteration at the Victor deposit, Sudbury. Supervisors: Dr. A. McDonald and Dr. D. Kontak.

Hall, M., Emplacement Mechanisms and Spatial and Temporal Relationships Between Low Sulfide and Sharp Walled Vein Systems in Footwall Cu-Ni-PGE deposit at the Broken Hammer deposit, Sudbury, Supervisors: Dr. B. Lafrance and Dr. H. Gibson.

Huggins, Jacqueline, Geophysical and geochemical property measurements in drill core, Victoria property, Sudbury, Ontario. Supervisors: Dr. R. Smith and Dr. D. Tinkham.

Ladan Kamiri Sharif, Application of the cross-hole radio imaging method in detecting geological anomalies, MacLennan township, Sudbury Ontario. Supervisor: Dr. R. Smith.

MacInnis, L., Characterization of sharp-wall type footwall Cu-Ni-PGE mineralization at the Podolsky deposit, Sudbury, Ontario. Supervisor: Dr. D. Kontak.

Parry, D., (M.Sc. candidate),). A comparative study of physical property measurements collected around the Sudbury basin. Supervisor: Dr. R. Smith.

BSc Theses

Schmidt, M., Using the geochemistry of tree cores from Sudbury to determine pre-anthropogenic signals as a guide to mineral exploration. Supervisor: Dr. M. Leybourne.

Publications

Petrus, J. A., Kenny, G. G., Ayer, J. A., Lightfoot, P. C., and Kamber, B. S. (2016). Uranium–lead zircon systematics in the Sudbury impact crater-fill: implications for target lithologies and crater evolution; Journal of the Geological Society, 173(1), p.59-75.

Schindler, M., Lanteigne, S., McDonald, A. M. and Hochella, M. F. Jr. (2016) Evidence of Cu- and Ni-Bearing Surface Precipitates and Adsorption Complexes *in* Remediated Soils At the Nanoscale: A TEM, Micro-Raman, and Laser-Ablation ICP–MS Study of Mineral Surface Coatings; The Canadian Mineralogist v.54 p.285-309.

TRINITY COLLEGE (DUBLIN)

Research

PhD Candidates

Kenny, G. (PhD candidate), meteorite impact melt sheets as a potential source for Hadean zircon: employing the analogous 1.85 Ga Sudbury impact melt sheet, Supervisor: Dr. B. Kamber.

MSc Candidates

Guyett, P. (MSc candidate), magma evolution reconstructed from the volcanic fill of the Sudbury Basin, Supervisor: Dr. B. Kamber.

O'Sullivan, E. (MSc candidate), chemostratigraphy of the Sudbury impact basin fill (most notably the occurrence of C in the Onaping formation), Supervisor: Dr. B. Kamber.

Publications

Kenny, G.G., Whitehouse, M.J. and Kamber, B.S. 2016. Differentiated impact melt sheets may be a potential source of Hadean detrital zircon, Geology, v.44, no.6, p.435-438.

O'Sullivan, E.M., Goodhue, R., Ames, D.E. and Kamber, B. S. 2016. Chemostratigraphy of the Sudbury impact basin fill: Volatile metal loss and post-impact evolution of a submarine impact basin; Geochimica et Cosmochimica Acta v.183, p.198–233.

UNIVERSITY OF TORONTO

Research

Dr. Henry Halls, Emeritus Professor, is currently researching the paleomagnetism of the River Valley anorthosite (with Alan Lovette).

Dr. Jim Mungall, Associate Professor, is currently conducting both field-based studies of magmatic ore deposits and laboratory investigations as well as theoretical or modelling-based approaches to better understanding of the chemical and physical controls on their formation. The field component of the research program is mainly devoted to study of intrusion-hosted Ni-Cu-PGE-Cr deposit systems including the Sudbury Igneous Complex.

Dr. Bernd Milkereit, Professor, has numerous ongoing research projects including a focus on unique stress-temperature conditions related to meteorite impacts (Bosumtwi, Ghana; Sudbury, Canada), and in-mine geophysics (Sudbury).

THE UNIVERSITY OF WESTERN ONTARIO

Research

Anders, D. (2016). The Sudbury Impact Structure - New Insights Into the Origin and Emplacement of the Basal Onaping Intrusion and the Parkin, Trill and Foy Offset Dykes of the North Range. University of Western Ontario. Ph.D. Thesis Dissertation, (Supervisor: G. Osinski). 261p.

Publications

O'Callaghan J. W., Osinski G. R., Lightfoot P. C., Linnen R. L. and Weirich J. R. (2016). Reconstructing the geochemical signature of Sudbury Breccia, Ontario, Canada: Implications for its formation and trace metal content. Economic Geology, v. 111, p.1705-1729.

Osinski G. R., Grieve R. A. F., Chanou A., and Sapers H. M. (2016). The "suevite" conundrum, Part 1: The Ries suevite and Sudbury Onaping Formation compared. Meteoritics & Planetary Science (Accepted July 24 2016).

THE UNIVERSITY OF WINSDOR

Publications

Yurtseven-Sandker, A. and Cioppa, M.T. (2016). Magnetic susceptibility mapping of the Sudbury area, Ontario, Canada: evaluating pollution distributions decades later; Canadian Journal of Earth Sciences, v.53 p.466-484.

WILFRED LAURIER UNIVERSITY

Research

Jones, J. 2016. Spanish River carbonatite: Its benefits and potential use as a soil supplement in agriculture. MSc Theses and Dissertations (Comprehensive). Paper 1795, 111 p.

OTHER PUBLICATIONS

Lightfoot, P.C. 2016. Nickel sulfide ores and impact melts, origin of the Sudbury Igneous Complex. Elsevier, 606p.

RECENT OGS PUBLICATIONS

A selection of 2016 publications focused on areas within the Sudbury District is listed in Table 31. In addition, the Sudbury District Geologist Office receives copies of the *Canadian Mining Journal*, *The Northern Miner*, *Nickel*, *The Canadian and American Mines Handbook*, *Sudbury Mining Solutions Journal* and the Prospectors and Developers Association of Canada's *In Brief* newsletter and *CORE* magazine.

Table 31. A selection of publications received by the Sudbury District Geologist Office in 2016.

Title	Author(s)	Type and Year of Publication
Report of Activities 2015, Resident Geologist Program, Red Lake Regional Resident Geologist Report: Red Lake and Kenora Districts	Lichtblau, A.F., Ravnaas, C., Storey, C.C., Tuomi, R.D., Tims, A., Debicki, R.L., Pettigrew, T.K., Paju, G.F. and Wetendorf, J.	Ontario Geological Survey, Open File Report 6314, 130p., 2016
Report of Activities 2015, Resident Geologist Program, Thunder Bay North Regional Resident Geologist Report: Thunder Bay North District	White, G.D., Cundari, R.M., Brunelle, M.R., Pettigrew, T.K., Tuomi, R.D., Tims, A. and Debicki, R.L.	Ontario Geological Survey, Open File Report 6315, 68p., 2016
Report of Activities 2015, Resident Geologist Program, Thunder Bay South Regional Resident Geologist Report: Thunder Bay South District	Puumala, M.A., Campbell, D.A., Tuomi, R.D., Tims, A., Debicki, R.L., Pettigrew, T.K. and Brunelle, M.R.	Ontario Geological Survey, Open File Report 6316, 85p., 2016
Report of Activities 2015, Resident Geologist Program, Timmins Regional Resident Geologist Report: Timmins and Sault Ste. Marie Districts	van Hees, E., Bousquet, P., Pace, A., Daniels, C.M., Debicki, R.L., Wilson, A.C., Beauchamp, S.A., and Walmsley, J.	Ontario Geological Survey, Open File Report 6317, 91p., 2016
Report of Activities 2015, Resident Geologist Program, Kirkland Lake Regional Resident Geologist Report: Kirkland Lake and Sudbury Districts	Guindon, D.L., Farrow, D.G., Hall, L.A.F., Daniels, C.M., Debicki, R.L., Wilson, A.C., and Sabiri, N.	Ontario Geological Survey, Open File Report 6318, 106p., 2016
Report of Activities 2015, Resident Geologist Program, Southern Ontario Regional Resident Geologist Report: Southeastern Ontario and Southwestern Ontario Districts, and Petroleum Operations	Sangster, P.J., LeBaron, P.S., Charbonneau, S.J., Laidlaw, D.A., Debicki, R.L., Wilson, A.C. and Fortner, L.	Ontario Geological Survey, Open File Report 6319, 65p., 2016
Summary of Field Work and Other Activities 2016	Ontario Geological Survey	Ontario Geological Survey, Open File Report 6323, 408p., 2016
A Library of Standards for Rock Names, Rock Modifiers and Terms Related to Structure, Alteration, Mineralization and Minerals for Precambrian Rocks in Ontario	Muir, T.L., Buse, S., Trowell, N.F. and Duguet, M.	Ontario Geological Survey, Open File Report 6289, 204p., 2016

REGIONAL LAND USE GEOLOGIST ACTIVITIES—NORTHEAST REGION

The activities of the Regional Land Use Geologist are described *in* "Regional Land Use Geologist Activities—Northeast Region" in the Kirkland Lake District report of this volume.

MINERAL DEPOSIT COMPILATION GEOLOGIST—NORTHEASTERN ONTARIO

The activities of the Mineral Deposit Compilation Geologist are described *in* "Mineral Deposit Compilation Geologist—Northeastern Ontario" in the Kirkland Lake District report of this volume.

ACKNOWLEDGMENTS

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Dell, K.M., Fudge, S.P. and Hamilton, S.M. 2016. The ambient groundwater geochemistry Program: Sudbury Area; *in* Summary of Field Work and Other Activities, 2016, Ontario Geological Survey, Open File Report 6323, p.32-1 to 32-11.

Gates, B.I. 1991. Sudbury mineral occurrence study; Ontario Geological Survey, Open File Report 5771, 235p.

Généreux, C-A., Lafrance, B., Simard, R-L. and Gordon, C.A. 2016. Mylonite zone and regional deformation in Drury Township, Southwest Sudbury Structure: An Overview; *in* Summary of Field Work and Other Activities, 2016, Ontario Geological Survey, Open File Report 6323, p.19-1 to 19-9.

Gibson, A., Lightfoot, P.C. and Evans, T.C. 2010. Contrasting styles of low sulphide–high precious metal mineralisation in the 148 and 109 FW zones: North and South ranges of the Sudbury Igneous Complex, Ontario, Canada; *in* Abstracts, 11th International Platinum Symposium, 21-24 June 2010, Sudbury, Ontario, Canada, Jugo, P.J., Lesher, C.M. and Mungall, J.E. (eds.), Ontario Geological Survey, Miscellaneous Release—Data 269.

Glencore PLC 2017a. Resource and Reserves as of 31 December 2016. 65p. (http://www.glencore.com: | Investors | Reports and Results | Reserves & Resources | 2016 Reserves and Resources Report [accessed February 08, 2017]).

———2017b. Production Report for the 12 months ended 31 December 2016. 19p. (http://www.glencore.com: | Investors | Reports and Results | Reports | Glencore | 2016 | Production Report for the 12 months ended 31 December 2016 [accessed February 08, 2017]).

Hamilton, S.M., Brauneder, K. and Mellor, K.J. 2007. The ambient groundwater geochemistry project – southwestern Ontario; *in* Summary of Field Work and Other Activities 2007, Ontario Geological Survey, Open File Report 6213, p.23-1 to 23-5.

Hashmi, S. 2015. Quaternary geology and geochemical and mineralogical signature of surficial media in Drury and Denison townships, City of Greater Sudbury; *in* Summary of Field Work and Other Activities 2015, Ontario Geological Survey, Open File Report 6313, p.29-1 to 29-7.

Hashmi, S. 2016. Quaternary geology, Drury and Denison townships; Ontario Geological Survey, Preliminary Map P.3801, scale 1:20 000.

Inventus Mining Corporation 2016. Interim Management's Discussion & Analysis – Quarterly Highlights. For the Three and Nine Months Ended September 30, 2016. dated: November 15 2016, 13p. (http://www.inventusmining.com: | Investors | Financials | 2016 | September 30th | MD&A [accessed February 08, 2017]).

Jobin–Bevans, L.S. 2016. Geochemical data related to a study of platinum group element mineralization in Nipissing gabbro intrusions and the River Valley Intrusion, Sudbury Region, Southern Ontario; Ontario Geological Survey, Miscellaneous Release—Data 336.

KGHM 2015. KGHM Mineral Resource and Reserve Report as at December 31, 2014. 40p. (http://kghm.com/en | Investors | Reports and presentations | Regulatory Filings | 2015 | 25-06-2015 [accessed February 08, 2017]).

———2016a. KGHM Annual report R 2015 for the financial year 2015 comprising the period from 1 January 2015 to 31 December 2015. 177p. (http://kghm.com/en | Investors | Reports and presentations | Financial Reports | 2015 | 17-03-2016 Annual Financial Statments [accessed February 08, 2017]).

———2016b. KGHM Integrated Report 2015. 88p. (http://kghm.com/en | Investors | Reports and presentations | Annual Reports.| Annual Report 2015 [accessed February 08, 2017].

———2016c. KGHM Consolidated quarterly report QSr 1 / 2016. 52p. (http://kghm.com/en | Investors | Reports and presentations | Financial Reports | 2016 | 13-05-2016 Consolidated report 1st quarter 2016 [accessed February 08, 2017]).

———2016d. KGHM Consolidated half-year report PSr 2016. 97p. (http://kghm.com/en | Investors | Reports and presentations | Financial Reports | 2016 | 17-08-2016 Consolidated half-year report PSr 2016 [accessed February 08, 2017]).

———2016e. KGHM Consolidated quarterly report QSr 3/2016 . 59p. (http://kghm.com/en | Investors | Reports and presentations | Financial Reports | 2016 | 09-11-2019 Consolidated quarterly report QSr 3/2016 [accessed February 08, 2017]).

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Metric Conversion Table

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm^3	0.061 023	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.307 951	cubic yards	1 cubic yard	0.764 554 86	m^3
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 962	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 747	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 622 6	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton(short)	**907.184 74**	kg
1 t	1.102 311 3	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 9**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy) / ton (short)	1 ounce (troy) / ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights / ton (short)	1 pennyweight / ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

	Multiplied by	
1 ounce (troy) per ton (short)	31.103 477	grams per ton (short)
1 gram per ton (short)	0.032 151	ounces (troy) per ton (short)
1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

*Note: Conversion factors in **bold** type are exact. The conversion factors have been taken from or have been derived from factors given in the* Metric Practice Guide for the Canadian Mining and Metallurgical Industries, *published by the Mining Association of Canada in co-operation with the Coal Association of Canada.*

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